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JOURNAL OF THE SOCIETY OF ARTS.

No. 1,200.] FRIDAY, NOVEMBER 19, 1875. [Vol. XXIV.

ONE HUNDRED AND TWENTY-SECOND SESSION, 1875-76.

Arrangements for the Session.

Evening Meetings of the Society will be held on the following dates, subject to any alterations which may be found necessary :—

	CANTOR LECTURES.				AFRICAN MEETINGS.				ORDINARY MEETINGS.					INDIAN MEETINGS.				CHEMICAL MEETINGS.				SPECIAL LECTURES.			
	Mondays.				Tuesdays.				Wednesdays.					Fridays.											
1875.																									
November	—	—	22	29	—	—	—	—	—	—	17	24	—	—	—	—	—	—	—	—	—	—	—	—	—
December..	6	13	20	—	—	—	—	—	1	8	15	22	—	—	—	—	—	—	—	—	—	3	10	17	—
1876.																									
January ..	—	17	24	31	—	—	—	25	—	—	19	26	—	—	—	—	—	—	—	—	—	—	—	21	28
February..	7	14	21	—	—	—	15	—	2	9	16	23	—	—	—	18	—	—	11	—	25	4	—	—	—
March	6	—	20	27	—	14	—	28	1	8	15	22	29	3	—	—	24	—	17	—	31	—	—	—	—
April	3	—	—	24	—	—	18	—	5	—	19	26	—	7	—	—	28	—	—	21	—	—	—	—	—
May......	1	—	—	—	—	9	—	—	3	10	17	24	31	—	—	19	—	—	—	12	—	—	—	—	—

The Chair will be taken at Eight o'clock at each of the above Meetings.

The Annual General Meeting will be held on June 28th, 1876, at four o'clock.

At the Evening Meetings during the ensuing Session, papers on subjects relating to inventions, improvements, discoveries, and other matters connected with the Arts, Manufactures, and Commerce of the country, will be read and discussed.

Ordinary Meetings of the Society.

November 17.—Opening Address by Lord Alfred S. Churchill, *Chairman of the Council.*

November 24.—"On the Registration of Trade Marks," by H. T. Wood, Esq., B.A.

December 1.—"On the Legislative Enactments requisite for Safe Conduct of Sewage Grounds," by Alfred Smee, Esq., F.R.S.

December 8.—"On the Mode of Levying the Sugar Duties in France, and its Influence on the Sugar Industries of Great Britain," by Professor Leone Levi, F.S.S., &c.

December 15.—"On Health, Comfort, and Cleanliness in the House," by Thos. Blashill, Esq., A.R.I.B.A.

December 22.—"On a method of producing Pure Charcoal Steel directly from the Ore," by Henry Larkin, Esq.

Sectional Meetings.

The Indian, African, and Chemical Sections will each hold Meetings during the Session. The dates for these Meetings are given in the calendar on the first page, and the subjects will be announced in the *Journal.*

Cantor Lectures.

Three Courses of Cantor Lectures will be delivered during the Session.

The first, by Dr. Thudichum, "On the Discoveries and Philosophy of Liebig—with special reference to their influence upon the advancement of Arts, Manufactures, and Commerce."

The second, by W. Mattieu Williams, Esq., "On Steel Manufacture."

The third, by George Jarmain, Esq., "On Wool Dyeing."

The second and third courses have been arranged with special reference to the Society's Technological Examinations.

Special Lectures.

A series of reports has been prepared by Dr. Richardson, appointed by the Council to make special inquiry into the subject of "Unhealthy Trades." These will be delivered in the form of Lectures on Friday Evenings in December, January, and February.

Juvenile Lectures.

Two Lectures, addressed to the Children of Members, will be delivered during the Christmas Holidays.

Examinations.

Examinations will be held in Commercial Knowledge, in the Technology of various Arts and Manufactures, in Domestic and Sanitary Science, and in Fine Art applied to Industry. Programmes may be obtained on application.

National Training School for Music.

The Society will continue during the Session its action in aid of the establishment of a National Training School for Music and the Foundation of Free Scholarships as a means of carrying on its work.

Conversazione.

The Annual Conversazione will be held at the close of the Session.

Journal.

The Society's Weekly *Journal* contains Reports of the various Papers, Lectures, Discussions, and Proceedings of the Society, and other information connected with Arts, Manufactures, and Commerce.

The Society of Arts

Was founded in 1754, and incorporated by Royal Charter in 1847, for "The Encouragement of the Arts, Manufactures, and Commerce of the Country, by bestowing rewards for such productions, inventions, or improvements as tend to the employment of the poor, to the increase of trade, and to the riches and honour of the kingdom: and for meritorious works in the various departments of the Fine Arts; for Discoveries, Inventions, and Improvements in Agriculture, Chemistry, Mechanics, Manufactures, and other Useful Arts; for the application of such natural and artificial products, whether of Home, Colonial, or Foreign growth and manufacture, as may appear likely to afford fresh objects of industry, and to increase the trade of the realm by extending the sphere of British Commerce, and generally to assist in the advancement, development, and practical application of every department of science in connection with the Arts, Manufactures, and Commerce of this country."

One of the most important means by which these objects were promoted was the establishment of the great International Exhibitions of Industry, which, as is well known, were instituted by the Society. These brought into view the necessity of providing an improved General, Scientific, and Technical Education for those engaged in industry, if the manufactures of the country were to be successfully carried on in competition with its foreign rivals.

In furtherance of this object the Society established, nearly twenty years ago, a system of Examinations for Artisans and members of Mechanics' Institutions, and this, in a very few years, led to the establishment of the Oxford and Cambridge Middle-class Examinations and others of a similar kind, all contributing to show the importance of better and more systematic teaching. Scientific instruction is now regarded as a necessary adjunct to general education. To this end the Government of the country is seeking to promote scientific training, while the great centres of industry are establishing schools and colleges for the same purpose. The Society rejoices to see such results attained, and such efforts made. But it must be borne in mind that before all this was brought about the public at large had to learn that, if the industries of the country were to be carried on successfully in the future, education was a necessity, and that education to be efficient and of value must reach all classes, and be general, artistic, scientific, and technical. It has been the business of this Society, during the last twenty years, to act the part of schoolmaster in this great work. When it first took up this position, it was looked upon as interfering with a matter entirely beyond its province. It persevered, however, and established the examinations already referred to, and it is at present carrying on a system of Technological Examinations, in conjunction with the Government Department of Science and Art. In the last century the Society encouraged Art long before a Royal Academy or any Schools of Design existed, and in more recent years it created Exhibitions of Industrial Art and Art Workmanship for the promotion of superior skill in the production of Art Manufactures. It is thus engaged in fostering the acquisition of Technical Knowledge, by which it hopes to induce a better and more extended acquaintance with the scientific principles upon which the manufactures of the country are based. In short, the work of the Society has been to promote and advance such objects as were at the time not generally known or adequately appreciated by the public, and thus to act as a pioneer in the industrial and social progress of the country.

That the efforts of the Society have been appreciated is evidenced by the support which has been received, but the Council still ask for an Endowment Fund to secure increased efficiency under all the adverse circumstances which surround a Society dependent for its daily existence upon the voluntary support of its members. The first commercial crisis that occurs may diminish its income and cripple its many forms of usefulness, and it is for the purpose of placing it in a position to secure permanently the services of an efficient staff of scientific men as guides and teachers that it asks for this Endowment Fund, by means of which their adequate remuneration may at all times be secured.

PROCEEDINGS OF THE SOCIETY.

THE JOURNAL.

Members will notice that the present *Journal* is sent to them unstitched. The reason of the change is this. By the Post-office rules no publication which is stitched can be sent by newspaper post. Hitherto the *Journal* has been transmitted by the ordinary book post. The increased number of meetings during the Session frequently necessitates the production of a *Journal* too large to be carried by the book post for a halfpenny, and the additional charges for postage during last Session were consequently very heavy. In future the *Journal* will be treated as a newspaper, and to enable this advantage to be secured it is necessary to omit the stitching used to hold the pages together.

FIRST ORDINARY MEETING.

Wednesday, November 17th, 1875; Lord Alfred S. Churchill, Chairman of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Ames, George Acland, Union Club, S.W.
Archer, David, Arden-lodge, Adderley-park, Birmingham.
Arnott, George Washington, F.C.S., Bramshill, Harlesden-green, N.W.
Bateman, James, F.R.S., 9, Hyde-park-gate South, S.W.
Bay, Edwin, King's-parade, Cambridge.
Beavis, Richard, 38, Fitzroy-square, W.
Berthon, Rev. E. L., M.A., F.R.A.S., Romsey, Hants.
Beynon, Thomas, J.P., Richmond-house, Newport, Monmouthshire.
Borrajo, Joseph, 40, Richmond-road, Dalston, E.
Brock, Walter, Engine Works, Dumbarton.
Brown, G. C. Herbert, 64, Belsize-park, N.W.
Browne, Newnham, 91, Queen-street, Cheapside, E.C.
Burton, Captain R., Athenæum Club, S.W.
Carmichael, Peter, Arthurstone, Meicle, N.B.
Chinnery, Gerard Thomas, Elm-side, Grove-park, Chiswick, W.
Churchill, Lord Edward S., Bartley Manor-house, Totton, Hants.
Constantine, T. J., 61, Fleet-street, E.C., and 19, Downs-park-road, West Hackney, E.
Court, Stephen, 145, Cheapside, E.C.
Covington, Rev. William, M.A., St. Luke's Vicarage, Shepherd's-bush, W.
Cucksey, Thomas, 39, Railton-road, Brixton, S.W.
Currie, Donald, 13, Hyde-park-place, W., and Cluny, Aberfeldy, Perthshire.
Dale, John (Messrs. Roberts, Dale, and Co.), Cornbrook, Manchester.
Davis, James, 20, Brondesbury-road, Kilburn, N.W.
Eversley, Viscount, 114, Eaton-square, S.W., and Heckfield-place, Winchfield, Hants.
Ewart, William Quartus, Glenmachan-house, Belfast.
Fitch, Reuben A., 31, Lancaster-gate, Hyde-park, W.
Fitz Rayne, William Allen, 134, Tooley-street, S.E.
Gayfer, William, M.A., Middle Class School, Bromley-common, Kent.
Grant, Miss Maria M., 19, Eaton-place South, S.W.
Griffin, John, Dunster-house, Mincing-lane, E.C.
Grant, John, Grampion-lodge, Putney, S.W.
Harding, Horace W., 7, Foster-lane, Cheapside, E.C.
Hazard, Rowland R., 117, Piccadilly, W.
Henigan, Richard, C.E., 63, St. Andrew's-road, Southampton.
Hunt, Frederick, W., 27, Upper Baker-street, N.W.
Jamieson, John L. K., Mansion-house, Govan, N.B.
Jepson, William, Surveyor's Office, Heaton Norris, Lancashire.
Johnson, Thomas Lewis, C.E., Worcester-villa, Roath, Cardiff.
Johnston, Andrew, 158, Leadenhall-street, E.C.
Jones, E. W. T., F.C.S., 10, Victoria-street, Wolverhampton.
Just, Edward L., 5, Newman's-court, Cornhill, E.C.
Kenworthy, E., Borough Surveyor's Office, Barnsley.
Leighton, Robert, 16, New-street-square, E.C.
Leon, H. de, M.D., 26, Redcliffe-gardens, S.W.
Lewis, Henry, Springfield-house, West Bromwich.
Lynam, C., Stoke-upon-Trent.
Macdowall, G., 3, King-street, Cheapside, E.C.
Macleay, Sir George, Pendell-court, Bletchingley.
Marshall, Reginald D., Cockridge-hall, Leeds.
Marshall, Thomas Beirell, 6a, Rossuth-terrace, Victoria-park, E.
Milman, Rev. William Henry, M.A., 15, Cornwall-gardens, S.W.
Mylrea, F. Garland, 41, Redcliffe-gardens, S.W.
Nicholsen, Thomas, 10, Portland-street, Southampton.
Parry, Henry Richard, M.D., 29, Maida-hill, Burnley, Lancashire.
Proctor, J., Borough Engineer's Office, Bolton.
Roberts, Rev. J. Seed, Calabar, Kingston, Jamaica.
Robertson, Stewart, 89, Granville-park, Blackheath, S.E.
Rodgers, Samuel, Wath, near Rotherham.
Rogers, John R., Surveyor to the Local Board, Hornsey, N.
Rolls, J. Gouldsmith, 79, Coleman-street, E.C.
Russell, Philip, Palace Hotel, Buckingham-gate, S.W.
Savary, W. J. Holgate, 39, Lombard-street, E.C.
Sayer, Charles James, M.A., 6, Brondesbury-villas, Kilburn, N.W.
Schenley, Edward, 14, Prince's-gate, S.W.
Shaw, G., Rosstrevor Quay, Co. Down, Ireland, and 7, Garrick-street, Covent-garden, W.C.
Shute, Walter Thomas, 12, Langham-street, W.
Smith, Sidney, 1, Furnival's-inn, E.C., and Rutland-house, Quex-road, Kilburn, N.W.
Stableford, William, Broadwell-house, Oldbury, near Birmingham.
Stockwell, John Alfred, Sussex-house, High-road, Lee, S.E.
Storrar, John, M.D., 7, Southampton-street, Bloomsbury-square, W.C.
Taplin, Thomas, Knutton, Mount-house, Milverton, Somerset.
Thornhill, Walter, 30, Warwick-road, Maida-hill West, W.
Tidcombe, George, jun., Watford, Herts.
Turner, Frank de Mierre, C.E., 76, Brunswick-street, Sheffield.
Turner, Henry, Court-lodge, Knockholt, Sevenoaks.
Whisson, Henry Phillips, 31, Pembroke-road, Kensington, W., and Verulam Club, St. James's-street, S.W.
Woolcott, Henry Ward, Charing-cross Hospital, Agar-street, Strand, W.C.

The Chairman delivered the following—

ADDRESS.

According to the custom of my predecessors in this chair, I find it to be my duty in commencing my address to bring to the recollection of the members the losses the Society has sustained by deaths during the year. It is gratifying to note on the present occasion that our losses have been few.

Though obituaries have appeared of all in the pages of our *Journal*, I should be wanting in proper feeling or due appreciation of their merits, if I passed over their names in silence. In Mr. Thomas Webster, Queen's Counsel, the Society has lost an early, constant, and active friend, one who did much to resuscitate it from the lifeless condition into which it had fallen some forty years ago. Sir Alexander Spearman will be remembered as one of the promoters of the Great Exhibition of 1851, and as one of the treasurers of the Royal Commission. Mr. Benjamin Bond Cabbell was one of our oldest members, and at one time was a vice-president of the Society. The Rev. Samuel Clark gave excellent service to the Society in the establishment of the Examinations, and acted as an examiner and as chairman of the Board up to the time of his death. These constitute the main losses among our members, but there are others, who though not members, were so intimately connected with the Society's proceedings, that I should be guilty of a gross omission if I did not refer to their services, as having aided largely the objects which the Society endeavours to promote. Dr. Edward Gray, of the British Museum, widely known as a naturalist, a few years since was well known in this room as taking an active part in the discussions on decimal coinage, and reading papers on this subject before the Society. He also was an early promoter of the art of shell cameo cutting in this country. Mr. A. G. Findlay, well and honourably known as a Geographer, laid before the Society excellent papers on lighthouses, and these recorded, in the Society's transactions and in the *Journal*, are still referred to as having authority. All who have attended the annual conferences of the Institutions in Union will remember the earnestness with which Thomas Lawton, the active secretary of the Lancashire and Yorkshire Union of Institutions, entered into the educational work of that body in connection with the Society. In him the Society and the Institution with which he was so actively connected have sustained a serious loss.

When the Society of Arts was established in 1754, there were but two other societies for the promotion of science and literature in London, the Royal Society, and the Society of Antiquaries; while the Fine Arts had no representative whatever. I will not repeat here what has been so often told about the labours of our Society in the promotion of arts and the applications of science to industry—suffice it to say, that by means of its special standing committees in the several branches of Fine Arts, Agriculture, Chemistry, Mechanics, Manufactures, Colonies, and Trade, it laboured to promote the material prosperity of the kingdom. The field covered was vast, and as time rolled on specialities became more and more developed, till each demanded a special society for itself, and the working bees swarmed off, so to speak, each to establish its separate hive. The "London Directory" at the present time gives us a list of upwards of fifty such societies, each dealing with its own special subject. We claim to be parent of many of these institutions, and we rejoice to see them prospering. While, however, these bodies have to some extent carried off much which it was this Society's original purpose to include within its scope, there still remains plenty of good work to which the Society of Arts can profitably turn its attention. The broader questions of the day as affecting the progress of Arts, Manufactures, and Commerce, are within its cognisance divested of the purely scientific and technical considerations which may fairly be left to the special societies. When science has shown what is possible, and its applications are being brought to bear fruit in practice, it becomes the duty of our Society to diffuse generally a knowledge of what is being done, and by its influence endeavour to promote their extended use and development for the advantage of the trade and commerce of the Empire. It is in this sense that the Society labours. Sewage, drainage, commerce, trade, colonies, telegraphs, food, and education, are thus dealt with.

The great subject of Education has long been a standing portion of the Society's work, as the basis upon which our industries and commerce must depend for development, and the Council are gratified to find that its views, which twenty years ago were thought by some to be rather out of place in a Society devoted to the encouragement of Arts, Manufactures, and Commerce, are now unanimously adopted. I will not enlarge here upon what the Society did to foster education as the great engine for advancing the material and social progress of the Empire. The principle of Examinations, as set on foot by the Society, is now generally adopted, and the Government itself as well as the Universities are bringing it, indeed have already brought it, into extended operation throughout the Kingdom. Looking at what these bodies are doing, and the extent to which the means at their disposal enable them to develop the system, the Council have wisely, as it appears to me, relinquished such branches of Science and Art as those bodies have taken up, and have modified their Examination programme in the manner to which I will hereafter refer. While, however, the Council has thus restricted the scope of its Examinations to subjects more especially in the domain of secondary education, it by no means undervalues the importance of primary education as the necessary foundation for all subsequent progress, and it will do all that lies in its power to promote this object.

The Council have been long deeply impressed with the conviction that the attainment of its great object, the improvements of Arts, Manufactures, and Commerce, must be looked for in the advancement of science and art in secondary instruction, but this is eminently dependent on the solid foundation of good elementary instruction. It has therefore long laboured for this object; but it has found that, as at present generally conducted, the common method of elementary instruction employed in our schools, which keeps boys at these primary schools until their thirteenth or fourteenth year, practically excludes the children of the great bulk of the lower middle class from the benefits of secondary or art and science instruction, for, as a rule, the great bulk of the lower middle classes cannot afford to dispense with the earnings of their children beyond those years. Only a small proportion can afford to keep their children at school for art and science instruction until their sixteenth or seventeenth year. At the same time the great bulk of the wage classes, especially in the rural districts,

cannot dispense with the earnings of their children from their tenth or eleventh year to their thirteenth or fourteenth year. The conditions of the question were early appreciated by the Society's late lamented President, H.R.H. the Prince Consort, whose words it may be proper to recall:—

The root of the evil, the generally defective school attendance, will, I expect, be found to extend into that field on which the political economist exercises his activity, I mean the labour-market demand and supply. To dissipate that ignorance, and to rouse from lethargy may be difficult, but with the united and earnest efforts of all who are friends of the working classes, it ought, after all, to be only a question of time. What measures can be brought to bear upon the other root of the evil is a more delicate question, and will require the nicest care in handling, for there you cut into the very quick of the working man's condition. His children are not only his offspring, to be reared for a future independent position, but they constitute a part of his working power, and work with him for the staff of life. The daughters especially are handmaids of the house, the assistants of the mother, the nurses of the younger children, the aged, and the sick. To deprive the mother of their help would be almost to paralyse its domestic existence.

The Council, it may be recollected, directed inquiries into the present system of primary or elementary education, and examined various methods by which it might be reduced in time, and improved in quality. Evidence was brought before them to show that, on the half time principle, and by greater extension of class teaching, the time now devoted to primary instruction might be reduced one-half; that is to say, that the "three R's" as they are called, might be better imparted in three years or three years and a-half than they are now in seven, and at half the expense and with a superior teaching power.

Our present result, however, can scarcely be considered satisfactory. With a great expenditure it appears that only some twenty thousand out of two millions of children attain the very moderate, and, indeed, meagre, results of what is called the sixth standard.

But in its working it has been found, as the wise forecast of our late illustrious President shows, that it has cut into the very quick of the working man's condition—the domestic budget. So much has this been done in the rural districts as to produce resistance and almost a rebellion against the long time compulsion to school attendance required under the existing long time conditions; and to meet this the low standards have been further lowered, as of absolute necessity.

It would appear that, with competent administration and arrangements, which have borne the test of a large experience, the quality of the education that may be imparted within the time during which the labouring man can afford the school attendance of his children need not be lowered, but may be largely improved beyond the existing standard. The long time schools under the regulations of the Education Department are in the mean, seven year schools. On an examination of the returns of the district half time schools, for the Buckle prize, which was offered some time since in reference to this very point, the average of the time spent in these schools was found to be four years, and the elementary school course was completed by the tenth year, or within the time of the attainment of capacity for productive employment. Now, by a system of physical training in military drill and exercises, and in some industrial occupations, the time saved from the long-time schooling, gives, it is said by those competent to form an opinion, to two the efficiency of three for productive employment. Within that time the boy may have imparted to him lessons in freehand drawing, which for an artisan is next in importance to handwriting. The results have, however, been obtained by improved organisation with a class of children exceptionally low in type. With an average fair type of children, in a good school organisation, the like results are obtainable in three instead of four years from the commencement. In the reduction of primary school time, and the gain of secondary school time, good infant school instruction is stated to count for between one and two years. The cost of an improved quality of school teaching, instead of being augmented, is reduced by one-half. But one grave objection to the existing long time schools, and detention in school of the children of the wage classes up to the fourteenth year as proposed, without bodily exercises, is that it is positively detrimental to them for bodily labour. The only means by which the wage classes can obtain time for the acquisition of any higher or secondary education, is by shortening the time for elementary education. As against the further extension of a system "which cuts into the very quick" of the working man's condition, and practically, if carried out, excludes the lower middle-class children from the benefit of secondary and science and art education, it will be the duty of the Council to make renewed representations, to those in authority, in such form and manner as may appear to be the most expedient for the purpose.

This year, looking to the change of circumstances which I have previously referred to, the Council have thought it right to remodel their Examinations, and specially adapt them, so as to cover ground directly within the aims and objects of this Society, and not provided for by any other body. The scheme of Examinations now comprehends:—

1. Commercial, suited specially for those intended to occupy positions in commerce. These take the place of what have hitherto been termed the General Examinations.

2. Technological, suited specially for managers, workmen, and others, engaged in the manufactures of the country.

3. Domestic Economy, specially intended for women, though men are not excluded from the examinations comprising the subjects of Clothing and its materials, Health, Housekeeping and Thrift, and Cookery.

4. Fine Arts applied to Industry.

These Examinations, by means of the prizes offered in the several departments, and by certificates which will be awarded, will, it is hoped, draw attention to the several subjects to which they relate, and we look to the members of the Society exerting themselves to aid in this important branch of the Society's work.

As the Examinations have undergone the change before alluded to, it may not be out of place if I give some explanatory details connected with their principles and their working. The Commercial Examinations are intended to encourage

an education of a higher character among those who enter into commercial pursuits, whether as clerks or otherwise. It is well-known that, at the present time foreigners, who have taken advantage of the superior educational facilities which their own country affords, are competing largely with our own people in numerous commercial establishments; and it is with a view of drawing attention to this, as well as of supplying a stimulus to those who are proposing to enter into commercial pursuits, that these Examinations have been established. They differ in one respect greatly from what has hitherto been the practice in the Society's Examinations, for while the subjects of examination are in the main the same, the certificates will no longer be given for proficiency in any one subject, but for knowledge in three subjects at least, and these must include English and arithmetic. The three subjects need not necessarily be passed in one year, but when the three are accomplished, and not till then, the certificate is awarded. The certificates will be of two classes only. With regard to the Technological Examinations, these remain the same as hitherto, save that some additional subjects have this year been included in the programme. The object of these is to encourage skill and the cultivation of knowledge amongst those engaged in manufactures, whether as managers, foremen, or artisans. We thus endeavour, so far as can be ascertained by means of answers to written questions, to gauge the ability of the workman in the technical knowledge of the practice of his trade, and at the same time encourage him to make himself acquainted with the elementary principles of science involved in his special occupation, by making it imperative on him to have taken science certificates at the Government Examinations, before he can claim from the Society a certificate for his technical qualifications.

The examinations in Domestic Economy are framed to promote the acquisition of that knowledge and those arts which are essential to the good management of the house and the care of the family, and though especially intended for women, there is no necessary exclusion of men from engaging in them. Among the Examiners in Domestic Economy the Society has been so fortunate as to secure the services of two ladies who have given great attention to the subjects in which they have undertaken to examine. The National Training School for Cookery takes charge of the examination in cookery. Before I leave this branch of the Society's work, I may point out to the attention of the members, although it has already been announced in the *Journal*, that the Council have established five free scholarships of £10 10s. each, entitling female teachers, selected by competition, to a complete course of instruction at the National Training School. The members of the Society and of Institutions in Union have the privilege of nominating candidates to compete. It is confidently stated that any such educated lady who becomes a certificated teacher in cookery (not a domestic cook) may look forward to obtaining an income of £100 a-year, by conducting a local school where adults of all classes may attend to receive instruction, and to practise.

In Fine Arts applied to Industry there is a wide field for the Society's operations, and the examinations in this subject will cover ground not at present occupied by the examinations of the Science and Art Department. They are intended specially to test the candidates' knowledge of the literature and history of decorative Art, and lead them on to make themselves acquainted with the works of the great masters of old. Hand work, unless supplemented by brain work, will never raise the workman above the ordinary rank of his fellows.

First and second prizes of £5 and £3 are offered in each of the foregoing subjects, and special prizes of a higher amount in the Technological Examinations. For other details I must refer you to the usual programme, which may be obtained on application to the Secretary.

Drill in schools, as you are aware, has long been advocated by our Society as an important element in the training of the young, and the members will be glad to learn that the reviews of school drill, so successfully inaugurated and held by the Society during the last few years, are now taken in hand by the School Board for London, and we may expect in the coming year to see, under the auspices of that important body, a drill review on a most extended scale. The Society offers a handsome challenge banner to be held by that school which acquits itself the best on these occasions, and it further gives a sum of £20 to be distributed among the most deserving of the schools.

The National Training School for Music is now well on the road to becoming an active working Institution. The building, the munificent gift of Mr. Freake, is now completed, and the Society is actively engaged in promoting the establishment of free scholarships. A very considerable number have already been promised, and it is hoped that by the commencement of the new year a sufficient number will have been placed on record to justify the Committee of Management, under the chairmanship of the Duke of Edinburgh, in organising the staff for commencing the practical work of teaching in the school. Already the Committee have secured the services of Sir Michael Costa, Sir Julius Benedict, Sir George Elvey, Professor Ella, Mr. Charles Hallé, and Mr. John Hullah, as professional examiners of the school, and to these the Committee will look for counsel and advice. It is, however, obvious that until sufficient promises in the way of support are secured, no step can be taken to start the institution. It is considered that with 100 Scholarships of £40 a year, secured to the school for five years, and a considerable number of promises have been already obtained, a fair start may be made, and the Committee feel confident that, when once started in actual work, there is no reason to doubt its ultimate success.

The adoption of the Telegraphs as a branch of Post-office duty was pressed on the notice of the public and the Government year after year by this Society, and it claims some credit to itself for having aided the creation of that public opinion, which ultimately induced the Government to undertake the duty.

The advantage to the public has been enormous, in spite of all that may be said as to the cost at which it has been effected, and the statements in a recent Treasury report that the system is not self-supporting. The way in which this conclusion is

arrived at to my mind is unsound; amounts are charged to revenue which are properly due to capital only, and thus an unfavourable result is put forward. The way, however, in which the telegraph revenue keeps increasing—and there is no practical limit to be placed to its increase, while there is reason to believe the expenditure has almost reached its limit—is a full justification of the measure, even if we exclude from consideration the advantages the system has conferred on the public at large, whether we view the matter in a social or commercial light. The Post-office is a public department which carries on its operations for the benefit of the public at large; and purely commercial considerations, which naturally and very properly governed the proceedings of the companies, should hold a very secondary place in the proceedings of such an establishment. The idea put forth by the Treasury report, that in order to bring the telegraph revenue into due subordination to its expenditure the tariff should be changed from the uniform shilling to the penny a word system (which would practically raise the average cost of messages to 2s. 5d.), must not for one moment be thought of, and even the Treasury report admits that such a tariff would raise more revenue than the necessity of the case requires, for it goes on to suggest that after a time this tariff might be reduced to one halfpenny per word. By such an arrangement as this, however, the whole benefit of a uniform charge would be lost, and it is needless for me here to enlarge on the advantages of uniformity of charge. This was the mainspring of Rowland Hill's grand reform in the letter service of the day, and it still remains the successful principle of the letter post. The report, however, does suggest, as an alternative plan, a uniform charge of 6d. a message, but would restrict the message to ten words. That such a relaxation in tariff, even so restricted, would bring an enormous increase of business cannot for one moment be doubted, and I have reason to believe that the Post-office authorities themselves are not unfavourably disposed to such a relaxation, asking simply for a short delay to enable their arrangements to be sufficiently matured to meet the business which would flow in. We must bear in mind that an increased number of messages does not involve a proportionate increase of staff or stations; and even if at first a deficit on the balance of revenue and expenses should occur—and this I am not prepared to say might not, for some short time, be the case—the very fact of the increased extent to which the public were taking advantage of the new facilities would in itself be a sufficient reply to the economical side of the question. The example of the Swiss and Belgian telegraphs in the lowered tariff for messages, may at once be cited in favour of the change in this country.

The whole system, however, should be completed by the Government taking into its hands the Ocean telegraphs. This the Society has been persistently urging, and will continue to urge in the interests, not only of commerce, but of society generally. Social telegrams, if I may use such a term, are comparatively rare. The main traffic is confined to commercial messages, as pecuniary transactions, and even these of a wholesale character only, will bear the costs of the higher tariff, which practically ignores the retail trader, and naturally checks the sending of messages of mere social or family news. While these undertakings remain in the hands of private companies, it is obvious that we cannot expect these changes or extensions in the way of branches and stations as well as diminution in tariff, which a Government can fairly and with propriety undertake. Take the example of the inland telegraphs; whilst in the hands of private companies the stations were only 2,932, whereas there were in 1873, under Government administration, 5,790, and this is still further increased at the present time, the public deriving enormous advantage from them, even if the Post-office is not in all cases fully remunerated for the service which it renders. It is obvious that private Companies cannot and will not—nor can they be expected to—adopt such a course; they must look to their shareholders; they must look to a dividend.

It is, I know, said that a shilling a word tariff, for which the Society has contended on a public footing, does not pay; but would it, or any intermediate charge, pay as a public service? What would be said of conditions which allowed the ground for such a justification, that the fourfold augmentation was needed to pay a high dividend to the shareholders? But let it be considered how the low tariff pays to the public. Take the two American cables. On the last day of the four shilling tariff, the messages were 697 a day; but in the week of the one shilling tariff they were very speedily 1,254 a day. Now, it is to be borne in mind that, as a rule, every telegram to America saves ten days of time by speeding some large transaction. It is estimated that every business message by an inland telegram saves a day in time, of a value of ten shillings; and that the total saving to commerce must have been upwards of five millions a-year, for comparatively small transactions. But the value to commerce of the time saved by Ocean telegrams must be in pounds as against shillings.

For the Society's Sectional work there is abundant scope for useful action. India day by day is brought nearer and nearer to us. Whilst formerly an Indian career meant estrangement from home and home ties, home influences, and home civilisation, practically banishment, it is now so no longer. India now presents a field for enterprise and advancement, where, if the road to riches is not so rapid as heretofore, it is no longer confined to the few, and the visit of the Prince of Wales (our illustrious President) to India has already popularised our great empire here to an extent not before attained. This enlarged attention must lead to a better knowledge of the real interests of the country, and it will promote the objects for which the Indian Section of the Society continues to labour. The complaints of those who think that India does not receive its share of public notice will, we hope, henceforth not be so loudly heard.

Among the subjects that are likely to occupy the Indian Section during the Session will probably be the advisability of applying to Parliament for a renewal of the Committee appointed in 1858 and 1859 to examine the question of both Sanitaria and Settlements.

Our intercourse with Central Asia and Western

China during the year has been more largely discussed, and can scarcely fail again to be brought before us for further elucidation.

Our African Section, too, has much of interest to occupy its attention. The coming year promises to be fraught with movements and events that will be fertile in subjects of interest for the Section that is devoted to this branch of work. For the Western Coast it may be hoped that the admirable practical suggestions of the Rev. Mr. Schrenk, of the Basle Mission, for providing the natives with instruction in some special handicraft operation that is adapted to their inclination and tastes, such as the construction of pottery and the manufacture of soap and candles from palm oil, may have further development and consideration. The almost universal disinclination of the Negro and Kaffir races of Africa to meddle with agricultural pursuits, and their readiness to engage in some of the operations of trade and manufacture, is a curious fact well worthy of the notice of practical men. The influence of the advantageous change in the seat of the Government on the Gold Coast, simultaneously with the breaking up of the Ashantee power by the recent successful military campaign, upon the prospects and progress of the West Coast trade, will, no doubt, have illustrative record from men occupied with the commerce of the region, and especially from one member of the committee, Mr. Swanzy, who has already manifested so steady an interest in the proceedings of the Section. The progress of the survey of the entrance by the channel of the Belta into the El Juf depression of the Sahara by Mr. McKenzie, which aims at finding a more speedy and ready means of access to the great northern bend of the Niger, and to the teeming population of the interior, now only reached by the painful and almost prohibitory instrumentality of land caravans, will of necessity be followed with the most earnest attention. In South-Eastern Africa the recent award of the island of Inyak, and of some of the neighbouring territory, to the Portuguese, and the attempt to establish a short and direct communication for purposes of traffic between Algoa Bay and the gold-yielding mountain frontier of the Transvaal States, will suggest useful topics of inquiry and remark. In that direction further reports also may be looked for of the explorations and negotiations of Mr. H. Vincent Erskine in the Juhamhave district, and of the adventurous investigations of Mr. Stanley and of Lieutenant Cameron in the regions surrounding the great interior lakes. Some word also, indicating the use which our recent visitor, the Sultan of Zanzibar, is making of the geographical atlas presented to him by the Church Missionary Society, may possibly also be heard. From the Transvaal States there will be unquestionable testimony of the progress of the gold mines in the neighbourhood of Lydenberg, as there are records of 1,184 ounces of gold dust having been passed through the banks of Natal, and as gold for the first time appears in the annual statement of exports through Natal to the value of £27,710, and as nuggets of 15 lbs. weight have quite recently reached the Cape, and there being reports of the arrival of 140 lbs. of gold at Port Elizabeth. The progress of the settlement of affairs in the diamond fields of the Vaal River, and of the changes which may have occurred in the diamond collecting operations there, will require some mention. But first and foremost, before all else in South Africa, will stand the most interesting inquiry into the general relations of the black population to the civilised States, which will issue from the action that has recently been taken by her Majesty's Secretary of State for the Colonies, in suggesting a formal conference of these States, in which it is understood the first subject for discussion will be the possibility of striking out some common policy and plan for the management of the native tribes, and of organising some scheme for common defence, and for consentaneous action in the matter of railway construction and customs' imposts. It is already known, indeed, that a very important first step has been taken in Natal, in regard to the management of the native tribes, under the inspiration of Lord Carnarvon; this consists in the appointment of stipendiary officers to administer native law amongst the native tribes, in the place of the old hereditary chiefs, and in the restriction of the processes of native law to civil actions, all criminal cases, with the exception of any that may be specially excepted by the Lieutenant-Governor, being henceforth held to be amenable to the ordinary law courts of the colony. The peculiar position held by the Dutch Free States of South Africa as the great natural advanced ports through which the commercial influences of Natal have virtually to be poured into the vast recesses of the interior, will come prominently out in these inquiries, and will draw more lively attention to them as organised States, and political powers, and as favoured seats of growing enterprise and industry than they have yet received. In Natal itself, a movement has just been commenced for quickening the growth of sugar production by the establishment of central mills, in which cane will be crushed for planter-tenants on the estate, under specific arrangements, so as to divide the proceeds of the work between the manufacturer and the planter; and this will be noticed as a scheme which really promises, in the particular circumstances of the colony, to exert a very material influence over the fortunes of the young community. There is also a very curious theme, which more or less bears upon the industrial capabilities of all the civilised States of South Africa, and which on that ground will be somewhat pointedly brought under the notice of the Section, namely the rapid growth of a system of ostrich farming, in which the eggs of the bird are artificially hatched, and the birds themselves carefully and royally tended, and fed upon lucerne and maize, with duly-apportioned doses of phosphate of lime, so that crop after crop of the costly feathers, amounting upon the average to the value of £15 per annum for each bird, is clipped from his skin as wool is clipped from sheep, instead of the bird being hunted to death and destroyed for a single yield. There is one breeder I am told in the district of Albany who is reputed to be so successful an incubator that he can hatch more eggs than the birds themselves. Under the remarkable success which appears to be attending this ingenious plan of "growing" and feeding the ostrich for his quills, the fancy involuntarily arises whether the African Section may not yet have to chronicle the success

of preserves of the hippopotamus for the growth of sea-cow ivory, and of elephant farms, where the noble pachyderm is bred and fed for the reversion of his tusks.

In Chemistry the sectional business has a high interest for many. The application of chemistry to technical purposes is a matter which is continually growing in importance, and one in which this Society takes much interest. The keen air of competition, and the hard pressing which we are getting in some industrial directions from other nations, have had their influence over our interested manufacturers, who have rapidly come to the conclusion that the older methods of production, based as a rule not upon accurate scientific data, but rather upon a wasteful and more or less erroneous rule-of-thumb reckoning, must now be abandoned, and that in their place the scientific knowledge which has already been obtained, and which is consequently at their disposal, must be made the foundation of more accurate and systematic processes.

In this way we are at the present time seeing the fruit of work and labour, which, when it was being accomplished, seemed of comparatively little value, its application being at that period a thing of the future.

Up to the present time the introduction of chemical science into the arts, although eminently successful in those cases in which it has been applied, has not, however, been by any means general; there is a natural tendency to cling to established methods and processes of manufacture, which sets itself in opposition to any innovations. This tendency forms a great safeguard against wasteful expenditure, but it has undoubtedly retarded some of the applications of modern chemical knowledge. There are not a few manufacturing processes at work at the present time in this country of the most crude and imperfect character, and this, not because the necessary knowledge for their improvement is wanting, but really on account of a sort of conservative feeling. Enterprise and competition are gradually changing this, and are continually aiding and helping forward all matters connected with scientific industry, and each year gives more and more satisfactory indications of its advance.

The applications of chemistry have hitherto been mostly in the direction of improving already existing processes, assisting labour, increasing speed of production, saving material, and from this source an immediate result has been seen in the cheapening of the product. All processes which involve a change in the composition of any part of the raw or manufactured material are more or less chemical in their nature, and as such, are likely to be affected by the progress of chemical science. When, then, the number of industries which come under this description is considered, the great influence which chemistry must have upon our commercial prosperity is readily understood. But although this is in itself a very wide field, it is certain that technical chemistry will exceed and reach further than this. There are some manufactures which are solely the outgrowth of modern chemical research, and although their number is at the present time small, there can be no question but that it will rapidly increase. The most notable instance is perhaps that of the Coal-tar Colour Industry, which originating only a few years ago, has become of considerable importance, springing entirely as it has done from the discovery in the laboratory of certain chemical reactions, interesting at the time only as a contribution to our knowledge of the chemistry of some of the hydro-carbons.

Looking to the future, there seem to be three important directions in which the industrial application of chemistry will assert itself; the first of them is the one just mentioned, viz., the establishment of entirely new industries growing out of freshly acquired knowledge; the second, by the discovery of new sources of raw material, or by more perfect and exact processes, bringing into the manufactory material, which up to that time had been considered to be of no value. Advance in this direction will be necessarily slow and gradual, but will be perfectly certain and very beneficial. A very good typical illustration of this occurs in the beautiful processes of M. Claudet for the extraction of gold and silver from copper pyrites. Up to within the last three or four years this material, after having had its copper extracted, was considered to be of no further use, albeit it contains about 18 dwts. of silver and three grains of gold in the ton. No process was anything like perfect enough to allow of these small quantities of the precious metals being extracted at profit, but M. Claudet, applying a purely chemical method, now extracts the silver and gold at an expense not exceeding eightpence for each ton of material treated, and obtains consequently about three quarters of an ounce of silver and three grains of gold, giving a net profit of about three shillings per ton of pyrites. 400,000 tons of pyrites are used annually in England alone, and consequently the profit arising from such a process will be large, such profit being in this case as much that of the community as of the individual. The third direction in which we may look for a great advance from the technical application of chemistry is to be found in the recovery and use of what are termed waste products. In many manufactures a raw material is used which contains a number of substances; it is worked, however, usually for one of them only, and at some stage or other of the process, the other constituents become waste products. To recover such as are useful, and to make useful those which are not so at the present time, is a splendid field for chemical science, and it is one likely to be taken advantage of. Already there are some well-known processes of this kind, amongst which may be mentioned Mond's process for the recovery of sulphur from the waste of the alkali works, and Weldon's process for the recovery of the manganese used in the production of chlorine in the manufacture of bleaching powder.

These remarks afford some indication of what the future advance of chemistry in the arts will be. No science is capable of such wide and advantageous application, and as this is being gradually understood, a demand for scientific technical education is arising, the satisfaction of which must undoubtedly be productive of much good. A few years ago and there seemed to be no such immediate want, but now colleges of science, lectures, and classes are being started in nearly all the centres of industry, principally with the view of training those who are in some way connected with manufactures. All such efforts must receive from the Society hearty good

wishes of success; and here it may be said that the most good will be done when the scientific information is acquired by those absolutely engaged in the work of manufacture; they alone are able to see what necessities for improvement there are and the way in which such improvement may be brought about. At the same time, they are face to face with the difficulties of the matter, and should they have the requisite knowledge will be most likely to see their way out of them. It is perfectly natural, and it is also a very good thing, that there should be eminent scientific men who are able and willing to bring their professional knowledge to bear upon matters connected with manufacture, but it will be generally allowed that it is preferable that those who are daily engaged in the work should themselves be possessed of as large a portion of that knowledge as they can obtain.

The establishment of the Chemical Section of this Society was a step towards spreading a knowledge of what has been and is now being done by means of applied chemistry, and the experience of two sessions has quite justified the action.

The papers read in this Section during the last two years have as a rule contained the results of considerable experience in the various matters written of, and the discussions which have taken place cannot but have been useful to many who either heard them or who afterwards read them in the *Journal* of the Society.

The attention of the Council has been drawn to the importance of investigating the effects on the health produced by the unhealthy conditions under which those engaged in many trades have to carry on their occupations. For this purpose the Council have been fortunate in obtaining the services of Dr. Richardson, whose brilliant Cantor Lectures last year will long be remembered. He has undertaken to enter upon this investigation, and the results, so far as they have already gone, will be given by him to the Society, in the form of a course of lectures, during the Session. These lectures are in addition to the three Cantor Courses, which will this year be delivered by Dr. Thudichum, Mr. Mattieu Williams, and Mr. George Jarmain. The first will embrace the investigations and discoveries of Liebig, as affecting the arts and manufactures; and the two latter will be on subjects specially connected with the Technological Examinations, viz., Steel, and Wool Dyeing.

It will be remembered that the Society drew attention to the importance of improvements in the transit from this country to France. It seemed strange that with all our engineering talent, and the vast improvements that had taken place in our means of locomotion, the Channel passage partook so little of these advantages, and the Council appointed a committee to report on the subject, offered prizes for improved vessels, and entered into friendly relations with the railway and steamboat companies, who most cordially entered into the subject. The Society may, I venture to think, claim credit for having taken up the question, and already its action is leading to practical improvement. All are familiar with Mr. Bessemer's great ship, which, if it have not already accomplished everything that is needed, shows that much may be done by an enlarged type of vessel and vastly improved accommodation to the passengers, even if the swinging saloon has not yet redeemed its promise. The *Castalia*, too, if still somewhat slow in performing the distance, appears from report on all sides to mitigate the sufferings of the passengers to such an extent as to disarm the passage of its horrors, even if it be not shortened in time.

Captain Pittock, who for many years has commanded the Channel packets for the London, Chatham, and Dover Company, and has had both these ships under his command, states that in moderate weather, when from a third to one-half the passengers would be under sea-sickness, there has been on board the large *Bessemer* no sea-sickness whatsoever, nor does he believe there ever will be any. In moderate weather sea-sickness, in his opinion, may now be declared to be practically abolished, and in very rough weather reduced to a minimum. The statements as to the performances of the other large vessel, the *Castalia*, are not equally precise, but the testimony is to the same effect. The condition has now arrived when the Railway companies concerned should be called upon to perform their promise by the adoption of one of the proved means, or of some other equally effectual. It must, however, not be left to separate companies to accomplish the transit, it must be an inclusive service with the railway.

There is another subject of no little importance to the dwellers in this metropolis especially, though the principle involved is not restricted to that alone, viz., the prevention of the spread of fires. We have of late had frightful instances of this in America; Chicago and Boston at once come to our recollection, and remind us that it may be well to look at home in time.

The results of the inquiry directed by the Council into what could be done for the prevention of the spread of fire and conflagration, led to the further inquiry how far the application of science and art might be brought to bear on the special improvement of the entire water-supply of the metropolis. This important subject still awaits the attention of Parliament to the Bill based on the conclusions obtained by the inquiries of the Special Committee appointed by the Council. In the Session before last, that Bill was thrown out by the unexpected opposition of the water companies, for there was reason to expect that they would not have opposed its being taken into committee on the main question affecting them. Last Session, compensation facilities were promised on the part of the Government which it appeared they were unable to realise. But towards the end of the last session, public attention was roused, and in another matter which came before Parliament the popular sentiment prevailed, and a precedent was established, that measures affecting the security of life and property should have the precedence over those that do not. On this new and humane principle it is to be hoped that a due place will be yet accorded to a measure which, as relates to the metropolis, would prevent at least two out of three of the losses of life and personal injuries that regularly occur from fire, and save the great majority of the regular annual sacrifice of more than two hundred lives. It must be remembered

that an improved water supply has not reference merely to prevention of fires, but largely affects the health of the population, and greatly facilitates the cleaning of the streets. Thus, proper measures would certainly prevent the injuries annually done to more than two thousand persons in the streets. All this has been clearly shown by the elaborate report issued last session by the committee of this Society. The President of the Association for the Promotion of Social Science, at the meeting held at Brighton, late a Secretary of State for the Home Department, ascribed a large amount of the existing criminality to the wide-spread drinking habits of the population. But what more powerful cause contributing to drinking habits is there than impure or repulsive supplies of water—of water which, if pure at its source, is made impure by the intermittent mode of distribution. which detains it in butts and vessels in crowded rooms, where it is kept stagnant, and absorbs the mephitic gases, and is made mawkish, offensive, and repulsive. It is not pretended that the provision of pure water is in itself a specific against the great evils of the drinking habits of the population, described in a recent important article in the *Quarterly Review*, but it certainly goes to the removal of a great provocative. Our late lamented member, Mr. William Fairbairn, excluded the beer-can rigorously from his works, but he took care to provide for his people the best pure water that could be got. It would have been a sorry conclusion, if he had left them the alternative only of water made repulsive by stagnation, in water-butts over cess-pools, or water de-aerated in crowded rooms. The present conditions of the Metropolitan supply, besides great waste, are inferiority, if not impurity, in the sources from whence the supply is drawn. It was shown by Mr. Quick and Mr. Rawlinson, and other practical witnesses, that full one-half the water pumped into the metropolis on the intermittent system is pumped to waste. This is confirmed by the fact that by measures conducted by Mr. Deacon, at Liverpool, where the supply is on a public footing, the consumption has been reduced from 33 gallons on the intermittent system, to 17 gallons per head on the constant system. It follows if that system were adopted in the metropolis one half of the 110 millions daily pumped might be saved, the other half being now pumped to waste. Nearly all this half, or 58 millions is pumped from the Thames, which is yet sewer tainted, and tainted, at times very much with the surface washing of heavily manured lands, giving matter in solution for drinking purposes, which filtration has as yet failed to remove. There is, however, another source of crime, to which the present conditions of water supply are contributory to an extent to which the right hon. gentleman must have been ignorant. At present the services of the fire brigade and its engines are limited as a rule to the prevention of the spread of fires beyond the premises where they occur. The incendiary for insurance money is pretty sure to have his object accomplished, and the trace of his work is limited to the particular house, and obliterated before the fire engines can arrive. How systematic all this work goes on is shown in the evidence collected by our member, Mr. McLagan. Mr. Tozer, in his evidence, showed that one third, at least, of the serious fires in London, are not accidental, but intentional, and criminal. But if water can, by means of hydrants, be applied, as it is proved it may be, in two minutes instead of twenty-four by fire-engines, incendiary speculations for insurance money are baffled. Whilst the supply of the metropolis still remains in the hands of private companies, and there are eight of these companies who divide the metropolitan supply among them, it is obvious that the first and main object must be, and indeed it is their duty, so to manage their affairs as to give the largest amount of dividend to their shareholders. This can hardly be consistent with a due regard to the perfect interest of the consumers. Doubtless, under unity of management, large economy could be effected, and, if administered on a public footing, the water supply might be rendered far more effective for the public benefit. A constant supply, with hydrants at frequent intervals, might be obtained without further burthen on the ratepayer, who would thus obtain a more adequate protection from fire, and increased facilities for cleanliness in the streets. Manchester and Liverpool are instances in proof. If unity of works and management, had been got when it was first proposed, the extension of duplicate and triplicate trunk mains (one of them, extending from east to west, costing upwards of a million of money) extended reservoirs, providing for a waste, under the present system, of nearly double the actual consumption, would not have been incurred. Now, nearly the actual draught from the Thames, and the continuance of multiplied establishments, might all have been spared, and the expenditure of some three millions of money might have been, by unity, prevented, and the shareholders have received improved dividends from the profits which have gone elsewhere. It is to be observed that the Metropolitan Board of Works have, in consequence of the complaints on account of the increased rating by the water companies, given notice of a Bill to equalise the rate, and to extend a system of supply by meters to private houses. In this course, leaving the supplies to the separate companies as they are, that Board practically confirms the conclusion come to as to its ineligibility, from the restricted area of its jurisdiction and other causes, to take upon it the responsibility of undertaking the supplies directly for the public. But it is apprehended that, as separate works and extensions, and expenditures for them to an indefinite extent, must still go on together with the expenditure on multiplied establishments and directorates, that any considerable augmentations of dividend to the shareholders, or any material reduction of rates to the consumers, must be very remote. The only practicable source of considerable economy and early relief must be sought in the economy and great gains of unity of management on a public footing. Colonel Beresford, the member for Southwark, has renewed his notice of a Bill on the basis of the report of the Special Committee, which, it is acknowledged, has done gratis the work of a very special commission on the subject. But it is submitted that the work is of a nature that ought not to be left to them, or to any private member, however competent, nor to any overworked sub-

department, and that it is befitting the care of a superior department and Cabinet minister.

A kindred subject involved in the above presents work for the Society to undertake. The pollution of our rivers needs the practical attention of all concerned. Commissioners have investigated the subject in every variety of aspect, and the volumes of their reports abound with facts and scientific research of enormous value as guiding to the elucidation of the problem, which, however, still remains to a large extent practically unsolved.

The Council, considering how much the health of towns is affected by the systems adopted for dealing with sewage, and also the numerous, great, and many-sided difficulties which at present exist in its treatment throughout the United Kingdom; the still imperfect information which exists of the results of the various systems adopted; and the absence of any complete and comprehensive record of facts collected and published officially either by the Local Government Board or by Municipal Corporations, have appointed a General Sewage Committee for the purpose of collecting facts and holding a Conference yearly, at which the experience gained and the progress made in the past year will be reported and discussed, such Conferences to be continued as long as necessary.

The Committee will consist of the Council and members of the Society who express a desire to serve on it, together with eminent authorities on the subject, not members. The Committee may work by sub-committees, each one dealing with a different branch of the subject. At the Conference representatives of Corporations and Boards of Health will be invited to attend.

The model cottages erected by our late President, H.R.H. the Prince Consort, as his contribution to the first great International Exhibition, comprised sanitary principles of construction deemed of great importance, which, from routine or otherwise, have been lost sight of in later constructions of that class. The Council have under consideration the means of bringing these principles more prominently forward with the applications of sanitary science and art, in the construction of dwellings, under the authority of the Artisans' Dwellings Act.

The Society's Committee on the food supply of the people has a wide scope for action in endeavouring to stimulate an increased supply from those places abroad where sheep and cattle are abundant. Hitherto the tinned meats from Australia have been the only addition available, but though valuable as far as they go, they are very inadequate to meet the increasing demand. All other methods for enabling the surplus meats of distant foreign lands to reach our shores in suitable condition for the market must be said to have failed. The Society's Committee have had before them from time to time an almost endless variety of schemes for effecting this object, but none have shown any promise of successful result except treatment by ice, and how far this can be adopted commercially has not yet been proved. A spirited Australian colonist, Mr. T. Mort, has been indefatigable in pursuing this object, and has already expended, I am told, upwards of £60,000 in endeavouring to bring this process to a practical result. Within the last few days information has reached us of the highest interest in connection with this matter. Mr. Mort has succeeded in showing that, on a large scale, both meat and fish can, in specially constructed magazines, be preserved by means of cold, and thus be kept in a satisfactory condition for many months. At a public dinner lately given in Sydney, the tables were spread with viands of every description thus kept, some, indeed, for over a twelvemonth, and all were pronounced to be in excellent condition. Mr. Mort considers that he has now solved the problem of the economical production and application of cold for preservation of food. He intends shortly to despatch a cargo of meat across to this country in a ship suitably fitted up. He is confident it will arrive in a marketable state, and at a price which will bring it within the means of the consumer, and at the same time place the venture in the category of commercial undertakings. M. Tellier, in Paris, has made numerous experiments on a very extended scale in this direction, and has shown that meat can be most successfully preserved in a cold atmosphere. He is now about to put his plans to the test of actual trial by fitting up a ship to bring back meat and vegetables from South America, crossing the tropics on its transit. Should this experiment succeed, and M. Tellier expresses his highest confidence in the undertaking, there can be little doubt that his example will soon be followed.

The Society's Committee on Museums will continue its work, and it is highly gratifying to find that the Chancellor of the Exchequer thoroughly sympathises with the views of the Society, having expressed himself publicly on a late occasion, not only in favour of the multiplication of such establishments in all our great centres of industry, but he has affirmed the further principle for which the Society has been so long contending, that museums and public libraries, where the localities are themselves ready to bring them into existence, should be aided by imperial funds.

I have thus endeavoured to trace some of the objects which may be sought by the action of this Society; these it will be the aim of your Council to keep steadily in view, and promote them as far as in them lies. We trust that we may have the practical aid of our members in carrying out this noble work. Such is the wide field which still remains for the Society's operations, and the Council trust that their proceedings during the coming year may lead to the successful fulfilment of some, at least, of the benefits to Arts, Manufactures, and Commerce which I have endeavoured to shadow forth as needs for the future. In carrying out the operations of the Society, the Council seek the active sympathy of the members, who can materially assist them in extending the usefulness of the Society. Extended usefulness means increase of funds at their disposal; and though the Society was never more prosperous, and never had so large a number of members as at present, it is felt that, looking to the personal privileges alone in the way of lectures, discussions, and reports which the Society offers to its members, and setting aside any public benefit which may accrue from its operations, the Council are making no unreasonable request in asking each member during the year to place at least one of his friends on the Society's list of members.

Sir Antonio Brady, in rising to propose a vote of thanks to the Chairman, said—I am sure I speak the sentiments of all in this Hall in saying we have all listened with the greatest satisfaction to the able and exhaustive address of our distinguished Chairman. He has brought before us, in a concise and simple form, many of the important matters undertaken by the Council. I venture to say that never in the history of this most useful and flourishing Society did more important matters engage their attention, or were conducted with greater skill and ability than they now are under the guidance of our present Chairman and Council. The subjects brought to your notice this evening are of the utmost possible interest, tending as they do to the advancement of all that is useful in education, whether as regards art or science. Technical instruction has engaged and will engage a large share of their attention; on that depends the maintenance of our trade and commerce, and unless the education of our artisans can keep pace with that acquired by those of foreign countries, who have greater opportunities of technical instruction than we possess, we shall be left behind in the competition to which we are now exposed; it is therefore a matter of great satisfaction that this subject receives so large a share of the attention of our Council. The Chairman has especially referred to what we may expect as the result of higher education of our employers in regard to chemistry applied to industry; while our committees are doing good work in advancing and calling attention to many other subjects relating to our trade and commerce. One of these committees, the Food Committee, on which I have the honour of serving, is endeavouring to find out the best mode of improving and cheapening our food supply, especially as regards animal food. At this juncture in our history, when from the increase of population this small island cannot raise sufficient animals to supply our wants, and when meat, owing to the foot and mouth disease, is daily becoming an expensive matter even to the well-to-do, and almost a forbidden luxury to a large class of the community, it becomes of the very utmost importance to know how to bring over to our shores supplies from those countries where cattle are in so great abundance that they are of such little value as to be slaughtered by hundreds of thousands for the sake of their hides alone! To bring over supplies of these animals or their flesh in a satisfactory manner, is a problem which may well engage the time and attention of this Society, and is one of pressing emergency. In conclusion I will venture to say that, of all the societies which engage in our social questions, none are doing more real, hard, and useful work than the Society of Arts, and I invite you to join me in offering a cordial vote of thanks to our Chairman, who so ably presides over our deliberations.

Mr. Peter Graham seconded the vote, which was put by **Sir Antonio Brady**, and carried unanimously.

The Chairman acknowledged the compliment, and referred to the eulogium which had been passed on the Society by Mr. Gladstone in his recent speech at Greenwich, and the favourable comparison instituted by the right hon. gentleman between the work carried on by the Society, and that of various other bodies.

The Chairman then presented the following Medals and Prizes :—

The Howard Prize of a Gold Medal to Mrs. Grantham, widow of Mr. John Grantham, for a steam tramway car invented and constructed by him.

The Society's Silver Medal to each of the following gentlemen:—

Ordinary Meetings.

To F. J. Bramwell, Esq., F.R.S., for his Paper on "The Expediency of Protection for Inventions."

To George Fleming, Esq., Veterinary Surgeon, Royal Engineers, for his Paper on "Horse-shoes and Horse-shoeing."

To Clements R. Markham, Esq., C.B., for his Paper on "The Agricultural Statistics of India."

Indian Section.

To Frederick Drew, Esq., for his Paper on "The Possibility of Adapting the Roman Alphabet for the Languages of India."

To the Rev. James Long, for his Paper on "The Russian Advance in Central Asia in its Commercial, Literary, and Social aspects towards India and the East."

African Section.

To the Hon. T. Shepstone, for his Paper on "Early History of the Zulu Kafir Race of South-Eastern Africa."

Chemical Section.

To A. Nobel, Esq., for his Paper on "Modern Blasting Agents."

The Prince Consort's Prize of Twenty-five Guineas, accompanied by a special certificate, to Henry Beer, aged 24, of the City of London College, clerk, who has obtained the following First-class Certificates at the Society's General Examinations in the present and two preceding years :—

1873.—Logic.
,, Political Economy.
,, English Language, with the First Prize of £5
1874.—Theory of Music.
1875.—Arithmetic.
,, Bookkeeping.

The Council Prize (for Female Candidates) of Ten Guineas, accompanied by a special certificate, to Mary Elizabeth Rudd, aged 19, of the Carlisle Mechanics' Institution (no occupation stated), who has obtained the following First-class Certificates at the Society's General Examinations in the present and preceding year:—

1874.—English Language, with the Prize of £2 for Females.
1875.—Theory of Music.

MISCELLANEOUS.

MR. GLADSTONE AND INDUSTRIAL ART.

The recent address of Mr. Gladstone at Greenwich on the occasion of the distribution of prizes to the Science and Art students, contains so much that bears upon the special work of this Society, that if space had permitted it would have been well worth while to have reprinted it in full in the columns of this *Journal*. At all events, the following extract may be given, conveying, as it does, a high eulogium on the Society, and a discriminating appreciation of its labours :—

Whether it be true or not true that the feeling of beauty does not stand high among us at this moment, of course the main question to consider is how it can be improved. I freely and gladly admit that there are various descriptions of industrial productions among us which appear to show a considerable revival of artistic feeling, though I fear that the modern commercial spirit is sometimes not favourable to it, and needs to be modified in this country by other influences. In America, where the industrial spirit is, perhaps, more actively developed than in any other country, I fear we should also find a great want of the sense of beauty. In truth, we may assume that this is a time when all who feel concerned in the welfare of the country feel it to be desirable that efforts should be made to give instruction in science so as to improve the knowledge of the British artist and workman,

and enable him to hold his position in the markets of the world. I beg those who hear me to beware of imagining for a moment that this result can be attained through any other agency in the main than that of the individual mind and will. All that others can do is to offer assistance, and who should offer that assistance? I do not know what you will think of what I am about to say. It may be a foolish fancy of mine, and often those fancies which one thinks one's best are foolish. I confess, however, that I should like to see a great deal of this work done by the London Companies. I have not been consulted by the London Companies, but, if so, I would have besought and entreated them to consider whether it was not in their power to make themselves that which certainly they are not now—illustrious in the country by endeavouring resolutely and boldly to fulfil the purpose for which they were founded. What was the object for which those companies are founded? Do you suppose they are founded for the purpose of having dinners once a year, once a quarter, or once a month? Do you suppose they were founded for the purpose of dealing out little sums of money to certain applicants and then having it recorded of them how much good they had done? Nothing of the kind. Eleemosynary works are noble works—amongst the noblest, indeed, given to men. But to be eleemosynary work it must be the work of an individual, and not of a company. These companies were founded for the purpose of developing the crafts, trades, or "mysteries," as they were called. They were founded for the purpose of doing the very thing which the Government of the country, out of the taxes of the country, is now called upon to do—namely, applying their energies and intelligence to secure the great object which I described at the outset to be the application of human labour to all the purpose of industry in the most economical, effective, and beautiful manner. And at this time, if it was possible to inspire these bodies with missionary and propagandist enthusism, which I admit would be requisite, it would be in their power to perform the most noble works and to become the most formidable competitors with the Government in that which it is now endeavouring to do. There is one particular association that is doing good work. I mean the Society of Arts—a body which, so far as money goes, has not got a shilling of public money or of endowment. They are a body of gentlemen who have conceived the idea of the beautiful, the economical, and the effective production of works of industry, and of the application of high and sound principles of art to processes industrial. By their own means and their own exertions they have set about this work, and have earned for themselves in that respect a most honourable name. Here we have on one side a society which has no traditions, for it is a comparatively modern institution, not above a 130 years old, and it has no endowments. On the other hand we have great institutions full of traditions and full of endowments; but unhappily they have been seized with a kind of somnolent disposition, which I firmly hope and believe will one day awake to the really great and noble destiny which it is open to them to follow, if spirit and resolution shall be accorded unto them—and I admit it requires great spirit and great resolution to undertake the pains necessary for accomplishing that high end.

Messrs. Palmer and Howe, of Manchester, have in preparation a treatise on Dyeing and Calico Printing by the late Dr. F. Crace-Calvert, F.R.S., F.C.S. It will include a short account of the most recent improvements in the manufacture and use of aniline colours, and is being prepared under the editorial care of John Stenhouse, LL.D., F.R.S., and Charles Edward Groves, F.C.S.

The production of coal in the province of Hainault last year was 10,698,130 tons. This extraction was less than the corresponding production in 1872 and 1873.

CORRESPONDENCE.

THE CHAIRMAN'S ADDRESS.

Sir,—I regret that I shall be prevented by indisposition attending to-night, to take part in the discussion which may arise on the address of the noble lord, our Chairman of Council; but I desire to offer a few observations on the topic of education, which are occasioned by the progress of his Royal Highness, our President, in his great tour in India. Foreign potentates may regard it with surprise, as unusual, that his Royal Highness should have included children's institutions as objects of inspection during his great state tour;—unusual that he should, in his position, regard any other than military institutions! In doing so, however, he will, with a wise forecast, be viewing the up-bringing of his future subjects in that part of his dominions, in relation to which the cry has been raised here in our Indian Section that, for its future progress, it ought to be covered with a "network of schools." Very true; but the precautionary inquiry may be now raised, what sort of schools? for those which fail so largely here in the training required for the body as well as the mind, will, unless care be taken, be a worse failure there.

At home, however, in the distinguished review we had of the drill of the children of the half-time schools, his Royal Highness saw much of the results obtainable by a correct course of mixed physical, mental, and industrial training, and of sanitation in the conversion of the former lowest classes of soiled Arabs of our streets, living by depredation and spoil, or mendicancy, into law-abiding, orderly subjects, living by productive industry. In that review of ours, his Royal Highness had proof before him how rugged natures of every race and clime, who are hardened and past cure in the adult stages, may in youth be ameliorated and modified to beneficial ends. At Calcutta his Royal Highness may have an opportunity which (under the guidance of his sanitary monitor, Dr. Fayrer, who took part in a recent discussion in the Indian Section), it is to be hoped, will not be lost, of inspecting a children's institution, fraught with large portents, namely, an institution of an orphan asylum of female children of British parents. The horribly heavy death-rates amongst children of British parents in India has led to the very general conclusion that children of the British race cannot be reared or have succession in those climates. But the experience of that one institution of female children, as stated in the discussion to which I refer, would go to reverse that conclusion, for it shows that such heavy children's death rates are really factitious and preventible, as from other evidence I believe them to be.

It was proved that by sanitation in Calcutta, which has a climate of an inferior order, the death-rate of female children is reduced to nearly one-half the death-rate of children of the same ages of all classes in London. When it is considered what has been done by sanitation in the adult stages in India, where the death-rate, which was once upwards of sixty per thousand, has been reduced to thirteen and a-half, or less than it was in the line regiments at home;—that in India the death-rates of the much-exposed class, the railway engine-drivers, are not more than ten in a thousand, *i.e.*, not more than weather-exposed classes in this metropolis;—when it is considered what is already done in these adult stages in India, there is little doubt that if the children reared in the Calcutta institution were removed to the hill stations, or to stations moderately salubrious, the British race might be reared and have succession.

Dr. Fayrer attested, from his own observation, the results of sanitation in that particular institution in Calcutta. He stated that he had seen British children of a third generation in India; nevertheless he would

not go so far as to say whether the British race might have succession there. Certainly not, I should say, if they were to be located in malarious places, or places not rendered habitable by sanitation. But I would urge it that it is of importance for the object that the training in any network of schools called for there, and peculiarly so for British children, should be physical as well as mental, of the type of such special institutions as those of which his Royal Highness saw some of the outcome at our school drill review. But wheresoever it be thought fit the physical training may be imparted without the military element.

It is to be taken into account that the principles of the reformed mental, and physical, and industrial training we advocate here is a reform highly important for our colonies, where our trained teachers go, and where our educational institutions are commonly too literally copied.

It were unnecessary to observe here that efforts for the amelioration of semi-barbarous populations must, as a rule, be of inferior effect to those applied in the infantile stages of life.—I am, &c.,

Edwin Chadwick.

GENERAL NOTES.

Loan Exhibition of Scientific Apparatus, 1876.—During the past week, meetings of the sub-committees of the various sections of this exhibition have been held at the South Kensington Museum, at which the following gentlemen have been present:—Mr. W. B. Baskcomb, Mr. H. Banerman, Mr. H. W. Bristow, Dr. W. B. Carpenter, Mr. A. W. Chisholm, Sir Henry Cole, Dr. Debus, Mr. W. T. Thistleton Dyer, Mr. R. Etheridge, Mr. D. Forbes, Professor G. Carey Foster, Dr. Frankland, Dr. Gladstone, Professor F. Guthrie, Professor T. H. Huxley, Mr. J. Norman Lockyer, Dr. R. J. Mann, Mr. C. W. Merrifield, Professor G. Morris, Mr. Warren de la Rue, Dr. W. J. Russell, Dr. J. Burdon Sanderson, Mr. R. H. Scott, Mr. C. W. Siemens, Professor Henry J. S. Smith, the Reverend Professor Twisden.

Philadelphia Museum.—A movement has been set on foot at Philadelphia since Mr. Cunliffe Owen's visit to that city, for the establishment of a Museum of Science and Art of a character similar to our own South Kensington Museum. With this end a committee was formed to obtain the use of the "Memorial Hall" for the purpose, and a memorial has been presented to the Board of State Centennial Supervisors, asking that the hall may be permanently devoted to the use of such a museum. The project has the approval and assistance of the principal scientific and artistic societies, schools of design, &c., of Pennsylvania.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Cantor Lectures.

The first course of Cantor Lectures for the present Session, "On the Discoveries and Philosophy of Liebig, with especial reference to their influence upon the advancement of Arts, Manufactures, and Commerce," by J. L. W. Thudichum, M.D., will be delivered on the following Monday evenings:—

Syllabus.

Lecture I.—November 22.

Introduction.—General sketch of life and labours.—Analysis of researches and discoveries in chronological order.

Lecture II.—November 29.

Analysis of researches and discoveries continued.—Advancement of general and organic chemistry by elementary analysis.—Lectures and laboratory teaching.

Lecture III.—December 6.

Physiology of plant-life, chemistry of agriculture and natural laws of husbandry.—Works, and effect upon society.

Lecture IV.—December 13.

Physiology of animals, and the laws of their nutrition in particular.—Foods and food-extracts.—Works, and their influence upon professions and associations.

Lecture V.—December 20.

Therapeutic agents and collateral discoveries, chloroform, chloral.—The way from detailed labours to general scientific principles and laws.—Liebig's philosophy as influencing mode of thinking of present generation.

The lectures will be illustrated by selected experiments and demonstrations.

Special Lectures.

A series of reports has been prepared by Dr. Richardson, appointed by the Council to make special inquiry into the subject of "Unhealthy Trades." These will be delivered in the form of Lectures on the following Friday evenings:—December 3rd, 10th, 17th; January 21st, 28th; February 4th.

The subjects considered in this course will include:—

The influence of physical labour on individual and national vitality.

Injuries incident to physical labour. (1) By exposure to dust and other foreign substances. (2) By exposure to noxious gases and heated and impure air. (3) From mechanical concussions, peculiar postures of body, and excessive exertion.

Diseases incident to workers in the potteries, in trimming and furniture dressing, in sand-paper making, in flour-mills, amongst old rags, in fur dyeing, in walking-stick making, in hemp dressing, in patent leather dressing, &c.

Diseases of paviours, carpenters, blacksmiths, postmen, scriveners, &c.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m (Cantor Lectures.) Dr. Thudichum, "The Discoveries and Philosophy of Leibig, with special reference to their influence upon the Advancement of Arts, Manufactures, and Commerce."
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. G. Webb, "Fruit Cultivation and Management in Kent."
Medical, 11, Chandos-street, W., 8 p.m.
Asiatic, 22, Albemarle-street, W., 8 p.m.

Tues. ...Women's Education Society (at the House of the Society of Arts), 6 p.m. Mr. Sonnenschein, "The Method of Teaching Arithmetic."
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. M. Charles Bontemps, "Experiments on the Movement of Air in Pneumatic Tubes." 2. Discussion on "Pneumatic Transmission of Telegrams."
Anthropological Institute, 4, St. Martin's-place, W.C. 1. The President, "Excavations in Cissbury Camp, Sussex, being a Report of the Exploration Committee of the Anthropological Institute." 2. Prof. Rolleston, "Remarks on the Animal Remains discovered in the Excavations."

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. H. T. Wood, "The Registration of Trade Marks."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. G. Washington Moon, "Some of the Difficulties and Peculiarities of the English Language."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,201. Vol. XXIV.

FRIDAY, NOVEMBER 26, 1875.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The Council of the Society of Arts hereby give notice that a competition for four free scholarships will take place in London in January next. Persons of either sex desiring to compete may obtain terms and conditions of the competition by applying to the Secretary.

DRILL IN SCHOOLS.

A Meeting of this Committee was held on Friday, the 19th inst., when a design was selected for the Challenge Banner, which will be presented to the school showing the greatest proficiency at the Drill Review to be held by the School Board in the course of next spring.

RAILWAY LAMP COMMITTEE.

The Committee met on Tuesday, the 23rd Nov. Present—Seymour Teulon (in the chair), J. Tomlinson, and A. Beattie.

SECOND ORDINARY MEETING.

Wednesday, November 24th, 1875; A. J. Mundella, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Austin, Benjamin George, 143, Wool Exchange Central, Coleman-street, E.C.
Brewer, Richard, Suffield-house, Richmond, Surrey.
Burkinyoung, Henry, 85, Cornwall-gardens, South Kensington, S.W.
Chappé, Thomas Fletcher, 29, Stanhill-gardens, Kensington, W.
Hurwitz, Charles Benjamin, 3, Osnaburgh-place, Regent's park, N.W.
Hurwitz, Sidney John, 3, Osnaburgh-place, Regent's-park, N.W.
Jones, George Marsh, 147, Gleadless-road, Heeley, Sheffield.
Mann, Edward, 7, Pall-mall East, S.W.
Martin, James Thomas, 4, Vine-street, York-road, Lambeth, S.E.
Melliss, J. C., Kenilworth.
Reinecker, Captain G. H., East India United Service Club, 14, St. James's-square, S.W.
Ryland, Arthur, Birmingham.
Shattock, Thomas Foster, 7, Arlington-street, Piccadilly, S.W.
Tomlinson, Joseph, 160, Alexandra-road, St. John's-wood, N.W.

The paper read was—

THE REGISTRATION OF TRADE MARKS.

By H. Trueman Wood, B.A.

There can be little apology required for bringing the subject of trade marks once more before this Society. From time to time, when any reform in the law has been proposed—and it has only been by gradual steps that our present system has been arrived at—the Society of Arts has been foremost in investigating the question, and in promoting the needful changes. No less than three papers* on the subject have been read before the Society, and in 1866 a strong committee was formed with the view of promoting that amendment of the law which has only now been effected. Unhappily, our Society can but propose reforms; it has no power to carry them; or had the proposals brought forward in this very room years ago been carried into effect, we should not now be discussing, in anticipation, a new system of regulating the employment of trade marks; we should long ago have had all the advantages of that system, and should now perhaps be suggesting fresh improvements, the necessity for which only experience in the new scheme can show. For it is in the hope of raising a practical discussion, and thence eliciting valuable suggestions from those whose experience best qualifies them to express an opinion, that the subject is laid before you this evening. You are all doubtless well aware that the Act which establishes a registry of trade marks does little more than merely decree that establishment. It leaves to the Lord Chancellor, presumably as the principal Commissioner of Patents—since it is to that body that the direction of the new system has been entrusted—the duty of preparing the plan on which registration is to be carried on. It is so obviously important that from the outset the system should work smoothly and efficiently, that I feel sure considerable advantages cannot but result, if, before the rules and regulations are finally decided upon, an opportunity is given to those interested in the matter, of expressing their views and pointing out what it really is that the mercantile community requires. That even the minuter details of the system are worth thought and attention, will hardly, I think, be denied, inasmuch as on these details it must depend whether or no the object of all legislation on the subject be attained—the securing to the possessor of the easy and uninterrupted use of his property. It is for these reasons that I have been permitted by the Council to bring this matter forward, and in doing this I must ask your indulgence. No one can be better aware than myself of the deficiencies in the paper I am about to read, and the only use or merit I can claim for it is that it may serve as a text for comment by those better able to deal with the subject than myself. It is wholly with this view I have prepared it, and I have therefore been at some pains to ascertain

* "On Trade Marks" By Prof. Leone Levi. March 16, 1859. *Journal*, March 18, 1859, vol. vii., p. 262.
"On the Piracy of Trade Marks." By E. M. Underdown April 11, 1866. *Journal*, April 13, 1866, vol. xiv., p. 370.
"On Trade Marks." By W. Wybrow Robinson. April 21, 1869. *Journal*, April 23, 1869., vol. xvii., p. 414.

the principal points to which attention ought to be directed. These I shall endeavour to present to you as clearly as I can, and I hope that the practical experience and the legal knowledge of many here present may supplement what is at best the outcome of some thought and a good deal of careful study. I must also say that I shall touch as little as may be on the purely legal aspects of the question.

It must seem strange, if we give the matter a moment's thought, that we, the greatest trading nation in the world, have been so far behind our neighbours in protecting our own interests in such an important particular. Not only have America, France, and Austria for some time extended to their manufacturers an advantage we have never provided for our own, but even Spain and Turkey* have, at least in theory, done what we have so long hesitated to do, and by establishing a registry of trade marks, shown themselves more awake to the true interests of their commerce than we, with all our experience. Even Germany, who, if reports are true, had but little to gain by authorising the registration of English marks, and thus checking the production of spurious goods with English marks upon them—has been before us, and has anticipated by a year the process that with us is to begin on the first of January next. In the somewhat kindred subject of Patent-law, we took a very decided lead of all other nations, and, with all its undoubted imperfections, we still enjoy the advantages of a system which stands unrivalled by that of any other country. With regard to trade marks, we have been content to let our neighbours get a-head of us, and thereby reap for themselves an advantage we, as the first commercial nation in the world, ought assuredly to have been the first to secure for our own interests. This being so, it only remains for us to profit by the experience of others, so that by examination and comparison of their systems we may frame for ourselves one including the best points of all.

The connection between the various monopolies—the word is used in no invidious sense—patent right, copyright, and the right to use a distinctive symbol for purposes of trade, has now been recognised by bringing them—at least those portions of them relating to manufacturing or commercial interests—under one and the same jurisdiction, that of the Commissioners of Patents.† The wisdom of this step is obvious. The details of the systems to be applied in treating and recording grants of patents, and registrations of designs and trade marks, are almost identical. The Patent-office has now been at work on its present footing for over twenty years, and there is no question but that on the whole its work has been done efficiently and well. The Designs-office has only just been transferred from the Board of Trade to the Patent-office, and there is every reason to hope that its practice will be as soon as possible assimilated to that of the department to which it has been annexed. To ensure an efficient administration for the new Trade Marks Registration Office, it will merely be necessary to take the Patent-office system as a model, and adopt it, by a few necessary changes, to the altered conditions to which it is to be applied. It is therefore certain that the Patent-office, where the requisite machinery for registration is already provided, is the proper place for the registry of trade marks, and that the framers of the recent Act were in this respect wiser than those who prepared the former Bills dealing with this subject.

It is a remarkable fact, and one therefore which calls for at least a passing notice, that this question of granting to individuals certain privileges or monopolies, in return for some contribution made by them to the general stock of knowledge, is now, in various forms, widely attracting public notice, and that it has assumed during the last few years a larger shape than it had before by its extension beyond the bounds of separate nationalities. The question of international copyright every now and then raises up a fresh controversy which becomes more and more acrimonious till it exhausts itself for the time. A rather longer and calmer discussion than usual has just resulted in the appointment of a Royal Commission to investigate the subject in all its bearings. Patent-law reform was one of the questions of last session, and only the vigorous and united opposition of all the interests affected prevented the passing of an Act which would certainly have altered—for better or for worse—the existing law. The important Patent Congress at Vienna in 1873; the more recent Conference at the Hague, these and other events show a very widespread wish for the adoption of some scheme—what form that scheme should take is yet far from evident—by which protection should be secured for invention in all countries alike and at once. Less important indeed than these, but second only to them in importance, comes the question of protection for trade marks.

In this case, as with the other monopolies just mentioned, it is only the consideration of a general advantage that can justify a special privilege. The strongest arguments for the continuance of the few monopolies still existing are based upon the general benefit that results from their use, not on the inherent right—the right is after all but a creation of the law—of the individual to retain for his private benefit what he has produced. We believe that the protection of inventions fosters and encourages industry, therefore we grant to the inventor a patent-right in his ideas; we argue that the protection of literary and artistic property aids the development of our literature and our arts, therefore we grant the writer or the artist a copyright in his works; so experience teaches us that

* The registration of trade marks in Turkey seems, at least so far as foreigners are concerned, to be a mere farce. Messrs. Nowill and Sons, of Sheffield, have obligingly furnished me with some information as to their experience in the matter. About three years ago (in 1872 or 1873), they learned from their correspondent in Constantinople that goods were being introduced into the market from Germany stamped with their name and trade mark, and enclosed in wrappers with labels almost identical with theirs, the "w" in "Nowill" being reversed and turned into an "m," and "Sheffield" being altered to "Shemfield." Under these circumstances Messrs. Nowill determined to avail themselves of the recent Turkish law, and to register their trade mark in Turkey. This, however, proved no easy task, and it was not until the beginning of the present year (1875) that they succeeded, after taking considerable trouble, and spending a large sum of money. Having got so far, they proceeded to take action against the infringers, but the result was, that most of the offenders simply took no notice whatever of the summons of the court, and those who did were told to sell out in twenty-one days, and not to do so any more. At this juncture Messrs. Nowill took advantage of the recent German law, and by registering their trade marks in that country were enabled to get at the original offenders, the makers of the counterfeit wares.

† The Lord Chancellor, the Master of the Rolls, and the Attorney and Solicitor-General.

by giving the trader every possible assistance in the prosecution of the business he has established, we promote the growth of commerce. Thus the privilege granted to the individual results in the profit of the many, and it is only this beneficial result that justifies the restriction on general liberty.

There is indeed this great difference between the monopoly of a trade mark and that of patent right or copyright, In the two latter cases the recipient of the privilege gives an actual return for it. He gives to the public an invention before unknown, or he adds something to the literary or artistic possessions of the country. As regards a trade mark the return is less direct. Still it is none the less real. It is made in two ways. First, it enables the manufacturer to extend and protect his trade, and, secondly, it assists the public in obtaining the precise article they require. This second result is in practice the less important of the two, because there never can be any very wide-spread knowledge among the general public of the various marks used on merchandise. Even in the case of Hall-marks very few people know the meaning of the symbols employed, and so long as there is a mark of some sort on their purchases they are perfectly satisfied. Still there is a certain amount of protection in the use of a trade mark, if there is sufficient legislative protection to guarantee authenticity. So far is this the case, that it was for long a question in France, before the passing of the latest enactments on the subject, whether the use of a trade mark should not be compulsory, the manfacturer being obliged to put his mark on all his productions. As it is, under the French law, the power is reserved (and exercised) of ordering such a use in such cases as may seem necessary.

It is not a little curious that this wish to prevent the public from being imposed on by inferior imitations appears, from the preamble of the Act establishing the Cutlers' Company, to have been the principal reason for the passing of the Act, and as Mr. Hindmarch said in his evidence on this point, "the provision as to marks was rather in the nature of a restriction than a right conferred."

But the first point is the really important one. It is the obvious duty of the Legislature to provide every possible means for the protection of commerce, and as common experience has proved that the trader is enabled—amongst other means of greater importance—to develop his business and increase his reputation by associating all his goods with a special distinctive symbol, it is advisable that the Government should enable him to do this, and thus provide each individual with the means of performing his share of that labour which in the aggregate results in the extension of the commerce and the enhancement of the reputation of the entire community. More especially is this the case with regard to foreign markets. Here the reputation of the whole trading community is inextricably bound up with that of the separate members, and instances have occurred, over and over again, in which a market has been closed, either by inferior wares being supplied, or by the reputation of the traders being destroyed by an influx of worthless imitations not readily distinguishable from the genuine article. It is obvious, however, that the Legislature cannot fairly be asked to interfere for the special protection of trade marks, unless it can be shown that they are actually of use in thus promoting our commercial interests, unless, in fact, the community does, in one shape or another, get its due return for the privilege. It has been urged that the trade mark is a sort of relic of a barbarous age, when men could not read, and that with the growth of knowledge the necessity for such symbols has passed away. This argument, though specious, is not, perhaps, very difficult of answer. The mere fact of the extended use of trade marks is enough to entitle them to legal protection. But apart from this, they have, for several reasons, a value of their own, as supplying a want not readily to be filled by other means. It may be worth while to consider for a moment the points wherein the value of a trade mark consists.

Among the various means adopted by the manufacturer or the trader to protect his business and his reputation—to separate himself as it were from his numerous rivals, and secure that advantage of notoriety which in our crowded modern life it is so difficult to obtain — there are few more useful than a distinct and characteristic trade mark. The mediæval craftsman hung out his emblem over his shop door, because few of his customers could read. Nowadays, perhaps, we are all in too great a hurry to stop and read, so your modern tradesman finds his account in connecting with his wares some symbol which may catch the eye and fix itself in the memory, when one name among so many thousand others gets overlooked and forgotten. It is not of course to be supposed for a moment that the reputation of a firm is connected less with their name than with their trade marks. In nine cases out of ten a man's work is connected with himself, and the reputation of any firm obviously attaches to its name in the first place. All that is meant is—and this experience shows to be true—that the mark is a valuable assistance to the name. There have been instances of the courts restraining a man from the improper use of his own name, when there was an evident intention to deceive the public by selling a counterfeit article under the name of the original inventor (in the case of Holloway's Pills for instance, and of Day and Martin's Blacking), but this is very rare, and Brown, Smith, or Jones may spend his life in setting up a reputation, only to see some other Jones, Smith, or Brown stepping in to reap half the fruits of it. Here it is of the utmost value to him to have connected his wares, in the public mind, with some distinctive symbol, so that his opponent who is only morally, not legally, guilty in trying to steal for his own name the reputation belonging to another, has no longer a cloak for his knavery if he attempts active imitation as well as passive resemblance. It may be only a curious coincidence that a second Bass may brew bitter beer, but if he adopts the familiar red triangle as his symbol he at once furnishes evidence of his own rascality in attempting to steal the advantage of that "good name," which our great poet has told us, is worth so much more than the purse that in commercial matters the good name helps to fill. These, then, are the advantages in what we may perhaps call the advertising point of view, of a trade mark—the help it gives in attracting public notice, and fixing public atten-

tion. Another and perhaps a yet more important use of it arises from the universality of the language it speaks. It appeals to the ignorant, the foreigner, and even the uncivilised. Herein lies its great advantage over a name, and herein also lies the objection to the often-mooted proposals for the adoption of a system of initial letters or numbers as registered marks. I suppose few of our large manufacturers would be content with merely a home trade, and even at home, despite School Boards, too many of the most numerous class of customers are yet somewhat slow in the deciphering of proper names. The wholesale manner in which foreign pirates imitated the Sheffield marks before the commercial treaties, is the best possible proof that the foreign buyer went chiefly by the mark. A very special instance of this was given before the Parliamentary Committee which dealt with the subject in 1862 by a member of Messrs. Coats' firm, who said that a firm of the same name had imitated their wrappers in the States, and had thus seriously interfered with their trade. The Courts stopped the imitation, but could not prevent the use of the name. The name alone, however, was not sufficient, and as soon as the pirates were prevented from imitating the wrappers, their mere use of the name of Coats did but little harm. If a case is wanted to show the value of trade marks in dealing with illiterate customers, no better can be suggested than that given before the same committee by one of the proprietors of the Glenfield Starch. He said he had himself heard customers in country towns asking for "a pennyworth of starch with a long chimney on it," that being the device on the label of the Glenfield Starch. As to the effect in uncivilised, or partly civilised countries, Mr. Hyde Clarke, speaking at a former meeting of the Society, has born witness to the fact that in distant parts of Asia the inhabitants would purchase English wares by the trade mark which they knew from experience of former transactions. Evidence to much the same effect was given before the committee by the late Mr. W. Lockwood, who stated that one special kind of knife, which had a great reputation in certain parts of South America, quite went out of fashion from the fact of the market being flooded with inferior German imitations bearing the same mark. It would, however, be of little use to multiply instances of a fact which is notorious to all who have experience of the subject.

Such are some of the more obvious advantages of the trade mark, but the best proof of the importance of the question is given by the great and daily extending use of trade marks. A single large firm has been known to have spent £2,000 in three years, simply in protecting their marks from infringement, and this at all events shows the value they set upon it. Nor must it be forgotten that in many trades a mark is an absolute necessity. Many instances will occur to those present of wares on which the wholesale dealer would not permit the manufacturer to put his name, while he is not only willing but anxious that the goods should bear the hieroglyphic with which the public is familiar. It is not the interest of the maker in all cases to supply the consumer direct, and if by the publication of his name he attracted the smaller trade he would lose that of the large wholesale men. The button manufacture may be instanced as a case in point.

Considering then the value which attaches to a properly protected trade mark, and the fact that a trade mark without such protection is absolutely worthless, it is a matter of no small wonder that the matter was so long left without any attention on the part of the Legislature. It is doubtless true that an equitable right to a trade mark has always been recognised, but the protection thus afforded was utterly inadequate to the necessities of the case. With the exception of the special Acts for the benefit of the Cutlers' Company, there is no legislation whatever referring to trade marks prior to the Merchandise Marks Act of 1862.

The Sheffield Cutlers' Company was established by Act of Parliament passed in 1624 (21 Jac. I. c. 31) it having previously possessed a charter from the "Lords of Hallamshire." It was confined to six incorporated trades, the makers of scissors, shears, forks, files, sickles, and scythes. It was necessary for any person carrying on any of these trades to obtain a license from the company, and all apprentices were bound at Cutlers'-hall. The company had the exclusive right of granting trade marks in Hallamshire (about six miles round Sheffield), but could only grant them to members of the trades above specified. Other Acts relating to the company were passed in 1797 (31 Geo. III. c. 58), 1811 (41 Geo. III. c. 97), and 1814 (54 Geo. III. c. 119); the Act of 1814 repealing portions of the former Acts, and permitting any person to carry on any of the incorporated trades without a license from the company, which, however, continued to grant marks as before to freemen and non-freemen. The last Act relating to the company was passed in 1860 (23 and 24 Vict. c. 43). This was applied for by the company to enable them to extend their operations, and include various trades which had grown up, or largely developed, since its foundation. By its provisions the incorporated trades were made to include the steel trade, the saw trade, the edge tool trade, and generally any manufacture of any article made of iron, or of iron and steel combined, and having a cutting edge. In the Merchandise Marks Act of 1862, and in the recent Act of last Session, clauses were introduced to preserve the rights of the company, of which, indeed, the Sheffield folk have always been justly proud.

I believe that public attention, outside the interests affected, was first drawn to the great want of legislation on trade marks about the year 1859. In that year a paper was read before this Society by Dr. Leone Levi, and this was followed by a second paper by Mr. Arthur Ryland, before the Social Science Association, in the same year. At that time the complaints of the Sheffield cutlers against their German imitators were loud and bitter. In one foreign market after another their trade was being spoilt, and the reputation of English cutlery destroyed by wares of a most inferior character made in Germany and stamped with well-known English names. It is true that the Sheffield makers had to a great extent to thank themselves for this state of things, for they had been in the habit, under a press of business, of giving orders to German makers for goods stamped with their own English marks. Naturally enough this opened the eyes of

the Germans, who soon began to act for their own benefit on the suggestion given them. The effect of this before long was that Sheffield had not only to withstand the legitimate rivalry of Solingen, but, to see English reputations traded on by German imitators, while, and this was the greatest hardship of all, the spurious wares were so greatly inferior as, wherever they went, to destroy the credit of the makers whose productions they pretended to be. Whenever the German cutler made a good blade he marked it as his own, his soft iron knives he always stamped with a Sheffield punch. The manifold advantages he got by this method are obvious, as he succeeded, as it were, in robbing his unlucky British rival twice over.

It was, I believe, at the instance of some of the principal Sheffield makers that Professor Levi prepared the paper above referred to. The same gentleman also drew up a Bill which was promoted by several chambers of commerce, but was not introduced into Parliament. In 1860 the draft of a Bill prepared by Mr. Travers Smith at the request of Mr. Bass was submitted to Mr. Milner Gibson, then President of the Board of Trade, and the attention of the Government being drawn to the matter, a Bill was introduced into the House of Lords in the next Session (1861) by Lord Campbell. This Bill was read a third time in the Lords, but did not pass the Commons. The following year (1862) two Bills were introduced in the House of Commons, the first by Mr. Milner Gibson and the Attorney-General, and the second by Mr. Roebuck and Mr. Hadfield, the members for Sheffield. The Government Bill eventually passed into law as the "Merchandise Marks Act," the Bill of the members for Sheffield was entitled the "Trade Marks Bill," and this was dropped after the two Bills had passed through a Select Committee. The chief difference between the two Bills was that the "Trade Marks Bill" provided for a registration of trade marks, while the Government Bill did not. Of the witnesses examined before the committee nearly all the manufacturers were, more or less strongly, in favour of registration, but it was opposed by Mr. Hindmarch, Q.C., with whom the Attorney-General (as a member of the committee) concurred. The main grounds of objection were that it would be complicated and useless (as the question of "user" would still arise), that it would cause a mischievous alteration in the law if mere registration without use conferred a title, and that a proper register could not be kept. The great weight of legal authority carried the day, and notwithstanding the strong expressions of opinion on the part of many of the witnesses, the committee distinctly negatived the proposal of Mr. Roebuck for registration, considering, as it appeared, that it would be well first to try the effect of the new law without such a provision, which could afterwards be added if experience showed that it was required. Accordingly the Bill was reported to the House without any such amendment, and became law as the Merchandise Marks Act (1862).* By this Act "the various offences which it defines, such as the forging or application of a genuine or a false trade mark, or of a colourable imitation thereof with intent to defraud, are declared to be misdemeanours, and to be punishable by penalties recoverable in an action of debt, or by summary proceedings before two justices by action for damages, by imprisonment, with or without hard labour and fine, for not more than two years, and by forfeiture of the articles fraudulently marked."* The remedies thus defined were additional to those already described by Willes, J., who said (*Reg.* v. *Gray* and *Gosling*)† "In cases like the present the remedy is well-known; the promoter may, if he pleases, file a bill in equity to restrain the defendant from using the wrapper; or he may bring an action at law for damages, or he may indict him for obtaining money under false pretences." The last remedy has, it is stated, never been employed.

The operation of the Act has been, so far as it goes, unquestionably beneficial. It is true that the older methods of protection are still adhered to, as being in many cases the most convenient, but I believe that since the passing of the Act there have been fewer prosecutions, and the practice of pirating trade marks, both in this country and abroad, has largely diminished.‡ No doubt this beneficial result is, as regards foreign countries, in a great measure due to the adoption, in nearly all commercial treaties, of a clause for reciprocity in the protection of trade marks, by which the proceedings of foreign pirates have been extensively suppressed. Still, a good deal of the improvements can only fairly be attributed to the Act of 1862. The principal good resulting from enactments of this character comes, after all, from their deterrent effect in preventing crime. It is a notable fact that those who have set themselves to prey on their honester neighbours by trafficking under their names, have generally made themselves well acquainted with the law, and it is this acumen of theirs that renders detection and punishment difficult. The clearer the law, and the less room there is for evasion, the less easy it becomes for these gentry to invent some flimsy pretext which they may set up as a defence for their rascality.

That the Act of 1862, however, has not entirely effected its purpose, and that the objections to registration were not well founded, is shown by the persistent efforts which have been made to establish a registry in this country, and by the advantages resulting from the establishment of one in other countries. In 1866, a Bill was introduced by Mr. Bass for the purpose, and the proposal was revived in 1868, both times without success. In 1873 a very elaborate Bill was brought in by Mr. Chichester Fortescue (now Lord Carlingford) but this came to nothing, and last session was passed the Act which is to come into force practically at the beginning of next year.

We may now, therefore, be said to have obtained a registry of trade marks, and the question is, what good results may we expect. It has been remarked

+ "The Merchandise Marks Act." With Notes by H. B. Poland. London. 1862.

* "The Law of Trade Marks." By Edward Lloyd. London. 1865, p. 12.

† *Ibid.*, p. 11.

‡ That there is still room for much improvement is shown by such cases as those which occurred during the last Vienna Exhibition, in 1873. Messrs. Christie, the well-known hatters, and Mr. Atkinson, the perfumer, of New Bond-street, both brought successful actions against German tradesmen who were selling imitations of their manufactures. The particulars of these are given in an appendix, by Dr. Weinmann, to the Reports on the Vienna Exhibition.

above that nearly all the manufacturers or traders who were examined before the 1862 committee were in favour of registration, while on the whole it may be said that the legal authorities were against it. That a strong feeling exists in favour of something of the kind is evinced by the attempts made by a large number of proprietors of trade marks to protect them by a quasi-official registration of them at Stationers'-hall as artistic designs or as printed matter, according to the predominance of the pictorial or literary element. The advantage thus gained must, one would fancy, be but slight, but still it has been a common practice. A still simpler method has been to put "Registered" under their mark without going through the form of entering it at Stationers'-hall, or anywhere else.* There is, therefore, no doubt that very much is expected from the new scheme. How far are these expectations likely to be realised? To this a definite answer can hardly be given until we know precisely what form the Lord Chancellor will give to the system by the regulations it rests with him to draw up. Should the new code be such as manufacturers and the public generally have a right to expect, the wisdom of the method by which the Act was passed will be proved. Attracting little notice, and meeting with no opposition—except from the Sheffield Cutlers' Company, whose rights were not saved in the original draft of the Bill—an Act was successfully passed which ought to prove, in its consequences, one of the most important of the Session. As the *Times* observed, in commenting upon it:—"If it fulfils its promise, a great public service will have been done in a manner so singularly quiet and unobtrusive as to make us the more inclined to marvel at the noise and waste of time which too often attend the working of the Legislature."

Assuming, however, that the scheme will work as well as we have every right to expect it will, the resulting advantages may be briefly summed up as consisting of:—(1.) Simplicity of procedure in protecting trade marks. (2.) Facility of transfer of business and goodwill. (3.) A guarantee of originality to the owner. (4.) Security to the public by giving information as to genuine trade marks. Of these the first is beyond question the most important. At present the process of proof of ownership is tedious and costly, while it has to be repeated over and over again in every action for infringement. With a registry the certificate of the registrar would be at all events presumptive evidence of ownership, that is, the *onus* of proof that he had any right to the mark would be thrown on the defendant. It is to be remembered that the question of "user" does not arise, for, in the language of the Act, "Registration of a trade mark shall be deemed to be equivalent to public use of such mark." The process is thus rendered quite summary and inexpensive. The knowledge that so rapid and easy a process exists for the punishment of fraud will doubtless, on the principle before referred to, act most efficiently to deter attempts at infringement. This deterrent effect, like a notice that "Trespassers will be prosecuted with the utmost rigour of the law," is really the chief advantage of the whole system. The honest trader wishes to conduct his business in peace and quietness, and the process of going into a court of law to defend his rights is only less unpleasant to him than to the intruder whom he is bound to punish, for the sake of his own rights. The mere fact of being able to put "Registered" on his label is no small protection against imitation.

* Since the passing of the Act the authorities of the Stationers' Company have refused to register anything ostensibly a trade mark.

As regards facility of transfer, the recognition of property in a mark enables a proprietor to dispose of his business and goodwill without the inconvenience of having his name used. It is very possible that an extended use of trade marks, resulting from facility of protection, may render such a method of transfer more common than it is at present.

Next comes the advantage of providing manufacturers with information as to the trade marks of others. It has happened—not perhaps very frequently, but still cases have happened—that manufacturers have adopted marks already in use, simply because they had no opportunity of ascertaining the fact. A manufacturer now may select a mark, spend money in advertising it, use it for a short time and gain a reputation for it, and then suddenly discover that he has been using the mark of another firm, one which he has no right to, and could not defend in a court of law. With a properly kept register no such case could arise, except through gross carelessness. It would be the natural course for any person proposing to use a new mark, first to make a search, either himself or by an agent, to see whether anything like the mark he proposed was already registered. Having found that it was in truth not only new, but so unlike any other as to avoid all chance of confusion, he would feel more secure in his possession, and his mark would be of greater real value to him. Not only this, but it is probable that large users of trade marks would keep a watchful eye on the register, and if any mark nearly resembling their own was brought in for registration, they could at once enter an objection. It is obvious that any person using an unregistered mark would lay himself open to grave suspicion, especially if such a mark bore even a distant resemblance to that of any well-known manufacturer.

The third point, the direct protection of the public against spurious marks by giving them the opportunity of becoming acquainted with the genuine is not, it may be allowed, of much real practical importance. There is no doubt that those whose business it is to become familiar with the trade marks used by any particular firm or set of firms, can do so even without the added convenience of a registry. The ordinary retail customer will only retain a general remembrance of the crown, the anchor, the bull's head, he knows should be on the goods he requires. He will certainly not go to a Government office to inspect a register and see what the exact shape of the crown may be, whether the anchor is turned with its flukes up or down, or if the bull's likeness is taken full face or in profile. Still some good will be achieved even in this direction. Very probably the public may become more familiar with the marks when they are registered, especially if they are properly published and advertised, and at all events there will be an opportunity given to those

who choose to use it, of inspecting the manufacturers' trade marks and becoming familiar with them. Even if it did nothing more it would offer to the buyer a ready and simple means of verifying the mark on his goods.

It has, indeed, been suggested that those most interested in trade marks, as being the most frequent employers of them, can gain little advantage from registration, their marks being already familiar and well known. But even in these cases the question of legal proof remains the same, and Messrs. Bass or Messrs. Allsopp must bring the same amount of evidence to prove their right, as if their chosen symbols were less familiar than they notoriously are. Besides, it is an acknowledged fact that the number of trade marks pirated is comparatively few, and that these are pirated over and over again, when the whole process has to be repeated *ab initio.* Surely it is no small gain to the owner of such a mark that he can pursue and punish several offenders with no more expense and trouble than it formerly cost him to expose a single one.

Registration indeed will not do much—except by its indirect effect—in preventing such frauds as putting inferior goods into a receptacle bearing a genuine mark. The frequency of this practice is but too evident. It has been often brought to notice that retail dealers refuse to take back beer bottles of which the label has been defaced. A curious instance of this was reported from India; a native servant begged his master not to spoil the label of a bottle of Bass's ale, as he would then only get one pice for what would otherwise be worth two. That there is a regular sale for champagne corks bearing good brands is also a a well-known fact. These and such other frauds on the public and on the manufacturers of the genuine articles can only be so far checked by registration, inasmuch as the process of punishment is made somewhat more easy.

It is, however, obvious that none of these advantages can result unless both the Act itself is efficient, and it is worked in an efficient way. The Act itself is good so far as it goes, but it goes such a very little way that its effect will depend entirely on the method of its application. It commences by establishing a registry of trade marks, and directs that no person shall be entitled to institute any proceedings for any infringement of a trade mark after the first of July next, unless such trade mark be registered; it also provides that an office shall be opened not later than January the first, 1876, for the registration of marks. A trade mark is defined in the following words :—"A trade mark consists of one or more of the following particulars; that is to say, a name of an individual or firm printed, impressed, or woven in some particular and distinctive manner; or a written signature or copy of written signature of an individual or firm; or a distinctive device, mark, heading, label, or ticket; and there may be added to any one or more of the said particulars any letters, words, or figures; also any special and distinctive word or words, or combination of figures or letters used as a trade mark before the passing of this Act, may be registered as such under this Act." Each mark is to be registered as belonging to "particular goods or classes of goods," and this will consequently require some sort of classification to be drawn up, under one or other heads of which the mark may be entered as received. The registrar is not to receive a mark similar to, or colourably resembling one already registered for the same class, so that a previous examination will be required, before a mark can be registered, and the act of registration will of necessity confer an authoritative right to the mark. The person registering has also to give "*prima facie* evidence of his right to the exclusive use of such trade mark." A mark must belong to particular goods, or classes of goods, and can only be assigned or transmitted in connection with the goodwill of the business; and it is determinable with such goodwill. The registration of a trade mark shall be *prima facie* evidence of proprietorship, and, after the lapse of five years, such registration shall be conclusive evidence of the exclusive right of the person registering to the sole use of the mark. In case of the subsequent registration of the same mark by another person, his title shall be subject to the adverse claims of any person claiming under or through the first proprietor. In case of any registration of a trade mark by any person who is not entitled to the use thereof, or in case of the refusal of the registrar to receive any mark for registration, or if a mark which is not a "trade mark" within the meaning of the Act, be registered, "any person aggrieved" may apply to the superior courts to have the register rectified. When several different persons claim to be registered as proprietors of the same trade mark, the registrar is empowered to refuse to make any entry until the rival claims have been settled by the superior courts. The court has power to direct an issue to be tried for the decision of any question of fact which may require to be decided for the purpose of the appeal. It shall not be lawful to register as part of, or in combination with a trade mark, any words which, by reason of their being calculated to deceive or otherwise, would not be entitled to protection in a court of equity. This provision will demand considerable legal knowledge on the part of the registrar, and will, as do some of the other provisions of the Act, throw on his shoulders a very serious responsibility. The rights of the Cutlers' Company are preserved, and the Act provides that copies of all Sheffield marks now in use shall be transmitted to the registry. Sheffield marks, granted by the Cutlers' Company, may be registered at the principal registry in London for additional security, but no marks for steel goods will be placed on the register in London without giving notice to the Cutlers' Company. The authorities of the Cutlers' Company on their part will be bound to give the registrar of trade marks due notice of all applications for the assignment of marks, and they cannot proceed to assign a mark until after the expiration of a certain time.

That the new rules will be sufficient and satisfactory there is of course every reason to expect. With the experience of the Patent-office to guide them, the Commissioners of Patents have ample means of elaborating a system. There is of course a difficulty in estimating the amount of labour involved, and the consequent amount of preparation to be made, but with the resources of the Patent-office to fall back upon, such slight obstacles will, doubtless, be overcome; and though

it is certain that there must be hitches and difficulties at first, yet I think we may feel assured that a very few weeks will see the whole in working order. It is true that there seems a considerable delay in publishing the rules, but though they are not yet published we may fairly assume that they are by this time nearly ready, and that the consideration of a matter of such importance has not been postponed till the last moment. The arrangements for carrying out the new Judicature Act have doubtless fully occupied the time of our chief legal functionaries, and this is a sufficient excuse for a certain amount of backwardness. Still, however far the process of organisation may have been carried, it will, I think, in some slight degree, be simplified, if it is made quite clear what are the requirements and the wishes of those most nearly interested in the question.

As the simplest and clearest method of bringing the matter before the meeting, I have noted under separate heads the points which it seems should be principally attended to. The experience of those present will doubtless suggest others. These points are:—

1. As to novelty. How far should the responsibility of search be thrown upon the registrar, and how far upon the applicant.
2. The classification to be adopted.
3. The period for which registration should hold good.
4. The fee. Should it be annual, or should there be but a single payment.
5. What method of procedure should be adopted for registry.
6. The manner of publication, and the provisions for public inspection.

It will be convenient to take these in order. As to the first head, the question of novelty:—

The Act expressly states that, except with the special leave of one of the superior courts, the registrar shall not "register in respect of the same goods, or classes of goods, a trade mark identical with one which is already registered with respect to such goods, or classes of goods, or so nearly resembling the same as to be calculated to deceive." It will therefore be necessary for him to make a search through all the trade marks already registered in that class before he can sign the certificate. Now experience shows that in the corresponding case of patents such searches involve considerable length of time' and are beset with considerable difficulty. In our own office no attempt at a search is made, but a patent is granted to anybody, at his own risk, without any guarantee as to its value. In the case of trade marks this certainly could no be done, or it would be a source of mere confusion. On the other hand, it is more than probable that when the marks become very numerous such a search would be a lengthy and troublesome affair, and would require a large staff to carry it out properly. It must be remembered that an index to the marks themselves cannot possibly be made. They may indeed be classified, as we shall see presently, so as to lessen the labour of a search, but this is all. It would therefore appear advisable to throw the work of ascertaining novelty as far as possible on the applicant, and this might be done by adopting a suggestion frequently put forward for the case of patents. The applicant might be required to send in with his application a declaration that he had made, or had caused to be made, diligent search through the register, and that he had not succeeded in discovering any mark at all resembling that submitted for registration, or if he had discovered any such, he should make a reference to the same in his application. The registrar could then compare the old and new marks, and register, or refuse to register, accordingly. There can be no question that at first, until all existing marks have been brought on to the register, a great many difficulties will arise. No one who had not taken the trouble to look into the matter would imagine how often the same, or a slightly different mark, is adopted by various firms. Crowns, anchors, eagles, lions, arrows appear over and over again as the emblems of different manufacturers or traders, and though they are generally applied to different classes of goods, yet the applications frequently trench so closely upon one another as to make it certain that many knotty points will be occurring for the decision of the registrar.* As soon as the great mass of trade

* In order to show the frequency with which certain emblems are repeated, and the consequent difficulty of deciding between rival claimants to the use of the same or a similar mark, the following list is given of firms using three of the most popular marks, a crown, an anchor, and an eagle. The lists are merely the result of a very cursory examination, and might probably be doubled or trebled without much difficulty. In some cases the marks are almost identical, in others the resemblance is less obvious, so that practically the marks may be considered perfectly distinct. Similar lists might readily be prepared of firms using such emblems as a horse, an arrow or arrows, a lion, a cross, a double triangle, &c., &c.

Firms using a Crown as a Trade Mark.

Smith and Withers, Deptford, wharfingers.
Pearson and Knowles, Warrington, engineers.
Barry and Co., London, cocoa, &c., merchants.
J. Russell and Co., Wednesbury, tube makers, &c.
Bees and Moore, Adelaide, aerated water makers.
J. Peace and Co., Sheffield, metal founders.
Preserving Meat Company, Sydney.
Crown Perfumery Company, Strand.
Tull, Glanville and Co., London, kamptulicon makers.
W. B. Wright and Co., Bristol, galvanised iron workers.
M. P. Manfold, Northampton, boot and shoe manufacturer.
W. S. Thompson and Co., London, stay makers.
E. Senior and Son, Sheffield, cutlers.
Homes and Hickton, Birmingham, nail makers.
Burgon and Ball, Sheffield, cutlers.
Heath and Son, London, iron workers.
Turner and Co., Sheffield, cutlers.
Warrington Iron Wire Company.
Moore and Manby, Dudley, iron workers.

Firms using an Anchor.

Barclay and Perkins, London, brewers.
G. Wood, Adelaide, grocer.
G. Porter, Adelaide, brewer.
Izod, London, stay maker.
T. F. Bristow and Co., London, perfumers.
C. T. Tyler and Co., Woking, provision dealers.
Canada Tanning Extract Company, London.
Clark and Co., Paisley, thread makers.
J. D. Davenport, London, chemist.
Stirchley Nail Company, Staffordshire.
G. Webb, Birmingham, nail maker.
Askham and Renton, Sheffield, tool makers.
Petre, Philip and Co., Dublin, whisky.

Firms using an Eagle (or Falcon).

Burton Brewery, Trent.
W. K. and C. Peace, Sheffield, tool makers.
W. Blews, Birmingham, metal workers.
Eagle Edge Tool Company, Wolverhampton.
J. Fletcher and Sons, Salford, metal founders.
L. J. Levinstein and Sons, Blackley, dye makers.
J. Elwell, Birmingham, iron and metal merchant.
Child Brothers, Birmingham, manufacturers of bolts, nuts, &c.
Seebohm and Dieckstahl, Sheffield, steel works.
J. Fairbrother, Sheffield, steel works.
J. T. Morton, London, provision merchant.
Middlemass, Edinburgh, biscuit maker.

It is hardly needful to say that no suggestion is intended as to the right of any of the above firms to use their mark, nor does the writer

marks now in use are on the register, the difficulty will be much diminished. Supposing that two firms have both been in the habit of marking their goods with marks almost exactly similar. Say that a needle maker at Redditch and a pin manufacturer at Birmingham have both been using a crown as a trade mark. I presume needles and pins would be classified together, and the registrar would be justified in refusing to register the crown for the second of the two applicants. Now, both having an equal right, it would be manifestly unfair that the needle maker should be allowed to register his crown on January 1, and the pin maker should be refused on January 2, because of a prior application. Hence I take it that until all marks actually in use are brought on to the register, there must be a certain amount of laxity for which there could be no reason in the case of newly-invented marks. The possible variety of designs is so infinite, that there can be no justification for the adoption by any person of a mark resembling one already in use. It is true that it has been stated on authority that the Cutlers' Company find a difficulty in contriving new marks, but then it is to be remembered that all their marks are of a very special class, they must be simple, and shown by a very few lines, so that they can be stamped on a knife blade, &c. In these there is little room for variety, since it is only very wide differences that can be distinguished at all.

This leads us naturally to a consideration of our second point—the method of classification to be adopted. There can be no question as to either the importance of a good classification or the difficulty of drawing one up. No one who has not had experience of such work can imagine the extreme difficulty of thus mapping out all industries into a number of classes, none of which shall overlap or interfere with any other. To my mind this is the greatest difficulty in the way of drawing up the scheme required, and I believe that, unless great care and thought is given to this point, it will be a very serious hindrance in the whole execution of the new system. Still this is not a point to be settled by discussion, and it may, perhaps, be left, with the observation that the scheme should be as broad and comprehensive as possible, so that only trades differing in the widest possible way should be allowed to use the same mark. Thus, while a cutler and a starch manufacturer might certainly use the same mark, it would be inexpedient to allow the makers of any two articles of food, however dissimilar, to designate them by a like symbol.

To each of the main headings, of which, perhaps, there might be about twelve, would be appended a list, as far as possible complete, of all the trades and manufactures included therein, so that any person wishing to register would have no difficulty in deciding under which class to do so. Perhaps it might be as well to allow the applicant to register under as many classes as he liked, but to charge a separate fee for each. This would tend to prevent attempts at claims for registration under many heads, and consequent complication of the register.

The next two points are dependent on each other. For the sake of clearing the register, it is advisable that the right to a mark should lapse after a certain interval, when re-registration should be required. If this interval be a short one, and if a new fee be required at each fresh registration, the fee, both in the first instance, and for the re-registration, ought certainly to be smaller than might fairly be asked if a single payment were to cover the grant in perpetuity. The Bill brought forward two years ago by Lord Carlingford laid down a scale of fees which included a charge of £5 on registration and an annual payment of £1. It may be worth notice that in the Bill as originally brought in last session, a reference was made to an annual fee, but this was struck out in committee, and the Act as it now stands gives no hint as to the amount or the manner of payment. The charge by the Cutlers' Company is £2 10s., and the grant endures during the life of the grantee and of his widow. The practice of foreign countries varies widely; in America the charge is 25 dollars (£5), the German fee is 50 marks (£2 10s.), the Spanish 100 reals (£1 1s.), the Austrian 5 florins (10s.), the French a merely nominal fee of 2 francs. The duration of the protection also varies, but without reference to the charge. In France the registration holds good for 15 years, in Germany for 10, in the United States for 30. On the whole the ten years period appears to be as good as any, and a smaller fee might be fairly charged for re-registration. With regard to the amount of the original fee it seems certain to me that it should only be sufficient to cover the expenses of the office. There can be no just reason why a particular class of the community—even though that class be a wealthy one—should thus be indirectly taxed in the conduct of their business. There exists already one example of this evil system. The Patent-office—or to speak more precisely, the inventors whose fees are swallowed up by the Patent-office—is mulcted yearly in some £100,000* while the Treasury refuses the necessary funds for carrying on in a proper way what ought to be the principal scientific department of the Government. There is indeed a feeling among many manufacturers that a large fee, £10 or more, should be charged, so as to provide a check on the number registered. It is difficult to see the reason for this, or what good there can be in thus limiting the use of trade marks. As to convenience of registry, that ought not to be considered. It is the duty of the office to suit its arrangements to the requirements of the public, not to force those requirements to come within the limits of its convenience. The fee charged ought to cover all possible necessities of the office, it should pay a sufficient staff, cover charges for printing, indexing, and the like, but that is all.

Till some estimate can be formed of the probable number of applications, it would be difficult to fix the exact fee, but perhaps it may be admissible to throw out the suggestion that a fee of two guineas would suffice for all necessary charges, with a fee of 10s. for re-registration.

wish it to be understood that there is an undue similarity between any two or more of them. The list is merely given for what it is worth, as showing the natural tendency to repeat the same or like ideas. It is hoped that no inaccuracy of any importance has been made in the list, but the writer has not had the opportunity of properly verifying it, so that it is very probable some slight errors n the names, trades, &c., may have escaped notice.

* The surplus income of the Patent-office for 1874 was £110,618.

The charges for transfer or for alteration of register might be on a like scale, £1 or 10s. It is hardly necessary to say that all registers should be open to the public free, while *fac-similes* should be published by the Commissioners themselves, or with their authority, so as to preclude any necessity for obtaining—except in special cases—office copies of the documents in the registrar's keeping. It might be necessary to charge, as is now done in the Patent-office, a small fee for inspecting original documents, in order to preserve them, but as every document of public importance in that office is printed, and can be consulted by anyone who will walk into the Patent-office library, this is no hindrance whatever to public searches. On this point, however, more will be said hereafter.

We now come to the fourth head, the system of procedure. The simplest method of proceeding to obtain registration would be something of the following sort. The person proposing to register a trade mark would be required to deposit two *fac-similes* of it, of a certain specified size (say, the sheet of paper containing it to be $11\frac{1}{2}$ inches by $7\frac{1}{2}$ inches—the size of a printed patent specification), and such description as he might consider necessary. He would also be required to send in a statement of his name and address, the class of goods to which the mark was applicable, the manner of applying it, and also—as above suggested—a declaration that he had made, or caused to be made, due search through the official indexes, and that to the best of his knowledge and belief, no similar mark was then upon the register, or if any similar one existed he should be required to make reference to the same, and show how his mark differed from any one or more in use at the time.

There is one point here worth considering, and that is that very many marks, especially those used in the cutlery trade, cannot well be represented in a drawing so as to show the precise effect produced on the steel by the punch. In the register of the Cutlers' Company, the marks are represented by an impression from the punch itself, blackened in a smoky flame, and this rough-and-ready process is stated to show plainly enough all that is wanted. Still it is presumable that cases may arise in which a drawing or representation of any sort on paper would be insufficient. In such cases it might be allowable for the applicant to send in, besides his drawing, an example of the mark itself impressed on a specimen of the manufactured article, or a piece of any suitable material, metal or otherwise, provided the specimen was of such a character that it could be conveniently attached to a page in a book. The Act for the registration of designs permits samples of the goods to be registered, and I understand that the practice of the office has been only to receive these samples when they are of such a nature that they can be conveniently preserved in the above manner. In the case also of labels to be attached to a bottle or other receptacle, it is certain that the applicant should be permitted to file a specimen of the label, provided it came within the specified limits of size. In all cases the drawing might be coloured or not, as the applicant chose, but the mark as filed should be taken to be in in every respect the very identical sign, as regards colour, form, general appearance, and the like, with which the goods will be marked.

Of the two copies sent in, one should be signed by the registrar, stamped, dated, and numbered with a successive number, these numbers being, either current from the beginning, or, as in the case of patent specifications, commenced afresh the beginning of each year. This should be returned to the applicant as soon as the mark had been entered on the register, and in the meantime he should receive a certificate that the mark had been sent in for registration. The other copy, similarly numbered and dated, would be filed by the registrar.

The application having been made, a certain time should be allowed for objection, perhaps six months, to allow time for objection on the part of foreigners or residents in the colonies, who possessed trade marks registered in England. During this time the mark would be provisionally protected, and at the end of the period it would be secure from objection without further proceedings. It would be the duty of the registrar to publish as widely as possible by advertisement the mark chosen, immediately upon the application, and at suitable intervals during the six months of probation. This should be done as widely as, or more widely than, applications for patents are now published. These are advertised in the *Commissioners of Patents' Journal* and in the *London Gazette*, the latter being, for all practical purposes, useless. The official announcement is made in the Patent-office Journal, and this is quite sufficient. Every inventor or manufacturer can procure this periodical, while the *Gazette* does not reach the class intended at all. As a matter of fact, very few private individuals either take in or purchase the *Commissioners of Patents' Journal*. According to an answer of Mr. W. M. Michell, one of the principal clerks in the Patent-office, to the Committee on Patent-law, in 1872, only 500 are printed; of these about 120 are distributed to public libraries, &c.; a small proportion are subscribed for, and part of the remainder are sold singly. What is the average number disposed of weekly is not, I believe, stated in any return on the subject; at any rate it is very small, and probably very few of those given away are ever looked at, except in the libraries of the great manufacturing towns. The real publicity is obtained through the technical and the trade journals. Two of the latter, *The Engineer* and *Iron* (the successor of the *Mechanics' Magazine*), publish weekly all the important information contained in the Commissioners' *Journal*, and the other weekly official publication, containing abridgments of the current specifications. *Engineering* used at one time to publish a selection from the lists of applications, &c., but has now given this up. The trade periodicals extract from the same source all the matter bearing on the special subjects to which they are devoted. Thus we have on the one side an official and authentic publication for the parties specially interested; on the other the most extended publicity. The value of the official Journal is unquestionable; it has been imitated by the United States office and in our own colonial offices, and in every case it has been found equally useful. We may assume that the Commissioners will publish in it a weekly or bi-weekly list (the *Journal* appears every Tuesday and Friday) of applications for and grants of trade marks.

This has long been done in the United States Patent-office *Official Gazette*, in which from ten to twenty applications appear weekly. Probably also the applications will be published in the London *Gazette*, and the further publicity thus obtained will be a unquestionable gain, though perhaps hardly worth the cost incurred. It has also been suggested that the applications should be advertised in the local newspapers, but this again would be a very slight and partial help. The honest trader might almost be trusted to advertise his proposed mark for himself, so obviously is it his interest to take every precaution to secure his right before he proceeds to spend his money, so to say, in establishing the reputation of his mark. The laws, however, are made for knaves as well as for honest men, principally indeed for the former. It will, therefore, be necessary for the registrar to adopt some means of advertising applications as widely as possible, so that every registered proprietor may have the greatest available facilities for watching the registry and stopping the issue of any mark unfairly representing his own. In doing this it will be of very little use indeed to give only names and descriptions. A reproduction of the mark itself ought certainly to be advertised. In Germany a reproduction of every trade mark as registered is given in the supplement of the *Deutsche Reichs-Anzeiger*, or official Gazette of the Empire. There is also an unofficial publication which gives them in a very superior manner to that adopted in the Gazette. In France the Ministry of Commerce has authorised the publication of a similar work by a private individual. That a wide publicity should, in one way or another, be obtained, is perhaps the most essential point of the whole scheme. However careful the registrar may be, he is certain to make occasional oversights, but if the power of easily watching the registry is given to the public, such oversights will be of less consequence. Any person whose trade mark is infringed by one similar thereto will have only himself to thank for not having kept a keener watch over his own interests.

At the expiration of the provisional protection, the mark would be duly entered on the register, unless want of originality had been proved to the satisfaction of the registrar, either from his own examination, or through the objection of any proprietor of a similar mark. In this case he would refuse to register unless ordered to do so by the superior court on appeal. In either case he should send notice to the applicant that he had registered or had refused to register. This might be done by retaining the duplicate copy in his keeping, and returning it at the proper time stamped and signed, or with notice of refusal stating the cause therefor. Should the mark be refused registry, it would probably not be desirable that the fee should be refunded, as the chance of its loss would induce applicants to be careful in making searches for themselves, and would thus tend to relieve the Registration-office of very much useless labour. The Act provides that after a period of five years has elapsed, the proprietor shall enjoy an indefeasible right.

With regard to the proposal of a provisional protection, it is to be noted that the registry would be considered complete at the end of six months (or other period determined upon) without any further action on the part of the person registering. He could, therefore, if he had made a proper preliminary search, and assured himself of the novelty of his mark, use it from the date of his first application, and treat it in all respects as if the final grant had been made. There need therefore be, in practice, no interval of uncertainty, during which the right to the mark is doubtful, provided due care had been exercised in the matter. The only practical difference would be that during six months the proprietor would hold one sort of certificate, and after the end of that time another.

To pass on from the question of immediate publicity to another only less important, that of the provisions for public inspection. Since the matter has passed into the hands of the Commissioners of Patents, it may safely be assumed that the method will be adopted which has been so successfully carried out with regard to the specifications of patents, and that all documents of importance will be printed and published as soon as possible. In the case of a trade mark the document left with the registrar might be lithographed in exact *fac-simile*, with colours if necessary, and published at once. It is to be hoped that arrangements will be made by which this can be done from the very beginning, and that the issue of specifications of trade marks may be carried on with the same regularity as that of the patent specifications. These copies would be distributed in the same way as the Patent-office publications now are, so that it would be as easy to make an accurate search at Manchester or Birmingham, even at New York or Melbourne, as in London. It would be quite worth while that each mark should thus be printed and published separately, both for a permanent record and for the convenience of the manufacturer, who would always be glad to have at his command a number of official certified copies of his mark. It would even be well that, prior to printing, the applicant should have the option of ordering at his own cost any number of his specification he might require. An index of names and a subject-matter index would obviously be required, and it is a question whether some attempt should not be made at an index to the character of the marks themselves. This would certainly be very difficult, but if it could be managed it would be an immense aid to searches. Even a division into some half-dozen classes would be very useful. For instance, we might have (1) initials, cyphers or monograms; (2) figures of animals; (3) representations of inanimate objects; (4) arbitrary symbols (squares, triangles, stars, crosses, &c.); (5) names or signatures; (6) miscellaneous (to include any not coming under one of the above marks). If we had as suggested twelve classes of goods, and the marks for each class arranged under these six heads, it is obvious that the number of entries to be examined for each search would be very materially reduced. Further classification than this would probably be undesirable as tending to cause uncertainty.

Such is, in outline, a scheme which, I venture to think, would meet most of the requirements of the case. It is obviously not practicable to draw up beforehand a perfectly complete and satisfactory code, nor is the above sketch more than a sort

of skeleton on which the whole system might be hereafter built up. Much more thought and care would have to be given to it before it could fairly claim even tolerable completeness. It must, however, be remembered, that unless the work is begun on a regular and fully organised plan, it can hardly ever afterwards be systematised, and that upon the practice of the first few weeks will depend that of the years to follow. Hence I do not think that time can be wasted in discussing even the minutest details of the system, since it is on the organisation of the details that the proper working of the system depends. Once properly started, the whole thing becomes a mere matter of routine which works itself, but the proper construction and arrangement of the machine requires not a little thought and care. Surely then it is well worth the while of those to whom this matter is one of real practical importance to devote a little time and consideration to it once for all. This must be my excuse for having entered perhaps unduly into detail. I have done so because it seemed to me the best way of bringing the matter before the members of this Society and that portion of the general public who are concerned in the question.

I could indeed wish that the task had been entrusted to more capable hands than my own, and that greater legal knowledge, more extended experience of the special interests involved, might thus have been brought to bear upon it. I was merely induced to study the question by the fact that circumstances have obliged me to acquire a considerable familiarity with the ordinary practice of the Patent-office, and I thought that the experience thus obtained might serve as a guide towards the most suitable method of dealing with a very similar set of circumstances. At all events, I hope the suggestions I have been able to put forward this evening may not be without value in aiding the proper accomplishment of an object to which many, both of our legislators and our commercial authorities, have devoted a very considerable amount of thought and time. Such as they are, they are offered for the fullest possible discussion and criticism. Should any useful results arise out of them, should they have directed attention to any points which might otherwise have escaped notice, my endeavours will have received their full measure of reward.

DISCUSSION.

Mr. Campin was much pleased that this subject had been taken up by Mr. Wood, but he must say, knowing something of the Patent-office, that it looked rather like a joke to commit to the present Commissioners of Patents the superintendence of this matter. That body consisted of the Lord Chancellor, the Master of the Rolls, and the law officers of the Crown, none of whom knew anything of commerce or trade, and therefore if they were to do any good they must first have the necessary information supplied to them. They would no doubt listen to any well devised suggestions, but he thought they must really look to their secretary, Mr. Woodcroft, to do what was wanted. As far as he could learn, the registration of designs had not worked more satisfactorily under the Commissioners of Patents, but rather less so than under the Board of Trade. It should be remembered that there was this important difference between patents and trade marks, that copying or infringing the latter was really analogous to forgery, while the infringement of a patent was merely interfering with a private right of property. He had no doubt that the Chairman, who had taken a great part in endeavouring to improve the Patent-laws, would also use his best endeavours in this matter, and, if it must be left in the hands of the Commissioners of Patents, would do his best to get that body improved in constitution. After a great many years they had at last got a Bill passed of a *bona-fide* character, but it was a law Bill, and if any dispute arose litigation would still be necessary, as the Commissioners had no power to decide disputed questions.

Mr. P. L. Simmonds said this question was one of great importance to trade and commerce, and he believed it would in the first place tend to elevate in some degree the morality of trade, because the man who put a stamp or mark on his goods would be cautious as to the character of the goods he issued. There was no doubt that English commerce had suffered in foreign quarters by the injurious character of the goods sent out, such as over-sized cottons, woollens with too much shoddy in them, papers loaded with 50 per cent. of clay, and silks so badly dyed that they would not wear. It had been suggested in France that trade marks should be compulsory, but such a thing would never be carried out in a free country like England. Still the practice was rapidly extending in many quarters. He feared the present Act was too wide in its definition, because it stated that a person might use any signature, name, word, or hieroglyphic, and the question arose whether it would not be necessary, in the case of a manufacturer's name, to require some distinguishing mark as well. There were names, such as Brown, Smith, and others, which were very common, and would clash with each other unless combined with a mark of some kind. Again, any common word must not be used, such as "nourishing" in connection with stout. In America such names, and also names of places such as "Glenfield" were forbidden to be used as trade marks. Another question arose whether the registration would extend to the colonies, or whether a separate registration would be required in each colony. Again, foreigners would come in to register their trade marks, and some of them would be similar to our own. Classification had been referred to, and it was an important question how the marks were to be classified. His experience in connection with various exhibitions had shown him how difficult this was; for instance, tobacco had generally been classed with food; and many tobacco manufacturers used trade marks, and some of them several. The fees he thought should be as low as possible, and with regard to publicity, it was very important that the announcements should not be confined to the *London Gazette* and the *Patent Journal.*

Mr. Chadwyck Healey proposed to consider the Act from a technical rather than a commercial point of view; to take the Act as it stood, not as it might or should have been drawn; and to consider how far it was possible to make it work well. It was, however, necessary, he thought, that a true distinction should be drawn between patent-right, copyright, and the *quasi*-property which exists in a trade mark. If this distinction were not fully realised, there would always be a risk of erroneous deduction and false reasoning. The cases of patents and copyright were very nearly allied to the old monopolies. A man introduced a new manufacture, and thereby secured to himself and his assigns certain exclusive rights in connection with such manufacture. Every one purchasing the machines or goods, the subject of that manufacture, would realise that he was purchasing, and could only purchase, from one man or his assigns. That was not so in the case of a trade mark. That was not an artificial creation in the nature of a premium upon discovery, but a natural outcome of the law which ever protects the industry of a man against the attacks of cheats. The law refuses to allow any person to profi

by the superior business capabilities or resources of another, by passing off upon the unwary goods of his own as those of another maker. The goods themselves may be the subject of manufacture by anyone who chooses to undertake the task; they may not be the subject of any patent-right whatever; but in any case the law would not allow an article to be fraudulently passed off as the manufacture of a person having some celebrity in the particular line of business, to his prejudice and the injury of the public. Then as to the Act itself, he submitted that in practice considerable difficulties would be found to arise under the construction of the 6th and 10th sections. The definition of a trade mark contained in the Act of 1875 was not nearly so comprehensive as that embodied in the Act of 1862. He conceived that, under certain circumstances, the name of a maker was in itself a trade mark; indeed, Lord Westbury had already, in the well-known case of *Hall v. Barrows*, pointed out that the name of a first maker often became a sign of quality. It is true that name in its turn might come to signify the article itself, as, for instance, in the case of a Wellington boot, a Brougham carriage, Harvey's sauce, and so forth. He thought, therefore, that it was hardly clear to what extent a mark of that nature could be the subject of registration.

Mr. Mundella here observed that when the matter had been under consideration by the Committee, they had been advised that a name alone could not properly be registered, but that all the existing legal remedies would still prevail in respect of it.

Mr. Chadwyck Healey agreed entirely with the chairman. There was no doubt that the law upon that point was clear, that the use by any man of his own name could not be restrained, but he was about to suggest that between the mere use of the name and the conventional trade-mark—as to the right of registration of which latter there could be no doubt—there might be many cases which would be so finely balanced as to create the gravest doubt, and be productive of much litigation, before the right to registration or the contrary could be established. Then, again, many manufacturers relied upon peculiar forms of bottles or jars—most people, for instance, were familiar with the exhibition in shop windows of preserves enclosed in cups having saucers for lids—particular methods of packing their goods, either as to wrapper or otherwise. All these he submitted were trade marks—*indicia* of the quality of the goods they contain, and stamping them as the products of given manufacturers. But he was unable to see that any provision was made by the Act for such cases, unless, indeed, the word "device" in the 10th section could be strained to cover them. Again, was it intended by the Act to dispense with the question of "user" in relation to a trade mark? Could a mark be registered in respect of goods not then the subject of manufacture? Section 2 was not, he thought, quite clear. He apprehended that "user" must still have all the importance it ever had. If the Act really meant that registration should be equivalent to user, then almost the whole of the existing law was revoked. But the Act said that the right to a trade mark was attached to the goodwill. Now, it was clear that until the goods were a subject of manufacture, there could be no goodwill; and further, he would ask, what would be the effect upon the registered trade mark when the particular trade became discontinued? The right to the mark then would legally cease, but the register would not show the cesser, and the registrar could hardly ascertain the fact. Again, a mark must not misrepresent facts. That was a canon of law. If, then, a mark were registered with the words "the only genuine" for instance, the words being perfectly true at the time, and subsequently some one else ascertained by fair means how the article to which the mark was attached was made—the case of a sauce or other preparation not patented may be taken—and made it for himself, the mark would no longer be truthful, and it would be doubtful whether the registered owner could sue at all to protect his mark. Mr. Wood had suggested that at first the registrar must be allowed some latitude in admitting upon the register existing marks, and he cited as an instance the supposed case of a needle maker and a pin maker having the same mark. Mr. Chadwyck Healey thought, however, that no such discretion could be possible to the registrar, or even to the Supreme Court. They could not travel out of the Act, and if a case arose, when there was a doubt as to the sufficient dissimilarity of the two classes, he thought an issue would have to be directed to ascertain which of the two was really entitled to the mark. For himself he was inclined to think registration, on the whole, unnecessary, and certainly inconvenient. Under the new system he maintained that the search must be made by the registrar and not by the applicant, except for the latter's own guidance. Mr. Wood suggested that a statutory declaration by the applicant to the effect that a diligent search had been made should suffice. That, obviously, was the only evidence that could be obtained, but what was to be the measure of the word "diligent?" If the State created a title by registration it was the duty of the State to satisfy itself, as far as possible, that such title was not illusory.

Mr. Seymour Salaman thought the last speaker had made a subject sufficiently difficult in itself more puzzling than need be. They were not there to discuss whether registration should be established, or whether it should be under the superintendence of the Patent-office, but to consider an Act of Parliament, and how it could best be worked. Trade marks had nothing to do with pickle jars, or such matters; a trade mark was a device or symbol used to denote a particular manufacture as that of a certain person, and any person infringing that Act was liable to be punished under the Act. The object of the Act was to effect a registry for the purpose of simplifying the title to the mark, so that a person had only to produce a certificate from the office to prove his title. The main subject to be discussed was how the Act should be carried out and put in force; and that would depend in a measure on the rules which were laid down. As solicitor to the Trade Marks Association, he had endeavoured to ascertain if the rules had yet been drafted, and as far as his information went they had not, and therefore, it was quite proper to discuss their form, and make suggestions. He thought the principal difficulty would arise with regard to classification. The Act said that a trade mark must be registered as belonging to a particular class of goods, and no doubt the rules would explain how the classification would be effected, but there might be great difficulty in it; indeed, it was the principal difficulty suggested to the witnesses who were examined before the Parliamentary Committee in 1862; but he thought they managed to surmount it. Some classes of merchandise, such as hardware, included a vast number of different articles, and the question would arise whether a manufacturer was entitled to claim a certain mark for all goods comprised in such a class as that, or must he confine it to a particular class under the general description. Another question was, would all owners of trade marks be required to take in their marks before July 1st, and would the registrar have to search to see if there were any similar to each other. He knew a case in which one gentleman in Sheffield claimed a corporate mark which he had applied to cutlery, and another in another large town claimed the same mark, to be applied to a particular article which really might not be cutlery.

The Chairman said the definition of cutlery was anything which had a cutting edge—there was no difficulty about it.

Mr. Salaman said the article he referred to was a cork-screw, and it might be a question whether it was in-

cluded under cutlery or not. Another question would arise with regard to labels. Chambers of Commerce had had a great deal of difficulty in dealing with this subject, and many Bills had been brought in, but no Government had succeeded in passing one but the present, and that he believed was because they had been content with a short Act. The former Bill contained 58 sections, and the draughtsman had endeavoured to provide in it for every possible contingency; the present one was very short, and as originally drawn would, he believed, have been very defective, but the addition in the House of Lords of the words "distinct device, mark, heading, label, or ticket," had made it effective. That brought him to a point in which he differed from Mr. Wood, who thought the label deposited should be of a certain size and properly coloured. He objected to colour being any element of a trade mark. The German system was to this effect—that you deposited a small sample of the mark, two inches square; if it were large, it must be reduced by a photograph; and that mark was put on the margin of the application, was verified, and, when approved, inserted in the official gazette. A great deal of the litigation about trade marks had arisen from the colours employed, and he thought a photograph the best means of identification. A specification he objected to as being very difficult of application in some cases. Some thought a label was not an appropriate trade mark, because some manufacturers, such as Crosse and Blackwell, Huntley and Palmer, or Peek and Frean, used many labels for different kinds of goods; but he thought all such labels might be registered if desired. He thought the definition in the Act was ample.

Mr. Arthur Ryland, who represented the Birmingham Chamber of Commerce, congratulated the Society on so admirable an Act having been passed. He thought their main business was not, however, to discuss its provisions so much as to make suggestions to the authorities who had to draw up the rules. He could not see any difficulty in carrying out the Act which could not be easily overcome, and he thought it would be well if the Society would appoint a committee to take into consideration the rules and regulations which must be necessary, and to forward their suggestions to the secretary of the Lord Chancellor, before the rules were laid on the table of the House of Commons, which would be much better than doing it afterwards. Another reason why they should lose no time in dealing with the matter was this. After July 1st, no one could bring an action to maintain his right to a trade mark unless he had registered it, but no registry could be made before the rules had lain on the table of the House of Commons for a month. It was clear, therefore, that as Parliament did not meet until February, those who wished to register would have to do so between March and July. Coming, then, to the points to be dealt with by the rules and regulations, he would mention a few besides those alluded to by Mr. Wood. In the first place he thought provision should be made for *caveats;* that any one who had a trade mark should be at liberty to enter a *caveat* which would entitle him to notice of any application to enter a trade mark in connection with his own manufacture; and if this were done he thought they might leave the present owners to take care of their own interests. If they did not take the trouble to enter a *caveat* their marks would not deserve protection. Then there was the question of an index, which seemed to him all important, for without it all legislation would be useless, and would only lead to confusion. But this appeared to him simple in the extreme. They did not want an index of the symbols themselves, but of the articles to which they were to be supplied. If he were a jeweller, for instance, and wanted to use a crown as his mark, he would look to the index for jewellery, and if he found "Crown—Elkington" in it he would know he must choose something else. This question of classification had been mentioned as a great difficulty, but he did not see why it should be so. Every trade mark must be confined to a certain class of goods, not such a large class as hardware, which in Birmingham was held to cover even jewellery, but to a more distinct class, about which there could be no mistake. It was said to be necessary to have the identical mark deposited, but he did not agree to that because the certificate to be of any value must have impressed upon it the figure of the trade mark; but it need not be the exact verisimilitude; if it were as exact as a drawing might be to the impression of a punch, that would be sufficient. He thought it was pretty well understood that the fees should not be more than enough to cover the expenses, and he thought they ought to be payable in stamps, so that applications might be sent by post. The more simple this process could be made the better; it ought to be so simple that people could manage their own business without legal assistance, except where contests or doubtful questions arose. Another point requiring attention was this. Power was given to a court to rectify or cancel the registry, and if that were done there ought to be some provision for calling in the certificate which had been issued, since the certificate was made legal evidence of the title to the trade mark.

The Chairman said this subject was of so much importance that it had been suggested the discussion should be adjourned, and he therefore proposed to adjourn it, if the meeting approved, to Thursday, December 2nd. He believed the Act was a good one, though not perfect, for he feared the omission of one word in passing the House of Lords had jeopardised some existing and valuable trade marks. However, if it proved to be the case, they must do as had been done in other cases, bring in an Amendment Act, and make it more perfect hereafter. It had been complained that the rules and regulations were left entirely in the hands of the Lord Chancellor, but that was really the only way in which the Act could have been passed. Preceding Governments had tried to pass an Act of some sixty sections, dealing in every detail, but a measure of that magnitude required many nights for discussion, and towards the end of the Session there were always so many other things considered of more importance that commercial Bills almost always went to the wall. The consequence was that although Mr. Shaw-Lefevre brought in a Trade Marks Act two Sessions running, and Mr. Chichester Fortescue another, all three were pressed out. This Bill came from the Lords at the very close of the Session, it was then very imperfect, and if passed would be worse than useless. It was introduced after midnight, and he, as one of the commercial men then in the House, said that if it were not referred to a Select Committee of business men he should move its rejection. The Chancellor of the Exchequer agreed it should be referred to a Select Committee: it was so referred, and in that committee was so carefully discussed, that it came out in a shape which he believed would be, on the whole, satisfactory. Very little had been said as to the effect of this registration on their foreign relations, but this was a very important branch of the subject. They had heard about the piracy of trade marks, and it was really just what the word piracy implied—the worst kind of robbery—by their foreign competitors. In this respect the Government had hitherto done very little for the English manufacturer, and it was generally said that the commercial classes could best look after their own interests. So they could in many respects, but there were some things they could not do so well as the State. For instance, they could not make commercial treaties, or induce foreign States to modify their laws, so well as the Board of Trade and the Foreign office might do, if they would only take the trouble. The Germans had made a good law with reference to trade marks, and one advantage of registration at home was that it was a proof to a foreign State of the currency of the trade mark in one's own country, and facilitated the registration of that mark in the foreign State, thus putting

an end to a great deal of the robbery of which they had heard, and from which his constituents suffered a great deal. He agreed with Mr. Ryland that there would not be nearly so much practical difficulty as had been supposed. Lawyers could always see a thousand difficulties, and if business men were never to be anything until lawyers saw everything perfectly symmetrical, they would never do anything at all. In Sheffield a system of registration had been in operation for two centuries with the most perfect success, and it only needed the same thing extended to other classes of goods. They wanted a proper classification of goods, not of marks. The illustration had been given of pins and needles, but in reality these two articles were quite distinct, and it would not matter if they had the same mark upon them. The whole of the marks in the Sheffield trade might be transferred to leather goods without creating any confusion; indeed, manufacturers might be so classified that the same marks might run through the whole list, and yet never cause any conflict between one and the other. With regard to the responsibility of the search it was quite evident to him that it must be thrown on the registrar, not on the applicant. The registrar had access to everything; but every business man knew the marks in his own trade, and there would be no danger of confusion. He believed the effect of the Act would be to greatly benefit, not only the honest manufacturer, but also the consumer. A man who stamped his mark on his goods staked his reputation on their quality; if they were not what they should be the mark would be of no value no matter where it was registered. The fee was taken out of the Act because, as originally inserted, it was considered too high, and the feeling of the Select Committee was that it should be as low as possible, just sufficient to cover the working expenses. All that was required was that the central registry should be in communication with the great centres of industry, which should also have their registries to which the central office should furnish copies of the register just as they did with regard to patents. In the wide realm of nature and art there were plenty of symbols and designs for every man to find a mark for himself without interfering with his neighbour. It had been signified to him on good authority that the Austrian treaty of commerce would be denounced at the end of the year, the consequence of which would be that in twelve months time it would expire unless renewed in some form or other, and that in consequence the protection of British trade marks in Austria would cease. This was a matter which Mr. Salaman should look to, but if the treaty did come to an end it ought not to follow that the protection of British trade marks should come to an end also. What was required, after a good internal system of registration, was that all civilised Governments having relations with each other should facilitate an honest system of interchange between nation and nation to reciprocate the protection of the trade marks of all honest men. Piracy in trade marks ought to be put down, as well as piracy on the high seas; and if the Board of Trade was worth anything more than the board at which the President sat, it would take care of commercial interests in that respect, having always access to the Foreign-office, through which it could act.

The meeting was then adjourned to Thursday, December 2nd.

As it is understood that the code of regulations for registration will be prepared in time to allow of their being submitted for the opinion of those practically interested in the question, a suggestion has been made that a Committee should be formed by the Society, on a similar basis to the former Trade Marks Committee of 1865, to consider the subject in detail, to bring the views of the commercial community before the Lord Chancellor, and, if necessary, to apply for the reception by his Lordship of a deputation from the Society.

MISCELLANEOUS.

AGRICULTURAL ENGINEERS' ASSOCIATION.

At the first general meeting of the members of this association, the following resolutions were passed:—

(1.) "That a committee be appointed to take steps to maintain the existing foreign customs tariffs and regulations when favourable, and to obtain their amendment when otherwise, on the occasion of the impending revision of our commercial treaties."

(2.) "That a committee be appointed to enquire into the charges of railway companies and other carriers for the transport of agricultural machinery with a view to their equitable adjustment, and the extension of the system of through rates at home and abroad, and to report to the Council."

(3.) "That in the opinion of this meeting it is desirable that an agricultural meeting should be held annually or biennially in one or other of the large centres of population during the summer months, by preference in London and under the auspices of the Royal Agricultural Society of England, and that the Council be requested to take such steps as they may deem advisable to accomplish this object."

(4.) "That a committee be appointed to report to the Council what steps should be taken with a view to the reduction of the charges made to the exhibitors by the Royal and other Societies, and to co-operate with the Council in regard thereto."

(5.) "That the present system of trials of and awards to implements is imperfect and unsatisfactory, and that it is desirable that the subject should occupy the attention of the Council at an early date."

(6.) "That the Council be requested to watch any proceedings in Parliament relative to the Patent-laws."

OBITUARY.

Mr. C. B. Vignoles, F.R.S.—This eminent engineer died on Wednesday, the 17th instant, at the age of 83. He commenced life in the army, and served with the army of occupation in France. After the termination of the war he left the army and soon adopted the profession which he followed till the close of his working life. He was employed in making the surveys for the Manchester and Liverpool Railway, he took part in the "Rainhill experiments" (1829), and afterwards, as is well-known, he was associated with a very large number of railway undertakings both in this country and abroad. It would, of course, be impracticable to enter into any history of them, for the name of Vignoles will ever be associated with those of the Stephensons, Rennie, and the other engineers of our early railway history. Besides his claims to renown as an engineer, he will be remembered as having done much in other branches of science. He was a Fellow of the Royal and Astronomical Societies, President (1870) of the Institution of Civil Engineers, and a member of various other scientific bodies. He became a member of this Society in 1850, and took part in several meetings, either occupying the chair, or speaking in the discussion.

GENERAL NOTES.

The Plasterers' Company of London and Technical Education.—There has just been issued a summary of the eleventh annual report of the Art Committee of the Plasterers' Company of London, which was laid before the last quarterly court held by that body. The report states the company, with the object of promoting technical education, as applied to its own special industry, has offered for the past eleven years prizes for modelling and for design to students in the art schools and artisan classes in connection with the Department of Art, South Kensington. The competitions and the results have (it is added) been for the most part very satisfactory, and a considerable stimulus is given to them by the hope of gaining some additional prizes in medals and other rewards given by the Department of Art, in which all the works, although specially prepared for the company's prizes, are allowed to participate, in consequence of its connection with the Department. The subjects for each year's competition are determined by the company, the details of the competition are carried out in accordance with the rules of the Department of Art, and the prizes are awarded by the national adjudicature. The committee submit that, in encouraging the study of ornament with special reference to its own industry, the Plasterers' Company is at the same time promoting the furtherance of art education in general, as applicable to every other industry in which tho arts of design and modelling are required.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

The following arrangements for the Wednesday evenings before Christmas have been made:—

December 1.—"The Legislative Enactments requisite for safe Conduct of Sewage Grounds," by Alfred Smee, Esq., F.R.S. On this evening Henry Letheby, Esq., M.A., M.D., will preside.

December 2.—Adjourned discussion, Mr. H. Trueman Wood's paper, on "The Registration of Trade Marks," On this evening A. J. Mundella, Esq., M.P., will preside.

December 8.—"The Mode of Levying the Sugar Duties in France, and its Influence on the Sugar Industries of Great Britain," by Professor Leone Levi, F.S.S., &c.

December 15.—"Health, Comfort, and Cleanliness in the House," by Thomas Blashill, Esq., A.R.I.B.A.

December 22.—"A method of producing Pure Charcoal Steel directly from the Ore," by Henry Larkin, Esq.

Cantor Lectures.

The remaining lectures of the first course of Cantor Lectures for the present Session, "On the Discoveries and Philosophy of Liebig, with especial reference to their influence upon the advancement of Arts, Manufactures, and Commerce," by J. L. W. Thudichum, M.D., will be delivered on the following Monday evenings:—

Lecture II.—November 29.

Analysis of researches and discoveries continued.—Advancement of general and organic chemistry by elementary analysis.—Lectures and laboratory teaching.

Lecture III.—December 6.

Physiology of plant-life, chemistry of agriculture and natural laws of husbandry.—Works, and effect upon society.

Lecture IV.—December 13.

Physiology of animals, and the laws of their nutrition in particular.—Foods and food-extracts.—Works, and their influence upon professions and associations.

Lecture V.—December 20.

Therapeutic agents and collateral discoveries, chloroform, chloral.—The way from detailed labours to general scientific principles and laws.—Liebig's philosophy as influencing mode of thinking of present generation.

The lectures will be illustrated by selected experiments and demonstrations.

Special Lectures.

A series of reports has been prepared by Dr. Richardson, appointed by the Council to make special inquiry into the subject of "Unhealthy Trades." These will be delivered in the form of Lectures on the following Friday evenings:—December 3rd, 10th, 17th; January 21st, 28th; February 4th.

The subjects considered in this course will include:—

The influence of physical labour on individual and national vitality.

Injuries incident to physical labour. (1) By exposure to dust and other foreign substances. (2) By exposure to noxious gases and heated and impure air. (3) From mechanical concussions, peculiar postures of body, and excessive exertion.

Diseases incident to workers in the potteries, in trimming and furniture dressing, in sand-paper making, in flour-mills, amongst old rags, in fur dyeing, in walking-stick making, in hemp dressing, in patent leather dressing, &c.

Diseases of paviours, carpenters, blacksmiths, postmen, scriveners, &c.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Thudichum, "The Discoveries and Philosophy of Liebig, with special reference to their influence upon the Advancement of Arts, Manufactures, and Commerce." (Lecture II.)
Royal Geographical, Burlington-gardens, W., 8½ p.m. Lieut.-Col. J. A. Grant, "Mr. H. M. Stanley's Exploration of Lake Victoria Nyanza."
British Architects, 9, Conduit-street, W., 8 p.m. Prof. T. H. Lewis, "Notes on Ancient and Modern Egypt."
Medical, 11, Chandos-street, W., 8 p.m.

Tues....Women's Education Society (at the House of the Society of Arts), 6 p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on "The Pneumatic Transmission of Telegrams."

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. Alfred Smee, "The Legislative Enactments requisite for safe Conduct of Sewage Grounds."
Geological, Burlington House, W., 8 p.m.
Microscopical, King's College, W.C., 8 p.m. Professor Rupert Jones, "Remarks on the Foraminifera."

Thurs...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Adjourned Discussion on Mr. H. T. Wood's paper, "The Registration of Trade Marks."
Linnean, Burlington-house, W., 8 p.m. 1. Mr. Baker, "Genera and species of *Anthericæ*." 2. Mr. Baker, "Polynesian Ferns of the *Challenger* Expedition." 3. Mr. Moseley, "The Plants of the Admiralty Islands." 4. Dr. King, "A Sport in *Paritium tricuspe*." 5. C. B. Clarke, "Botanic Notes from Darjeeling to Tonglo."
Chemical, Burlington House, W., 8 p.m. 1. Mr. M. Pattison Muir, "Certain Bismuth Compounds." 2. Dr. William Ramsay, "Bismuthiferous Tesseral Pyrites." 3. Dr. Gladstone and Mr. Tribe, "Decomposition of Alcohol and its Homologues by the joint Action of Aluminium and its halogen." 4. Dr. Stenhouse and Mr. Groves, "Note on Incense Resin." 5. Mr. John Spiller, "The Occurrence of Native Calcium Chloride at Guy's Cliff, Warwickshire." 6. Mr. G. S. Johnson, "Certain Sources of Error in the ultimate Analysis of Organic Substances containing Nitrogen."

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Dr. Richardson, "Unhealthy Trades."
Archæological Institution, 16, New Burlington-street, W., 4 p.m.

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FRIDAY, DECEMBER 3, 1875.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The Council of the Society of Arts hereby give notice that a competition for four free scholarships will take place in London in January next. Persons of either sex desiring to compete may obtain terms and conditions of the competition by applying to the Secretary.

EXAMINATION IN DOMESTIC ECONOMY, AND IN FINE ARTS APPLIED TO INDUSTRIES.

The Programme of Examinations in these subjects is now ready, and may be had gratis on application to the Secretary.

THIRD ORDINARY MEETING.

Wednesday, December 1st, 1875; Dr. Letheby in the chair.

The following candidates were proposed for election as members of the Society:—

Hall, J. A., Toxteth-park, Liverpool.
Hall, John G., 8, St. Margaret-street, Canterbury.
Mercer, John Sharp, 1, Copthall-court, E.C.
Monson, Edward, High-street, Acton, W.
Rae, James, 32, Phillimore-gardens, Kensington, W.

The following candidates were ballotted for and duly elected members of the Society:—

Ames, George Acland, Union Club, S.W.
Archer, David, Arden-lodge, Adderley-park, Birmingham.
Arnott, George Washington, F.C.S., Bramshill, Harlesden-green, N.W.
Bateman, James, F.R.S., 9, Hyde-park-gate South, S.W.
Bays, Edwin, King's-parade, Cambridge.
Beavis, Richard, 38, Fitzroy-square, W.
Berthon, Rev. E. L., M.A., F.R.A.S., Romsey, Hants.
Beynon, Thomas, J.P., Richmond-house, Newport, Monmouthshire.
Brock, Walter, Engine Works, Dumbarton.
Brown, G. C. Herbert, 64, Belsize-park, N.W.
Browne, Newnham, 91, Queen-street, Cheapside, E.C.
Burton, Captain R., Athenæum Club, S.W.
Carmichael, Peter, Arthurstone, Meicle, N.B.
Chinnery, Gerard Thomas, Elm-side, Grove-park, Chiswick, W.
Churchill, Lord Edward S., Bartley Manor-house, Totton, Hants.
Constantine, T. J., 61, Fleet-street, E.C., and 19, Downs-park-road, West Hackney, E.
Court, Stephen, 145, Cheapside, E.C.
Covington, Rev. William, M.A., St. Luke's Vicarage, Shepherd's-bush, W.
Cucksey, Thomas, 39, Railton-road, Brixton, S.W.
Currie, Donald, 13, Hyde-park-place, W., and Cluny, Aberfeldy, Perthshire.
Dale, John (Messrs. Roberts, Dale, and Co.), Cornbrook, Manchester.
Davis, James, 20, Brondesbury-road, Kilburn, N.W.
Eversley, Viscount, 114, Eaton-square, S.W., and Heckfield-place, Winchfield, Hants.
Ewart, William Quartus, Glenmachan-house, Belfast.
Fitch, Reuben A., 31, Lancaster-gate, Hyde-park, W.
Fitz Rayne, William Allen, 134, Tooley-street, S.E.
Gayfer, William, M.A., Middle Class School, Bromley-common, Kent.
Grant, John, Grampion-lodge, Putney, S.W.
Grant, Miss Maria M., 19, Eaton-place South, S.W.
Griffin, John, Dunster-house, Mincing-lane, E.C.
Harding, Horace W., 7, Foster-lane, Cheapside, E.C.
Hazard, Rowland R., 117, Piccadilly, W.
Henigan, Richard, C.E., 63, St. Andrew's-road, Southampton.
Hunt, Frederick W., 27, Upper Baker-street, N.W.
Jamieson, John L. K., Mansion-house, Govan, N.B.
Jepson, William, Surveyor's Office, Heaton Norris, Lancashire.
Johnson, Thomas Lewis, C.E., Worcester-villa, Roath, Cardiff.
Johnston, Andrew, 158, Leadenhall-street, E.C.
Jones, E. W. T., F.C.S., 10, Victoria-street, Wolverhampton.
Just, Edward Z., 5, Newman's-court, Cornhill, E.C.
Kenworthy, E., Borough Surveyor's Office, Barnsley.
Leighton, Robert, 16, New-street-square, E.C.
Leon, H. de, M.D., 26, Redcliffe-gardens, S.W.
Lewis, Henry, Springfield-house, West Bromwich.
Lynam, C., Stoke-upon-Trent.
Macdowall, S., 3, King-street, Cheapside, E.C.
Macleay, Sir George, Pendell-court, Bletchingley.
Marshall, Reginald D., Cockridge-hall, Leeds.
Marshall, Thomas Beirell, 6a, Rossuth-terrace, Victoria-park, E.
Milman, Rev. William Henry, M.A., 15, Cornwall-gardens, S.W.
Mylrea, F. Garland, 41, Redcliffe-gardens, S.W.
Nicholson, Thomas, 10, Portland-street, Southampton.
Parry, Henry Richard, M.D., 29, Maida-hill, Burnley, Lancashire.
Proctor, J., Borough Engineer's Office, Bolton.
Roberts, Rev. J. Seed, Calabar, Kingston, Jamaica.
Robertson, Stewart, 89, Granville-park, Blackheath, S.E.
Rodgers, Samuel, Wath, near Rotherham.
Rogers, John R., Surveyor to the Local Board, Hornsey, N.
Rolls, J. Gouldsmith, 79, Coleman-street, E.C.
Russell, Philip, Palace Hotel, Buckingham-gate, S.W.
Savary, W. J. Holgate, 39, Lombard-street, E.C.
Sayer, Charles James, M.A., 6, Brondesbury-villas, Kilburn, N.W.
Schenley, Edward, 14, Prince's-gate, S.W.
Shaw, G., Rosstrevor Quay, Co. Down, Ireland, and 7, Garrick-street, Covent-garden, W.C.
Shute, Walter Thomas, 12, Langham-street, W.
Smith, Sidney, 1, Furnival's-inn, E.C., and Rutland-house, Quex-road, Kilburn, N.W.
Stableford, William, Broadwell-house, Oldbury, near Birmingham.
Stockwell, John Alfred, Sussex-house, High-road, Lee, S.E.
Storrar, John, M.D., 7, Southampton-street, Bloomsbury-square, W.C.
Taplin, Thomas, Knutton, Mount-house, Milverton, Somerset.
Thornhill, Walter, 30, Warwick-road, Maida-hill West, W.
Tidcombe, George, jun., Watford, Herts.
Turner, Frank de Mierre, C.E., 76, Brunswick-street, Sheffield.

Turner, Henry, Court-lodge, Knockholt, Sevenoaks.
Whisson, Henry Phillips, 31, Pembroke-road, Kensington, W., and Verulam Club, St. James's-street, S.W.
Woolcott, Henry Ward, Charing-cross Hospital, Agar-street, Strand, W.C.

The paper read was—

PROPOSED HEADS OF LEGISLATION FOR THE REGULATION OF SEWAGE GROUNDS.

By Alfred Smee, F.R.S., F.L.S., F.C.S.

Vice-Chairman of the Scientific Committee of the Royal Horticultural Society; late Chairman of the Fruit and Vegetable Committee of the same Society; Medical Officer to the Bank of England, &c.

The extension of the water-closet system in our towns during the last quarter of a century has been attended with great convenience to the inhabitants of individual towns, but the consequences have entailed corresponding injury on the general public. The quantity of water required for the water-closet system amounts to about thirty gallons per head a day, which for a town of reasonable magnitude causes a river of sewage to run from the town, which has to be disposed of.

At first the sewage was carried to the nearest stream in such quantities that every river in England was converted into a huge sewer, and the Thames itself on one occasion was black from the putridity of the sewage matters discharged into its waters.

The pollution of rivers was of so serious an extent that a Rivers Pollution Commission was instituted, and steps were taken to prevent our rivers from being destroyed and contaminated by the sewage of our towns.

To remove sewage from the rivers it was determined to apply it to the earth, and at first the most exaggerated notions were entertained by high authorities as to its value as a manurial agent, and theorists indicated that by its use so much vegetation would be grown, and so large an amount of meat produced, that every one in this land who scarcely tasted animal food once a week would have a daily and ample supply.

Unfortunately, however, such fallacious hopes have been long dissipated. Sewage irrigation has been found, as a general rule, to be a troublesome, an expensive, and an unsatisfactory process. Wherever practicable it is preferable to carry it to the wide ocean, there to be oxidised by the winds and waves, and only when that is impossible, from the distance to be traversed, are sewage grounds, with the present state of our knowledge, to be adopted.

There are situations where the water-closet system is employed, in which it is necessary to purify the sewage, and in these cases the question of the conduct of irrigation grounds has to be considered.

The theory of returning to the earth, by sewage, that which is taken from the earth by food, commands our respect and attention. But the sewage is diluted with so much water that it cannot be practically returned to the earth in a suitable state for plants. Up to this moment it has not been satisfactorily separated from the fluid so as to be economically applicable in a dry state, and the enormous bulk of the liquid prevents its being economically employed in the fluid state.

In considering the qualities of sewage, the large quantities of inorganic poisonous matter which is cast into sewers deserves notice. Cyanide of potassium and the refuse of all the photographic establishments, various metallic poisons from the electro-chemical works, the fluid residue of various manufactories, disinfecting solutions, &c., are passed into the sewage.

Sewage has had so poisonous an effect on the river Thames that where fish formerly abounded none are now to be found. Within my memory flounders were caught in abundance between London and Southwark bridges. At Erith abundance of fish used to be caught, but now it appears that the river there is void of fish. Lamperns are now only taken by hundreds where thousands were formerly caught, and eels are gradually disappearing.

Sewage grounds are to be employed solely for the purpose of sanitary protection. All questions of cost must be subservient to sanitary science. Sewage grounds should never be employed except in the absence of better methods of disposing of the sewage, and when used should be regarded as a necessity, to be placed under the most stringent regulations, to protect the health of those exposed to their influence, and to protect damage to property which may arise from their vicinity.

The idea of profit from sewage grounds is fortunately now exploded. The real object is to get rid of the sewage at the least possible cost, and by the least objectionable method, and if judiciously used the value of the produce may tend to diminish the expense of the abatement of the nuisance, and that is all which is possible to be effected. In some cases a subvention from the town may be necessary to get rid of the sewage.

Sufficient experience has been afforded of the properties of sewage grounds to enable us to settle the chief points which are required to be enforced for their proper conduct, and it is manifestly desirable to obtain a legislative enactment that they may be so controlled that they may inflict a minimum injury on the health of the adjacent inhabitants, and the least possible depreciation of the value of the neighbouring property.

If sanitary science be true, then is the principle on which sewage grounds have been hitherto conducted false, and if the principle of the present conduct of sewage grounds be true, then is all known sanitary science false.

The usual plan which is adopted for the location of a sewage ground is to select a spot in a district away from the town to be cleansed, so that in fact nuisance is simply transferred from one district to the a second which has no voice in the management, and the residents of which are powerless to help themselves against the encroachment. Thus Croydon cleanses itself, but pollutes Beddington. Croydon has no interest but to save expense to itself, whilst Beddington has to suffer from the parishioners of Croydon.

This manifest injustice might be remedied by requiring a majority of the ratepayers of any other parish to concur in the establishment of a sewage ground within its district. Should a sewage ground be formed in any neighbouring parish without such leave, a fine might be inflicted of £100 a day. The fine may appear large, but the irrigators having to deal with the funds of the ratepayers would take no heed of small sums, unless, indeed, it was enacted that the persons

violating the order should pay the amount of the fine from their own pockets, when probably a much smaller fine would be adequate. At present the sewage is no more disposed of by carrying it from one district to another than if the housemaid of one house were to throw the refuse over the wall of her master's house into the garden of the adjoining house.

When a sewage ground is proposed to be located, the scheme should, in the interest of all concerned, be approved by an independent public officer. The nature of the ground to be irrigated is of importance, for it is necessary for successful irrigation that the sewage should pass completely into the ground. Any place which is waterlogged is not suitable; and even at the Croydon sewage ground water lies on an average within two or three feet from the surface of all parts of the sewage farm. Again, care should be taken that in the choice of a situation underground channels capable of directly conveying the sewage to distant parts should be avoided; for example, chalk strata have cracks probably of miles in length, having an uneven character. The cracks or fissures vary in width from a hair's breadth to a width of nine or ten inches, and if sewage were turned into one of these fissures it might reappear some miles off. The question of these fissures, which exist all round London, opens up very serious considerations, as the water is liable to contamination from cesspools. The importance of the subject has attracted the attention of engineers, and may possibly be the subject of a paper at some future period. The employment of a sewage ground without the approval of a public officer should be forbidden under a penalty of at least £50 a day.

Knowing the large amount of cesspools now existing in the chalk districts from which the deep spring water supply of London was derived, I was very anxious to ascertain whether any noticeable quantity of organic matter now exists there, and I sought permission from the Bank of England to have a most minute examination made. The following is the letter of instructions to Professor Odling and the result of his investigations.

ARTESIAN WELL.

Bank of England, June 18th, 1875.

MY DEAR PROFESSOR ODLING,—I am instructed by the Governors of the Bank of England to submit to you samples of the water taken from the artesian well of the Bank of England.

It was drawn on the afternoon of Friday, June 18th, in the presence of Mr. Hensman and myself, after pumping had been continued all that day and uninterruptedly during the whole week.

The well is sunk nearly to the bottom of the London clay, and a boring exists through the lower tertiary beds to the chalk and 100 feet into it.

The level of the water was about 60 feet below high-water mark, and the suction-pipe was inserted about 30 feet into the bore-hole, so that the water was obtained directly as it permeated from the solid chalk.

The bore-pipe is not supposed to communicate with any fissure, and all water above the chalk, which is itself capped with an impermeable layer of flints, is believed to be effectually stopped out.

It is desired that your analysis should be of a minute character, for future reference and comparison, and that you should direct special attention to the presence and amount of organic matter.—Yours faithfully,

ALFRED SMEE.

Dr. Odling, F.R.S., Prof. Chemistry to University of Oxford.

Museum Laboratory, Oxford, August 6th, 1875.

MY DEAR SIR,—In accordance with your instructions, I beg to forward herewith the results of my analysis of the water of the Bank of England well, taken under the circumstances detailed in your letter, and received by me at the laboratory in bottles sealed with the Bank of England seal:—

	Parts in 100,000.
Saline ammonia	0·000
Organic ammonia	0·000
Oxidised nitrogen	0·080
Organic carbon	0·040
Total carbonic acid	21·81
Fixed carbonic acid	10·26
Original hardness	5·55
Hardness for boiling	1·05
Total solid residue	68·35
Chlorine	11·05
Sulphuric acid, anhydrous	12·03
Silica	0·30
Alumina, with iron oxide	0·17
Sodium	19·52
Potassium	4·38
Calcium	1·41
Magnesium	0·65

The water thus manifests all the characters of an uncontaminated deep chalk water of the London basin; namely, extreme freedom from organic matter and ammonia, great softness, a comparatively small proportion of lime and magnesia salts, a large proportion of soda salts, including carbonate of soda, and a notable proportion of salts of potash. It is free alike from saline and organic ammonia.

The amount of organic carbon, or 0·04 part in 100,000, may be taken as equivalent to about 0·08 part of organic matter in 100,000, or to something over $\frac{1}{20}$th of a grain of organic matter per gallon—a proportion almost infinitesimal.

The water is, further, of only 4 degrees of hardness per gallon.

The above results show the complete exclusion of surface drainage from the well.

The amount of chloride of sodium, or common salt, is 12·75 grains, and the amount of carbonate of soda 12·66 grains per gallon.

The total amount of solid matter is 47·84 grains per gallon. According to an analysis of the Bank of England well-water made by Mr. Dugald Campbell, in 1854, the total solid matter was then found to be 48·20 grains per gallon. The accordance in these results seems to indicate the permanent uniformity in composition of the water; the difference of 0·36 grains per gallon being within the limit of analytical variation.

Believe me yours very truly,

WILLIAM ODLING.

Alfred Smee, Esq.

This analysis clearly shows that if organic matter percolates for a sufficient distance through suitable strata, it is thoroughly oxidised, and no trace remains. As this examination has been made regardless of trouble, it may be convenient to compare future analyses of deep springs with it.

At the present time parts of the sewage ground actually employed for irrigation frequently abut on the property of neighbouring proprietors, which is greatly damaged. It is also frequently abutting on the highway. I have heard it given in evidence before a committee of the House of Lords, that a sewage ground was so near suburban villas, that the inmates played at croquet upon the very verge of the pestilential marsh so created, a state of things which should be rigidly prevented. At Beddington, I have often seen the irrigation carried to the very verge of the high

road, or beside the property of neighbouring land-owners. Now not less than 200 yards should intervene between the part irrigated and any highway or adjoining property, under a penalty of not less than £10 a day. The interval of 200 yards is by no means sufficient under all circumstances to fully protect the public from the abominable stench and pestiferous effluvia of sewage grounds, though it would afford very substantial relief from the emanations whenever the atmosphere possessed an average state of diffusive power. In calm "muggy" evenings the distance will be manifestly insufficient, and therefore should be increased wherever practicable. The nuisance committed by the emanations of a sewage ground varies every day, and at every hour of the day, with the atmosphere. In a clear bright day, with wind and a rapid motion of the air upwards, it is reduced to a minimum. In evening and morning with slight haze and stillness it is increased to a maximum.

At the time I was writing the work, "My Garden," I was examining historical remains on the sewage grounds. I was there one evening (when only one irrigation had taken place); the ground had dried, and the grass-seed was sown, and yet the stench at sun-down was so intolerable that we were glad to leave the place. I have also been at the sewage grounds during frost, when even then the exhalations were most offensive and disagreeable.

The fact is, that unless the sewage is defecated before irrigation, a layer of fæcal matter is deposited on the surface of that part of the ground which has no crops upon it, and if there are crops the fæcal matter is deposited upon the plants growing upon it. For this reason sewage irrigation cannot be practised without creating a nuisance, except by the previous removal of the solid matter, and the precipitation of the greater part of the dissolved parts of the animal matter.

As defecation is a necessity, the penalty for neglect should certainly be not less than £50 a day. It would not be desirable to compel sewage to be defecated by any particular process, because some experience is required as to which, in the long run, under all circumstances, and at all times, shall have the preference. The processes of precipitation by lime, by alum, by sulphate of alumina, by phosphate of alumina, by alum, blood, and clay, are in good repute, for their powers of precipitation, but not for the expense which they entail. General Scott has invented a remarkable and very original mode of dealing with the sludge. He converts it into cement to be used in building, and the similarity of the mud with that on the Medway, ordinarily employed for the manufacture of cement, is remarkable. Doubtless this process would never entirely cover the cost of the purification of sewage, though it may tend, in a great degree, to lessen the expense.

There is no question but that sewage may be rendered perfectly bright and clear by precipitation, even when coloured, as at Leeds, with dye matters, but then it mostly contains some animal matter in solution, which has to be afterwards removed. Most praiseworthy attempts have been made to render this precipitate of real agricultural value. The sludge ought to contain all the manurial properties, but probably it is altered, for farmers will hardly carry it away at one shilling a ton. Some inventors have sought to add to it elements which may increase its value, but although some of those products are claimed to have a value of from £3 to £4 a ton, experience does not warrant us in saying that any one process, up to this time, is a substantial commercial success. It is a curious fact that the sludge of a charcoal process has the remarkable power of oxidising organic matter, from the animal charcoal which it contains, and if an animal be placed in it the flesh will be entirely destroyed without smell. If ever one process be found which shall yield a precipitate of universally acknowledged value, the difficulties of the sewage question will in a great measure be overcome. The question is not yet quite satisfactorily determined which process, taking into consideration the value of the resulting product, is attended with least expense. The sewage water when defecated and precipitated should pass into the ground and not over the ground, for when it passes over the ground, as I have myself often seen, it passes off as sewage with all its concurrent evils.

The fine for the impropriety of neglecting to cause the water to pass into the ground might well be fixed at £10 a day, as the result would greatly depend upon the irrigation being conducted in a proper and suitable manner.

It not unfrequently happens that the sewage, when allowed improperly to run over the ground, is not retained in the sewage ground but passes to the territory of neighbouring proprietors. This is a serious injury to them, for whilst the proprietor of the sewage ground obtains as much as £12 an acre for permitting the abomination on his land, otherwise not worth £3 an acre, the adjacent owner is subjected to all the evils and inconvenience without any compensation whatever. A penalty for such a violation of the rights of property might be fixed at £20 for every day when such an injury is inflicted. I have myself seen the places where sewage has overflown the beautiful park of Beddington for fifty or sixty yards from the neighbouring sewage ground.

The general conduct of the sewage ground from the commencement of the process to its termination requires the most careful supervision. The great artery passing from the town is usually covered up within their own district, but the moment it passes from their district it is no more an object of solicitude to the ratepayers of the town, but is frequently left open to pollute the air of the neighbouring villages.

Sanitary science enjoins the most vigilant care of sewers in the district, but the moment the district is crossed, sanitary science is disregarded as though it were unimportant.

What the Boards of Health of towns do not do with a good grace they should be compelled to do under fine, and it would not be unreasonable to subject them to a fine of £25 a day if they permit their main or sewage arteries to be exposed within 100 yards of a highway or of any private property. At the present time it not unfrequently happens that no precaution is taken against the sewage, whether not defecated or defecated, from passing on to vegetables used for food in a raw state. For instance, at the fever stricken town of Croydon, there are no special precautions taken to avoid the excreta of a typhoid case from passing to water

cresses, and hence fæcal matter may be served back to themselves, or on the tables of the unsuspecting aristocracy of London within forty-eight hours from its passage from a patient about to die of the disease.

Water cresses act as a scrubbing brush to the sewage, and remove all the solid flocculi from the water which adhere to the stalks.

Typhoid fæcal matter is absolutely poisonous in the sanitary district, but how many persons take it into the stomach after it has passed their own immediate district the so-called sanitary authorities appear to be perfectly indifferent.

To prevent this horrible, disgusting, and dangerous outrage on the community, a penalty of at least £100 a day should be inflicted on any person growing or permitting to be grown salad of any kind upon a sewage ground, and the public ought to be further protected against the cupidity of boards of health who would imperil the lives of communities for a small extra gain, by imposing a penalty of £5 on any person knowingly selling salads from sewage grounds, and this penalty should be imposed upon every offence committed. There is no reason whatever why unsuspecting persons should be exposed to this loathsome and dangerous risk, and the fullest protection ought to be offered to the public against it. Salad may be defined, for the purpose of such protection, to be any plant ordinarily used by man in an uncooked state.

As it may be regarded as an undoubted fact, that vegetables take up foul sewage matters, and it requires considerable time before they are changed in the tissues of the plant, no vegetable ought to be used for human food even in the cooked state until suitable time is allowed for the assimilation and changing of the sewage matter in the substance of the plant. The time would necessarily vary with the time of year, the temperature, the active state of the plant, the amount of light, and various other conditions, but probably an interval of two months would afford a reasonable protection after defecated sewage had been applied to the growing plant. The penalty for infraction of the law might be fixed at £20 for every offence, and any other person knowingly selling such produce might in like manner be subject to a penalty of £5 for every offence. It is known in France that when vineyards are irrigated by sewage the quality of the wine is impaired and not restored for years.

It cannot be a proper thing for cattle to be fed on food which in its relation to sewage is under circumstances unfit for the food of man. At the present moment we are not thoroughly acquainted with the action of the typhoid fever poison, the cholera poison, or the erysipelas poison on cattle, and until we have such knowledge we should act on the side of prudence. We know the communicability of disease from one kind of animal to another. We know that the milk of cows suffering from the foot and mouth disease is highly fatal to pigs, and so we ought to protect cattle by reasonable care from either eating or drinking the excreta of diseases of mankind of a contagious character.

Much grass is sold from sewage farms. Of the state of that grass one member of a Board of Health has favoured us with an account.

Probably a penalty of £5 for every offence of the sale or employment of vegetables for cattle, other than milch cows, less than one month after the application of sewage, would be an adequate protection to the community.

But everybody knows that the milk of all animals is affected by what the mother eats, and therefore it is much more important that milch cows should be further protected than cattle, hence a higher penalty may be inflicted in these cases, and a longer time after irrigation demanded. The real time actually required after irrigation must necessarily depend upon the temperature, the light, the power of assimilation by the plant, as has already been pointed out; yet, in a practical way, an interval of six weeks may be taken as a necessary time which ought to elapse after irrigation, and this might be enforced by a penalty of £10 for every offence.

The buyers of the sewage grass, in the state which has been described, are mostly poor men, of little experience and less knowledge. They believe that they are buying cheaply and safely, relying upon the honour of a Board of Health as to the quality, but whether the sale of such stuff as wholesome grass does not in point of law really amount to a fraud, I must leave to be decided by the legal advisers of boards of health.

We have experimented upon it with cows, but used alone it seemed to be insufficient for the support of life, and it had to be discontinued to prevent its killing the animal by diarrhœa and wasting. The milk from cows fed from such grass I have ascertained, by numerous experiments, to be liable to become putrid, while butter made from such milk goes rapidly rancid, and I have found the casein is frequently altered in quality, and sometimes will actually dialyse. An elaborate account of our investigations upon this head occurs in my son's book, "On Milk in Health and Disease," and so it is unnecessary to consider the matter further in this paper.

No infant or invalid should ever be fed on milk from cows fed with sewage grass. It is of such great importance to the public to insure the sale of a pure wholesome milk, that they should abstain from buying milk of any dairyman who is known to purchase sewage grass. As long as Boards of Health can sell sewage grass, their cupidity will prevent them from knowing that sewage grass is immature grass, plus fæcal matter.

If the addition of fæcal matter to grass and hay be right for cattle to eat, as irrigators pretend, then have all former agriculturists been at fault, as they ought to have added fæcal matter to the food wherewith they fed their cows and heifers.

Either agricultural science is true, and irrigation science is false; or, irrigation science true and agricultural science false.

I have suggested to the engineer of the Leeds works that the final oxidation of animal matter in effluent sewage water may possibly be effected in the water instead of exposing it on the land. For this purpose I have ventured to recommend tentatively that it be run through ponds full of *anacharis*, which is a rapid grower and gross feeder, and evolves much oxygen. I have also suggested that beds of reeds might be tried for the same object. By experiment it has been ascertained at my garden by Mr. Thornthwaite, that the growth of *anacharis* is enormously promoted by sewage,

and that the water is much purified thereby, but how far it may be advantageously employed on a large scale experience can alone decide.

The water, after it has passed over the sewage grounds, of necessity must pass to the nearest river, except in such cases where the ground absorbs the whole, or where there are underground cracks by which it can be carried away. At a late meeting of the medical officers of health, one of the District Board of Croydon pointed out that persons drank the effluent water, and spoke of it with such apparent delight that but for our natural understanding it might have been supposed that effluent sewage was a good and proper beverage. I have heard other persons descant upon the merits of effluent sewage for the beverage of the inhabitants of neighbouring villages, but never for their own use. Now a more disgusting insanitary idea cannot be imagined; and if the directors of sewage farm towns have not the good feeling to prevent so filthy a use of sewage by their neighbours, they surely should be compelled by law to pay the penalty of their want of decency.

Those who are likely to drink sewage water are travellers, tramps, and others, who do not know what it is, and if they contracted disease thereby would carry it away to distant places. On this account the entire community is interested in preventing its use unawares. Sewage irrigators in the height of their enthusiasm for their subject have been heard to declare that persons have preferred their effluent sewage to the well waters of the district.

The best protection might be afforded by enacting that every stream conveying effluent water from any sewage ground should have a notice-board affixed at every point where it abuts upon a highway, or on property belonging to other owners until it enters a river, and that the notice should be placed in legible letters:—"Town Sewage, Effluent Stream, Dangerous for Use." The penalty for any neglect should not be less than £50 a day, as the danger is so great and the remedy so simple. With such a notice-board our sense of propriety could never again be offended by innocent persons drinking the water which has passed within a few hours from the water-closets of sewage towns.

In all sewage farms the water in the district irrigated, or even in the neighbourhood, is more or less poisoned, according to the circumstances of the case, and it is only reasonable that those who poison should afford an antidote to the poison. Before a sewage ground is allowed to pollute the springs, pure and good water should be supplied. On the sewage ground itself pure water should surely be at hand at stations within 250 yards of each other at a minimum, and it would be no great hardship to place such a number of stand-pipes. The penalty for such an obvious neglect of sanitary principles might be £20 a day.

There is reason to suspect that milk on sewage farms has been directly adulterated with sewage, which unfortunately is very difficult to detect, and permits more to be added with impunity than when pure water is used, but at any rate when employed on sewage farms, cattle should at least have wholesome water for beverage. Wherever the wells in the neighbourhood of sewage grounds are poisoned by sewage, a similar penalty might be enforced for neglect to supply pure water for the wants of man and beast.

Sanitary science forbids the use of well water contaminated with sewage, but sanitary administrators take no heed of communicating sewage to the wells of their neighbours, as they appear to think that sanitary science is unimportant when any expense to themselves is incurred. Shallow wells, for instance, near the Croydon irrigation grounds, are unfit for use.

Sewage towns have always been very jealous of giving information, because it may lead to expense, but Boards of Health ought not to be allowed to shelter themselves under a suppression of facts. It was only at a late meeting of the medical officers of health, to which I was politely invited, that all present went away, at ten o'clock on Saturday night, firmly impressed that Croydon was perfectly healthy and free from all fever. We were all astonished, but delighted, for many of us considered that Croydon was in great peril of serious epidemic diseases. Judge my surprise, however, when the first person who came before me on Monday morning at the Bank of England, informed me that his child had typhoid fever. My informant stated that he knew of other cases, and of some deaths, and subsequently that his wife and servant died. These were followed on the following Wednesday by the declaration by the Registrar-General of five cases of death from fever from Croydon, and the following week of another five cases. On further inquiry from the inhabitants of Croydon, I found that cases of fever were interspersed all over the town, that a great epidemic was raging in it, so that at the very time that a member of the Council Board was giving information to the medical officers of health of this great metropolis, the excreta of numerous fever cases were being distributed over the sewage grounds, and no precautions were being taken that fever fæcal matter was not served with salad upon the tables of the inhabitants of London, Croydon, and the neighbouring villages, and no means were taken to prevent innocent persons from drinking the effluent water which, according to the information of persons whom I employ to watch the conduct of the sewage grounds, was to some extent running direct from the water-closets of Croydon to the affected stream. The public have a right, after such facts, to possess accurate knowledge. At Florence, the rate of death from fever, I have myself seen to be posted weekly at the door of the Registrar to warn the inhabitants, and what can be done at Florence can be done at any farm sewage town; then, is it not desirable that the Legislature shall enforce it to be done, under a penalty for every omission of £20, and that any person wilfully concealing a death from zymotic disease, or giving knowingly any false information to deceive the Registrar, shall be subject to a penalty of £5 for every offence?

It is perfectly plain that a certain member of the Croydon Board was not even aware that a terrible epidemic of typhoid fever was raging in his district. He wrote thus on the 15th May:—"Instead of the farm of Beddington being a dangerous swamp, a pestilential swamp, a pestiferous marsh as some persons have stated, no offensive odour can be detected, and the neighbourhood

is not injuriously affected by miasma, neither had the farm been the means of introducing disease and death into the district, as its introduction has been coincident with a less death-rate and a clean bill of health, and in particular no death from fever had occurred during the whole of last year." Now, if any person living in this lamentably fever-stricken town never heard of the epidemic, how are the public to know that every one of their families was exposed to disease and death? How urgently is it required that the members of Boards of Health, instead of giving imperfect information to the public through the newspapers and societies, should have the means of knowing the truth that they may not propagate error.

Ninety-one persons have perished from typhoid at Croydon since this erroneous information has been given to the public. How far might a right knowledge of the facts have saved valuable lives and permanent injury to the constitutions of those who have been attacked by disease? how far might the injury to property have been averted by persons leaving Croydon or abstaining from taking houses there? how far might the panic at this terrible epidemic have been prevented? This it is hardly possible to state. Truth alone can restore confidence; for, in spite of any amount of newspaper letters to the contrary, Croydon will be regarded justly with suspicion for a long time to come.

In our consideration of sewage grounds we should remember that there are two distinct modes of fermentation of excretal matter; one the ammoniacal, the other the putrid. The ammoniacal fermentation is used by the gardener in his hot beds, and it produces warmth and a genial atmosphere particularly favourable to the early and perfect growth of all plants. The putrid fermentation is to be noticed in sewage, which causes large leafy vegetation with delayed perfection, and so horticultural flowers have leaf with little or no flower when watered with sewage. Crops grown under sewage irrigation are always late, and consequently of much less value in the market.

In the present state of our knowledge sewage grounds should be avoided where practicable, but when they are absolutely necessary, (1) the sewage ground should be located by a public officer under the Privy Council; (2) the sewage ground should appertain to its own district, and on no account be placed in any other parish without leave of the majority of the inhabitants; (3) irrigation should not be conducted within 200 yards of any highway or private property; (4) the sewage should be carried to the grounds in covered ways; (5) and then defecated; (6) the fluid should then be passed through the earth; (7) in some cases it would pass through the earth to unknown districts, and in others it would pass off as a stream; (8) it ought not to run over the neighbouring private property, (9) but be retained within 200 yards of adjacent lands; (10) the effluent stream should be labelled, to show what it is; (11) the sewage should not be applied to any salad; and (12) no herbage should be sold or used less than one month after irrigation has ceased; (13) nor should herbage be used for milch cows less than six weeks after the cessation of the irrigation; (14) no vegetables should be sold for human food within two months of irrigation; (15) good and wholesome water should be supplied to the sewage grounds, (16) and to any district where the wells are poisoned by the sewage; (17) in all towns having sewage grounds the registrar of deaths should post every week at his office the number of deaths from zymotic diseases, and, where practicable, the number of persons attacked, particularising the name of the disease.

When all this is done, still the miasmatic, marsh-like influence of a sewage ground remains as a perpetual irremediable evil. If these conditions are requisite for the reasonably safe conduct of sewage grounds, then where is there a sewage ground which has attended to any one of them, and has not conducted its operations regardless of injury to adjoining property, but solely as a saving of cost to its own district. Surely legislation is urgently needed, and unless all known sanitary science is ignored, sewage irrigators should be compelled to act under recognised universal sanitary laws.

The penalties which have been recommended have been only those which would commend themselves to the minds of any impartial person to protect the public against the misdirection of sewage grounds. They are so obviously important as to require no comment. From my experience of these local boards of health every statement is met with a flat denial, and I should not be surprised to hear the necessity for such legislative enactments denied. If there are local Boards of Health, however, who deny the premisses upon which the necessity for penalties is concluded, they need not fear the consequences. The penalties would not apply to themselves, and they would conduct their self-esteemed perfect processes without fear of molestation. To those who assume that their operations are perfect I would say, help the public to make those who do not conduct their operations properly change their bad course.

The great sewage irrigation farm of Croydon is near my experimental garden, and I have therefore had the fullest opportunities of noticing its disgusting career. If the proposed penalties were enacted, the Board of Health would have fallen heavily under the lash. For instance—

1. Sewage is carried in a parish away from their land without leave of the inhabitants, they would incur a penalty of	£50	a-day.
2. They constantly irrigate within 200 yards of other property or highways	10	„
3. Sewage is not defecated	50	„
4. Sewage often runs over the ground, and is not filtered through the ground	10	„
5. Sewage runs over other property	20	„
6. Great sewer artery is not covered near highway	25	„
7. Sewage is used for the growth of salad to an enormous extent	100	„
8. Cooking vegetables sold for human food within two months of irrigation (no information).		
9. Sale of vegetables for cattle less than one month after irrigation	10	„
10. Employment of vegetables for milch cows within six weeks of irrigation	10	„
11. Effluent water not protected	25	„
12. No good water supplied to sewage farm	10	„
13. No good water supplied where wells are poisoned	10	„

14. No list of zymotic diseases posted at door of registrar's office	20 a-day.
Total	£350 a-day.

For the purpose of observing how far the principles which are inculcated in this paper are carried out abroad, I visited last week the sewage ground of Paris, which is situated in the district left by a bend of the Seine, between Asnières and St. Denis. About one-twelfth part of the sewage of Paris was distributed over the ground. It was pumped by an engine over a bridge of the Seine to a small reservoir, from which it flowed in a channel, to be subdivided into lesser channels to be distributed over the soil. The principal canal was, curiously enough, carried by the high road to St. Denis, so that travellers were exposed to its pestilential emanations, which had the most awful stench, and which under the proposed regulations would have exposed the authorities to a fine of £10 a-day. The position of the ground itself is not approved by the neighbourhood, for which a fine of £50 a-day would have been incurred. No good water was supplied to the irrigation ground, which would have rendered the authorities liable to a fine of £10 a-day, nor was good water supplied to parts where the wells were poisoned, for which they would have been liable to a fine of £10 a-day. The sewage was not defecated, which would have rendered them liable to a fine of £50 a-day.

Salad, as lettuce, endive, and it is stated celery, was grown upon the place, for which a fine of £100 a day would have been incurred. I could not ascertain that any precautions were taken to prevent cabbages and other vegetables being used immediately after irrigation, though asparagus was grown, which becomes most offensive when recently treated with putrid sewage. There was no visible stream, so that the recommendatory precautions against its improper use were not required, but the great sewage artery was not covered, which would render them liable to a fine of £25 a day. Upon the whole, it is difficult to imagine how the French people could possibly violate the laws of health, of physiology, and of physical science, as they have done in the conduct of their sewage, and what may be the results if twelve times the amount be conducted and concentrated on one spot may be difficult to be prognosticated. The state of the case has been well set out in a petition to the Government rom the inhabitants of the neighbourhood. The petition was signed by 414 persons residing in the district, and was presented to the National Assembly.

"The petitioners do not deny that the irrigation as hitherto practised has conferred upon the sewage grounds a fertility which they did not formerly possess and which has created some excellent kitchen gardens, but they beg to observe that the irrigation grounds have been selected amongst those best adapted for the purpose. The irrigation grounds on the 1st October, 1874, only comprised 113 hectares, and even then they have only been subjected to the application of 50,000 cube metres per annum.

"The petitioners are, therefore, not astonished to find that amongst the cultivators of Gennevilliers there are some who are satisfied with the irrigation and ask for the continuation, and even for the extension of it. However, the petitioners do not believe that their approval will be continued, for can the grounds continue for ever, and without rest, to imbibe 50,000 metres for each hectare for every year putrescent waters which deposit on the surface their offensive and putrid mud and permeate the ground with a liquid loaded with organic matters and deleterious gas.

"The petitioners question the future because the absorption of 50,000 metres per hectare is impossible, and is recognised as being exorbitant as was proved by experience in Lombardy and in England, and so far imperfectly at Gennevilliers, that a great number of cultivators have declared that they would not use a mode of irrigation which they consider as inconvenient, unhealthy, and prejudicial to their cultivation.

"The sewage after having penetrated the superficial layers of the soil is but incompletely purified, and does not return to the river as is wrongfully asserted in the report of the technical commission to the Minister of Public Works. The sewage water joins the subsoil water which percolates from the Seine, and is added to it, so that since 1872 the level has been raised two metres. In this case the subsoil water has overflowed the wells and corrupted the water. They have overflowed the cellars, which they have rendered wet and unhealthy; they have filled the vaults and the quarries where they are exposed to view, and exhale the noxious effluvia and the marsh fever heretofore unknown in this country has taken possession of it.

"If such results are already manifested by an irrigation which has only had an existence of three years, and which is limited in extent to 113 hectares, what would the result be if that irrigation were extended to 2,000 hectares with an amount of sewage amounting to 100,000,000 of cube metres per annum.

"The irrigation grounds would become an immense marsh, from which the pestilential eminations would evaporate, and not only effect Gennevilliers, Asnières, Colombes, and the other districts around, but would penetrate to Paris itself."

The land upon which the irrigation is carried on is naturally barren, and a contrary petition was presented by some cultivators, who benefited by the practice.

It is proper to notice that on a visit to the engineer, he distinctly stated to me that he did not subscribe to the notion that the level of the subsoil water had been raised two metres, but it appears to me that if the sewage flows on to the land more rapidly than it can penetrate through it, then the level of the subsoil must be raised.

The creation of so large a pestilential swamp must be a source of serious injury, and, according to all known science, may in the future lead to the fructification and distribution of some serious epidemic. Sewage nuisances may exist for years without generating typhoid fever and cholera, but where the diseases exist they intensify their power to the destruction of the neighbouring people. At Paris the amount of vegetation is increased by the sewage being used over a deep bed of sand, and so the cultivators are anxious for the profit, but the use of such vegetation after recent irrigation with the prevalence of the typhoid which now exists in Paris, may well make all persons fear who value wholesome food as a preservative of health.

The whole tenor of these observations is to assimilate sewage grounds and sewage produce to the ordinary state of cultivated land and agricultural produce. If any of these precautions are omitted, then secondary protections would be required — for example, against tapeworm and diseased meat. There are strong reasons in the past for requiring, under very heavy penalties, that the buyers of sewage-fed cattle should have their names registered in a book open to the inspection of the public.

Under the system of penalties, which is the very minimum adequate to preserve the public health, the Board of Health of Croydon would sometimes have incurred a payment of £350 a day. If this scale of penalties is not found sufficient to restrain the above described reckless career of those who conduct the sewage farms of this country, then the Legislature might make the penalties personal upon the members of the Boards of Health. It is not to be tolerated that those appointed to protect the health of one district, should be permitted to impair the health of the neighbouring district. The effect of sewage grounds, as hitherto conducted, has been as bad morally on the minds of the people as it has been physically on their bodies. Largely exaggerated statements have been made by their supporters. Facts are suppressed, or not fairly given. General denials are made to all complaints. The most insolent observations are made to those who point out their dangers. Knowledge is arrogantly assumed where ignorance abounds; the promotion of sewage grounds is made a source of revenue at the public damage. Being an independent observer of the mad career which the conductors of the sewage ground are following, I have placed this paper before the Society to indicate the scientific principles which should guide their safe conduct, and also to serve as a public protest against sewage grounds as now conducted, that should in the future some terrible calamity occur from their abuse, blame may rest upon the heads of those who recklessly abjure all known sanitary science.

DISCUSSION.

The Chairman, in inviting discussion, said he hoped some gentleman was present from Croydon prepared to show why the Local Board there should not be subjected to a penalty of £350 a day, and then read the following letter, which he had received from Mr. W. Hope:—

Army and Navy Club, Pall-mall, S.W.,
Nov. 30, 1875.

My Dear Sir,—I am exceedingly sorry that I cannot attend the meeting at the Society of Arts to-morrow night, being obliged to go over to Paris to-night.

I write to say that I am prepared fully to endorse everything that you, or Mr. Smee, can possibly say against improperly laid out, or badly managed, sewage farms, and as you know I have often done so before.

Yet it remains a fact, both from a chemical and a practical point of view, that sewage has never been entirely purified on a large scale except by properly conducted irrigation, that is by making the sewage pass downwards through the soil, intermittently and in small quantities at a time, proportioned to the season of the year and to the power of the particular crops and soil.

Nothing can well be worse than the typical sewage swamp which I have heard you so often and so powerfully condemn.

All land irrigated with sewage ought to be drained.

The surface ought only to be moistened, and above all not by flooding the whole of a large field sideways out of one big channel, but little by little out of a great number of subsidiary channels.

No sewage ought to be applied to grass for some 14 days before it is cut.

No animals ought to be pastured on land that is constantly or very frequently irrigated.

No sewage ought to be applied to root crops for some weeks before they are harvested.

If these rules are followed no danger of any sort can, or does, arise. I do not see why a certain number of rules of this kind should not be drawn up, and magistrates empowered to fine those breaking them.

I write in very great haste, having only just time to catch the train, and therefore cannot say all I wish.

Believe me, yours very truly,
W. Hope.

Henry Letheby, Esq., M.B.

Dr. Alfred Carpenter asked leave to offer some remarks in answer to the charges which had been made against him by implication, if not by name, but he asked leave in the first place to put up a map of the Croydon farm, and a diagram of the vital statistics of Beddington. In the meantime perhaps some other gentleman would open the discussion.

Major-General Scott, C.B., F.R.S., said the paper would have been valuable if only for the purpose of eliciting the letter they had just heard from Mr. Hope. From whatever point of view the subject was regarded; the removal of the solids must have the most beneficial effects; even Mr. Bailey Denton admitted that he could purify sewage water in a much smaller area if the solids were removed, and in this Mr. Hope agreed. Dr. Voelcker was of opinion also, that if this could be done farmers would be as anxious to take sewage for their ground as they were now averse to it, and looking at the question from a sanitary point of view there was an even greater agreement amongst the authorities. Amongst all the evidence given before the Parliamentary Committee on the Birmingham Sewage Bill, whether that of Dr. Odling, Mr. Hawkesley, or Dr. Frankland in favour of the Bill, or that of Dr. Letheby against it, all agreed that the sewage should be defecated before it was put on the land, but at the same time he must confess he was by no means clear what the term defecation was intended to convey, whether merely the removal of the solid matter by subsidence, or actual precipitation. In any case he was of opinion that sewage water could only be purified by passing through a great depth of earth, though where it was simply to pass into large estuaries or rivers, not used for drinking purposes, a less purification might be sufficient.

Dr. Alfred Carpenter said he did not know which most to admire in Mr. Smee, his persistent determination not to see what was at his own door, his stolid indifference to the facts connected with the Croydon farm, or the idea he evidently entertained that he had in this paper brought forward any scientific principles for general guidance in the management of sewage farms. He appealed to all present whether any such scientific principles had been enunciated. Mr. Smee intimated that he would fine the Local Board £350 a-day for carrying out successfully the great scientific work, but he did not think that could be called a scientific principle. He would entirely prohibit the carrying out of sewage farms, and therefore there ought to have been in the paper some evidence that the farm he referred to had done some damage to the district. But this was not the case. If he were right, he and his neighbours ought to have applied to the Lord Chancellor for an injunction, and certainly those who did such things as were indicated ought to have been far more heavily fined than he proposed. Mr. Smee had led the meeting to assume that a certain epidemic in Croydon was connected with the sewage farm, but he would say in his presence that there was not the slightest foundation for such an inference. Mr. Smee also knew that at the meeting to which he alluded, he—Dr. Carpenter—told the members present that that very week a most extraordinary outbreak of typhoid had arisen, but they were perfectly satisfied as to the cause; as was known to the Chairman, it was connected with polluted water supplied to the inhabitants, but the pollution only occurred on two occasions—one week in March last and on one day in September—and the polluted water found its way into two or three of the water services, but it came from some distance and had no connection whatever with the sewage farm. For ten years

up to that time Croydon had been perfectly free from typhoid fever, though the farm had been all that time in operation. With regard to the health of fish, the river Wandle ran near the farm, as shown on the map, and they had had to make special regulations to prevent their own men from catching trout in the river near the farm, where Mr. Smee had seen them often enough. Then it was said that the sewage was so diluted as to be valueless; but he held that the more you could dilute sewage, if you could immediately apply it to the land, the more certain you were to get good crops. The reason why sewage farms often failed was because it was applied too strong. At Croydon there was no putrid sewage; the great advantage they claimed was, that in eight or ten hours after the sewage was discharged from the water-closets, it had passed over the land and was off into the Wandle; the effluent was comparatively pure, and had been shown by analysis to be almost as good as that supplied to Richmond for drinking; and though he never recommended it to be used, it was a fact that within 200 yards of the farm there was a large population dependent for their water supply on wells polluted from their own cesspools; they many of them preferred the effluent water from the sewage farm, and those who did so suffered less from disease than those who used the water from their own wells. As to the residents, who, it was said, were powerless to protect themselves, the greater number of the inhabitants in the neighbourhood were wealthy men, who would not submit to any such nuisance as Mr. Smee had depicted; nor would they suffer their property to be damaged. Within ten yards of the farm the Beddington Female Orphan Asylum had been established; was it likely that this would have been the case if there were the intolerable nuisance represented; or that young ladies would play croquet in the immediate vicinity of a stinking pestilential marsh? The following was a table showing the vital statistics of the district of Beddington:—

	Population.	Rateable Value.	Death Rate.
1861	1,556	£11,700	19·5
1871	2,834	20,674	11·13
1872	2,900	22,000	13·4
1873	3,360	26,000	14·3
1874	3,750	29,000	15·7

The returns for 1875 were equally favourable; the last monthly report made by the District Registrar showing the births 13, deaths 5. There had not been any epidemic disease amongst them, no fever, though there were a few deaths from scarlatina, which could never be prevented entirely by any sanitary measures. As to the milk, he must say Mr. Smee had done them considerable injury by the statements he had promulgated, and for some time they had a difficulty in disposing of their milk; however, they now had no difficulty in doing so, though they only delivered it once a day, and in quantities of not less than one gallon. It was true that they sold it at 1s. 6d. a gallon, whilst the milkmen charged 5d. a quart, but they were assured constantly that it kept better than that which was delivered twice a day. He had used a great deal of the farm produce himself; they had 108 head of cattle, many of which were bred and born there; there was not a better looking herd to be seen anywhere, and although they had had the foot and mouth disease amongst them, it always came to them last, and they always suffered less from it than their neighbours. He produced a specimen of hay made from rye grass grown on the farm, as sweet and good as need be desired, and also some very fine *kohl rabi*. The value of the produce was £23 per acre. With regard to defecation he joined issue with General Scott entirely, and thought it a great mistake to have depositing tanks, the delay in which allowed the sewage to become putrid, and to lose a great deal of its manurial value. If there were any foundation for the statements made by Mr. Smee, he should be one of the first to take steps for having such a nuisance put down. He had not a farthing of interest in the matter, and he had no reason to do other than put it down, except that he believed it was a way by which sewage could be used with advantage to the country, and with no disadvantage to the neighbourhood. He agreed with the rules laid down by Mr. Hope, and believed they were all carried out on the Croydon farm, with one exception, and that was the under-draining. It was not true that the sewage went over the soil and not through it, and though it was possible that Beddington-park might have been flooded in wet weather, it could not have arisen from the sewage farm, nor was it likely the proprietors would allow such a thing to be done with impunity. The sewage did occasionally go on to their neighbour's land at one spot, but there it was taken purposely by tapping the culvert, and without their consent. He considered an under-drained sewage farm a mistake, unless it were laid out on Mr. Bailey Denton's plan of intermittent downward filtration, because you could not prevent channels forming, and the sewage escaping without purification. He had seen that even in farms laid out by Mr. Denton himself, and he would not say it might not occur at their own outfall in times of flood, though he had never seen anything of the sort. That was one reason why he always strongly opposed the use of effluent water for drinking purposes. Last year he had 120 gentlemen to breakfast on the farm, and the whole of the eatables were produced from it, but not a drop of the water.

Mr. Pulling stated that it had been calculated that the total amount of pure excrement and urine produced in Great Britain per annum was 15 million tons, which would be of immense value for manure if it could be kept free from the water which was added to it, and which amounted to 328 trillions 500 millions of gallons. He contended that the Government ought to take some means for utilising this material by means of dry earth or charcoal, and that it could be made a large source of revenue, and would prevent the great loss of life which now occurred from typhoid fever.

Mr. William Botly, having seen many of the sewage farms in England, thoroughly agreed with every particular in Mr. Hope's letter. There was a little discrepancy between that gentleman and Dr. Carpenter on the subject of drainage, but he thought that could be reconciled by considering the different qualities of land; every agriculturist knew that the foundation of good farming was that strong land should be thoroughly drained. He had been twice over the Aldershot sewage farm, and had described it in one of the agricultural journals. Had Mr. Smee visited it he would have found that the grass was never sold within fourteen days, generally not within several weeks, after it had been irrigated; that land, originally worth £5 an acre, was now let at £25 an acre for market gardens; and only the day before he visited it some four bushels of violets had been cut from it. His father-in-law was almost the first to introduce the *kohl rabi* for sheep feeding, and he must say the specimens now produced were very fine. With regard to the grape vines in France, it was well known that this kind of manure was not suited to the vine at all.

The **Chairman** said the quantity of *kohl rabi* produced per acre was no test of its value, but the percentage of nutriment contained in the roots. He did not hesitate to say that the specimen before him, instead of containing from 70 to 75 per cent. of water contained more nearly 90 per cent. It was a dropsical, diseased plant.

Dr. Carpenter said he did not know why it should be, seeing that no sewage had been applied to the roots since they began to grow.

Mr. T. Wills thought the general question of sewage farming was of much more public interest than any particular differences between Mr. Smee and the Local Board

of Croydon. If all the calamities referred to in the paper were to follow sewage farming, that system would soon come to an end, but he thought many of them were rather shadowy, and seemed rather probabilities or possibilities than statements of facts which had actually occurred. Besides, many of Mr. Smee's strictures applied rather to mismanaged sewage farms than to those properly laid out and conducted. With all respect to Dr. Carpenter, he did not think the Croydon farm had been hitherto everything that was satisfactory, and therefore he regretted that no reference had been made to other and more recent experiments, such as that at Merthyr Tydvil, which he believed was the most successful of any. A paper was read before the Chemical Section of the Society last session by Mr. Thorpe, giving the details regarding that farm, and these more recent experience had, he believed, confirmed, showing that it had been perfectly successful. It was laid out under the superintendence of Mr. Bailey Denton, and as there were filtering beds connected with it, it was not necessary to apply more sewage to the farm at any time than was required, which was a very great advantage. In other farms the sewage came in at a steady rate, and had to be applied whether it was wanted or not, but this was not the case there, hence its great success.

Mr. Eggar, having the Aldershot sewage farm under his observation from day to day, was able to speak confidently as to its being the most perfect success, in an agricultural point of view, of any in the kingdom. That was simply because the sewage was of the most concentrated character, and was only used about two days out of the seven on an average, every other day it ran straight into the Blackwater, which was constantly silting up in consequence. Not long ago, an inspector from the Local Government Board came down to inspect it, and after going over the farm with him he said there was nothing which anybody could complain of; except what arose from the cause he had mentioned, that the sewage was flowing directly into the river. Some time ago they were told that the effluent water was so pure that the people broke down the fences to get it to drink, but it was based on a misapprehension, the fact being the water referred to ran from a drain with which the sewage had no sort of connection, and therefore, when it was analysed by Professor Abel, it was no wonder if it was found to be pure. There was a new system now being adopted, of which the public were not aware, whereby the sewage instead of being poured on to the surface was conducted by large pipes laid just below the surface, and when not wanted on the land, it ran straight into the brook in the same condition in which it entered. In this way the public were being deceived, and large sums were spent on sewage farms without really benefiting the public health. His opinion, as a practical farmer, was that sewage farms never would be successful, and he hoped before long some system would be devised by which any necessity for them would be removed.

The discussion was then adjourned to a day, the date of which will be announced, and the proceedings closed with a vote of thanks to the Chairman.

At the Philadelphia Centennial Exhibition there are to be no medals, but the judges are to give their written opinions upon inventions or products found worthy of mention, so that their verdict is intended to be not only a valuable distinction to the exhibitor, but a source of information to the public. Everything will depend, however, upon the judges, who are, it appears, to be appointed by the commission. There will be 200 of them—one-half American and one-half foreign—and they will be "chosen individually for their high qualifications."

The drawings and models for the prizes offered by the Goldsmiths' Company, for designs for plate, are now being exhibited at the Royal Architectural Museum and School of Art.

MISCELLANEOUS.

PHILADELPHIA EXHIBITION, 1876.

The Act of Congress which provided for "celebrating the one hundredth Anniversary of American Independence, by holding an International Exhibition of Arts, Manufactures, and Products of the Soil and Mines," authorised the creation of the United States Centennial Commission, and entrusted to it the management of the Exhibition. This body is composed of two Commissioners from each state and territory, nominated by the respective Governors, and commissioned by the President of the United States. The enterprise, therefore, is distinctly a national one, and not, as has sometimes been stated, the work of a private corporation. The Exhibition will be open on May 10th, 1876, and remain open every day, except Sunday, until November 10th. There will be a fixed price of 50 cents for admission to all the buildings and grounds.

The Centennial grounds are situated on the western bank of the Schuylkill River, and within Fairmount-park, the largest public park in proximity to a great city in the world, and one of the most beautiful in the country. The park consists of 3,160 acres, 450 of which have been enclosed for the Exhibition. Besides this tract, there will be large yards near by for the exhibition of stock, and a farm of 42 acres has already been suitably planted for the tests of ploughs, mowers, reapers, and other agricultural machinery.

The Exhibition buildings are approached by eight lines of street cars, which connect with all the other lines in the city, and by the Pennsylvania and Reading railroads, over the tracks of which trains will also run from the North Pennsylvania and Philadelphia, Wilmington, and Baltimore railroads. Thus the Exhibition is in immediate connection with the entire railroad system of the country, and any one within 90 miles of Philadelphia can visit it at no greater cost that that of carriage hire at the Paris or Vienna Exhibition.

The articles to be exhibited have been classified in seven departments, which, for the most part, will be located in appropriate buildings, whose several areas are as follows:—

Department.	Building.	Acres.
1. Mining and Metallurgy	Main building	21·47
2. Manufactures		
3. Education and Science		
4. Art	Art gallery	1·5
5. Machinery	Machinery building	14·
6. Agriculture	Agricultural building	10·
7. Horticulture	Horticultural building	1·5
	Total	48·47

This provides nearly ten more acres for exhibiting space than there were at Vienna, the largest international exhibition yet held. Yet the applications of exhibitors have been so numerous as to exhaust the space, and many important classes of objects must be provided for in special buildings.

An important special exhibition will be made by the United States Government, and is being prepared under the supervision of a board of officers representing the several executive departments of the Government. A fine building of 4½ acres is provided for the purpose, space in which will be occupied by the War, Treasury, Navy, Interior, Post-office, and Agricultural Departments and the Smithsonian Institution.

The Women's Centennial Executive Committee have raised 30,000 dols. for the erection of a pavilion in which to exhibit every kind of women's work. To this collection women of all nations are expected to contribute.

The list of special buildings is constantly increasing, and present indications are that their total number will be from 200 to 250. Most of the important foreign nations—England, Germany, Austria, France, Sweden, Egypt, Japan, and others—are putting up one or more structures each, for exhibiting purposes, or for the use of the commissioners, exhibitors, and visitors. Offices and head-quarters of this kind, usually of considerable architectural beauty, are provided by the States of Pennsylvania, Ohio, Indiana, Illinois, Michigan, New Jersey, New York, Connecticut, Massachusetts, New Hampshire, Missouri, Kansas, Virginia, West Virginia, Nevada, Wisconsin, Iowa, and Delaware; and it is likely that others will follow the example.

A number of trade and industrial associations, which require large amounts of space, will be provided for in special buildings. Among these are the photographers, the carriage builders, the glass makers, the cracker bakers, the boot and shoe manufacturers, beside quite a number of individual exhibitors. The great demands for space will probably render this course necessary to a considerable extent, especially for exhibitors who have been tardy in making their applications. In the Main Exhibition building, for example, 333,300 square feet of space had been applied for by the beginning of October by American exhibitors only; whereas, the aggregate space which it has been possible to reserve for the United States Department is only 160,000 square feet, about one-third of which will be consumed by passage ways.

The Machinery Building, like the others, is already fully covered by applications. There are about 1,000 American exhibitors in this department, 150 English, and 150 from other European countries, which is about 250 more than entered at the Vienna Machinery Exhibition. Extra provision is being made for annexes to accommodate the hydraulic machinery, the steam hammers, forges, hoisting engines, boilers, plumbers, carpenters, &c. Power in the Machinery-hall will be chiefly supplied by a pair of monster Corliss engines. Each cylinder is 40 inches in diameter, with a stroke of 10 feet; the fly-wheel is 31 feet in diameter, and weighs 55 tons; the horse-power is 1,400; and the number of boilers is 20. This engine drives about a mile of shafting.

For the Art Exhibition, the most eminent American artists are understood to be at work, and it may be confidently stated that, especially in the department of landscape painting, the United States will present a finer display than the public has been led to expect. Quite aside from the contributions of American artists, applications from abroad call for more than four times the exhibiting space afforded by the great Memorial-hall. Provision for the surplus will be made in temporary fire-proof buildings, though all exhibiting nations will be represented in the central Art Gallery.

The Secretary of the Navy has arranged that a United States war vessel shall call next spring at convenient European ports, to collect and transport hither to the Exhibition the works of American artists resident in Europe. Among the ports thus far designated, are Southampton for England, Havre for France, Bremen for Germany, and Leghorn for Italy, to which, if desirable, others may be added.

Mr. Bell, the eminent English sculptor, who designed the groups for the plinth of the great Albert Memorial in Hyde-park, London, is reproducing in terra cotta, at the celebrated works in Lambeth, the one which symbolises America. The figures in this group are colossal, covering a group space of 15 feet square. It will probably be placed in the great central gallery, opposite the principal entrance.

The Art Exhibition will include, in addition to the works of contemporary artists, representative productions of the past century of American art—those, for instance, of Stuart, Copley, Trumbull, West, Alston, Sully, Neagle, Elliot, Kensett, Cole. These, as well as the works offered by living artists, will be passed upon by the Committee of Selection, who will visit for the purpose, New York, Boston, Chicago, and other leading cities, in order to prevent the needless transportation to Philadelphia of works of art not up to the standard of admission.

A large number of orders and fraternities have signified their intention to hold gatherings at Philadelphia during the period of the Exhibition. Amongst those which may now be enumerated, are the Grand Lodge of Pennsylvania, Independent Order of Odd Fellows; the Grand Encampment, Independent Order of Odd Fellows; Grand Lodge, United States, Independent Order of Odd Fellows; Grand Commandery Knights Templar; Grand Army of the Republic; Presbyterian Synod; Caledonian Club; Portland Mechanic Blues; Welsh National Eistedfodd; Patriotic Order Sons of America; California Zouaves of San Francisco; an International Regatta; the Life Insurance Companies; National Board of Underwriters; State Agricultural Society; 2nd Infantry, N. G. of California; Philadelphia Conference, Methodist Episcopal Church; Cincinnati Society; California Pioneer Society; American Dental Convention; Catholic Total Abstinence Union of America; Independent Order of B'nai Berith; National Alumni Association; Salesmen's Association; 5th Maryland Regiment; American Pomological Society; Maltster's Association of the United States; Army of the Cumberland; Humboldt Monument Association, Christopher Columbus Monument Association; Board of Trade Convention; International Typographical Congress; Rifle Association of the United States; Centennial Legion; Philadelphia County Medical Society; International Medical Congress; Old Volunteer Fire Department of Philadelphia.

THE RESOURCES OF NEW ZEALAND.

The official handbook of New Zealand contains an account of the discovery and progress of the colony since the visit made by Capt. Cook in 1769, with the most recent information, agricultural, industrial and statistical, in a collection of papers contributed by experienced colonists from different localities, illustrated by maps, engravings, and photographs of the chief features of town or country.

New Zealand comprises two large islands, North and South, with one of smaller size called Stewart Island. They are situated in the South Pacific Ocean, nearly at the antipodes to Great Britain. The islands form one extended line for a distance of nearly 1,200 miles, their general direction being towards the south-west, but a straight line from the North Cape to the South Cape would not exceed 900 miles in length. Their average breadth is about 120 miles, but no part is anywhere more distant than 75 miles. Their area is nearly 100,000 square miles, almost equal to that of Great Britain and Ireland. Their distance from Great Britain is about 12,000 miles, and from Australia about 1,200. The North Island is about 500 miles long, its greatest breadth being about 250 miles. Its area is about 44,000 square miles, or rather less than that of England. The South Island is about 500 miles long, its greatest breadth being 200 miles long, with an area of 55,000 square miles, or about the size of England and Wales. It is separated from the North Island by Cook Strait, 13 miles across at the narrowest part—a feature of the greatest importance to the country, from its facilitating intercommunication between the different provinces without the necessity of sailing right round the colony if it was in one island. New Zealand is very mountainous, with extensive plains, which, in the South Island, lie principally on the eastern side of the mountains, and in the North Island on the western side, the interior and more mountainous parts being covered with dense forest, containing almost inexhaustible supplies of fine timber. In the North Island the mountains occupy about one-tenth of the surface

and in the South nearly four-fifths; but in the South Island the greater part of the mountains are open, well grassed, and used for pastoral purposes. Forest, or, as it is called in the colony, bush, is also sufficiently plentiful on the plains in the western slopes of both islands, and a very large export trade is done in timber. The rivers are very numerous, and of large size in proportion to the area of the country; but owing to its mountainous character they are rapid in their course, and in only few instances navigable. The greatest height of the main range in North Island is 6,000 feet, so that even the loftiest peaks are not covered with snow at all seasons of the year; but in the South Island the Alpine peaks rise from 10,000 to 14,000 feet, and, like the Alps of Europe, contain in the higher regions valleys filled with glaciers or masses of sliding ice, derived from extensive snow-fields, which form the sources of the principal rivers that intersect and fertilise extensive downs and plains in their course to the sea.

The changes of weather and temperature are very sudden; calms and gales, rain and sunshine, heat and cold, often alternating so frequently and suddenly as to defy previous calculation; so that there cannot be said to be any uniformly wet or dry season in the year. But although these changes are sudden and frequent, they are confined within very narrow limits, the extremes of daily temperature only varying throughout the year by an average of 20°., whilst in Europe, at Rome, and other places of corresponding latitude with New Zealand, the same variation amounts to or exceeds 30°. In respect to temperature, New Zealand may be compared either with England or with Italy, but London is 7° colder than the north, and 4° colder than the South Island of New Zealand, and is less moist. Strong winds are prevalent and particularly in the straits. Rain falls frequently, but seldom in such excessive quantity, or for periods of so great length, as in Australia; the heaviest rain seldom exceeding two days' duration, excepting on the west coast, while it is rare for a fortnight to elapse without a shower. The rainfall for the year 1871 was $54\frac{1}{2}$ in., the average rainfall in England being about 45 in.

A very large number of the population are occupied in mining for gold, which for the last twelve years has proved one of the most important exports of the colony. The gold is obtained in two forms, viz., as alluvial gold (which is washed from the sand and gravel which occupy valleys in the mountain ranges), and as veins in quartz reefs. Alluvial gold is chiefly found in the South Island in the provinces of Otago, Westland, and Nelson, in which districts mining operations are carried on over an area of almost 20,000 square miles. Other valuable metals, such as silver, mercury, copper, lead, chromium, manganese, and iron, have been discovered in various parts of the colony, and in due time will be profitably worked when the circumstances of the labour market permit. Ores of the last mentioned metal—iron—are remarkably abundant, and are already attracting attention, so that several mining and smelting companies have been formed, the operations of which will afford a very considerable employment of labour. Coal mines have been opened in all parts. The coal is of two distinct descriptions, viz., that which is adapted for steam purposes, or black coal, and brown coal, a variety which, though too bulky, and giving out its heat too slowly to be useful for steamers on long voyages, is nevertheless of great value for steamers on coast voyages, for stationary engines at manufactures, and for domestic use, being quite equal for the latter purpose to much of the coal that is used in Germany and Austria. The construction of railways and other works is now in active progress for the service of these coal-fields, and as they are sub-divided and let by Government on extremely favourable terms to lessees, it may be expected that in a short time several mines will be in full working order, and that communities will spring up in the above-mentioned places. Petroleum or rock-oil springs occur in various parts, particularly at Taranaki, on the west coast, and in the vicinity of Poverty Bay, near the East Cape in the North Island. The quality of the petroleum in the latter place is quite equal to that obtained in Canada and the United States, as it yields by a simple refining process 60 to 75 per cent. of commercial kerosine. A liberal bonus has been offered by the Government with the view of fostering this industry, the development of which, in recent years, has led to so much prosperity in certain districts of the United States.

There are about 12,000,000 acres of land fitted for agriculture, wherein the form of surface is suitable, and about 50,000,000 which are better adapted for pasturage; but from these estimates allowance must be made for about 20,000,000 acres of surface at present covered by forest. By the proper selection of soil, and with a system of agriculture modified to suit the great variety of climate which necessarily prevails in a country extending over twelve degrees of temperate latitude, every variety of cereal and root crop may be successfully reared; and with due care in these respects, New Zealand will not fail to become a great trading and exporting country of all the chief food staples. At one time very destitute of animal life suitable to the wants of civilised man, in more recent years all kinds of domestic animals, many of very high quality, have been imported, including valuable continental breeds of sheep and the American llama. Domestic poultry of almost every kind has also been introduced, and through the agency of the Acclimatisation Society, many species of game, such as hares, pheasants, partridges, black game, red grouse, quail, &c., and a host of the smaller birds of Europe and other countries have been spread over the islands. The rivers, which formerly produced only the eel and a few small salmonoid fish of little value, are gradually being stocked with trout; whilst perch, tench, and carp have also been satisfactorily acclimatised.

The seas around, however, make up, by the abundance and large variety of the valuable fish which they produce, for the scantiness of the terrestrial fauna. Amongst these may be named the hapuka, a very large species of cod, the king-fish, frost-fish, butter-fish, red schnapper, moki, barracouta, kawai, sole, dory, flounder, and many others, all in considerable quantity, and of delicious flavour; besides which, shoals of mackerel and pilchard occur during certain seasons of the year. Oysters, mussels, crayfish, and other mullusca and crustacea of great value, and of excellent quality, require only proper systematic culture to become a source of wealth to the colony. There is no doubt, in fact, that the New Zealand fisheries, which have hitherto been little looked after, but are now being protected under legislative enactment, will become of considerable importance with the spread of trade and navigation. As regards the vegetable productions it would be impossible in a limited space to give any proper account either of the indigenous or introduced flora. The indigenous forest is evergreen, and contains a large variety of valuable woods, amongst which are named the puriri, the matai (or black pine), the rimu (or red pine), the kalukatea (or white pine, whose timber is, from its lightness and roughness, well adapted for the manufacture of packing cases), the lotura (a specie of yew), the hinau (from the bark of which a very valuable tannin is extracted), and various species of beech. Most of these trees produce excellent timber for ordinary building purposes, many of them yield handsome furniture woods, whilst the beech is one of the most valuable shipbuilding timbers known, seasoning easily, and being extremely durable. Amongst the smaller plants, the *Phormium tenax*, or New Zealand flax, is of especial value; whilst large tracts of country are covered with indigenous grasses, of sheep-feeding quality, which support millions of sheep, and have thus been productive of great wealth to the colony. Many of the more valuable trees of Europe, America, and Australia have been

introduced, and have flourished with a vigour scarcely ever attained in their own natural habitats. In many parts the hop grows with unexampled luxuriance, whilst all the European grasses and other useful plants produce returns equal to those of the most favoured localities at home. Fruit, roots, and vegetables of all kinds grow abundantly; and, in fact, it may truly be said that nearly all the useful orchard and garden productions of England are now known in New Zealand, and come under proper treatment to equal perfection.

Those who are now seeking a home in New Zealand can scarcely appreciate the feelings of the early colonists, or the trials and difficulties they had to encounter. Instead of arriving on a shore unprepared for their occupation, without a single house to shelter them, they find all the machinery of social life, and the general aspect of everything very much as they left them at home. The immigrant who now lands at Lyttelton, Dunedin, Auckland, or Wellington, finds himself surrounded by numbers of his own countrymen, dressed like himself, hurrying about in the various businesses common on the wharves of any considerable seaport of the old country; he sees shops with plate-glass windows, and English names above the doors, filled with the latest novelties from London, Birmingham, and Paris; cabs plying for customers, omnibuses rumbling along the streets; hotels innumerable; churches and schools in moderate numbers; public buildings exhibiting pretentious feats of architectural skill; asphalte pavements, and Macadamised streets leading out to suburbs thick with comfortable and even handsome mansions, surrounded by well-kept gardens, gay with brilliant flowers and semi-tropical vegetation. The population, at the recent census in 1874, numbered 299,604 persons, inclusive of the aborigines, with a well-organised system of post-offices, insurance companies, savings banks, and telegraphs. The editor, the Hon. Julius Vogel, whilst giving this enticing account of the splendid resources of the country, warns intending emigrants, who incline to make New Zealand their home, not to form too extravagant anticipations, for it is neither paved with gold, nor is wealth to be gained without industry.

UTILISATION OF THE SUN'S HEAT FOR INDUSTRIAL PURPOSES.

M. Mouchot, who has devoted the last fifteen years to the study of this question, thus arranges his solar receiver or generator. It consists of three distinct parts: — A metallic mirror with linear hearth; a blackened boiler, the centre line of which coincides with this hearth; and a glass casing which allows the solar rays to impinge upon the boiler, but prevents their being reflected. The mirror is in the form of a truncated cone, the generating line of which makes with the axis, an angle of 45°. The base consists of a disc of cast iron, added for the purpose of counteracting the effect of the wind. In the centre of the disc rises the boiler, the height being equal to that of the mirror; it is made of copper, blackened on the outside, and is composed of two concentric casings, the larger of which is 80 centimetres (2ft. 7½in.) high, and one smaller, 50 centimetres (1ft. 7½in.), the respective diameters being 28 and 22 centimetres (11 and 8½in.). The feed-water occupies 1 annular space between the two casings. The volume of liquid should not much exceed 20 litres (4¼ gals.), so as to leave about 10 litres for the steam chamber. The glass casing is bell-shaped, 85 centimetres high by 40 in diameter (2ft. 9½in. × 1ft. 3¾in.), and 5 millimetres (0·19in.) thick. There is, therefore, a constant space of 5 centimetres (2in.) between the boiler and the glass, which latter only adheres by its foot or rim to the bottom of the mirror.

Thus arranged, the boiler should revolve, at the rate of 15 degrees in an hour, on an axis parallel to that of the earth, and also become gradually inclined on this axis in accordance with the declension of the sun.

The following are the results achieved by the apparatus at Touraine. In ordinary fine weather, 20 litres (4¼ gals.) of water introduced at 20° Centigrade (68° F.) at half-past eight o'clock, were turned into steam at a pressure of two atmospheres in 40 minutes. The pressure was then quickly raised to five atmospheres, a limit which it would have been dangerous to exceed in the boiler with which the experiment was being conducted. The steam was used to drive an engine working a pump, &c.; it also distilled five litres (a gallon) of wine in a quarter of an hour. It may be concluded, from the trial, that, in our latitudes, the apparatus utilises from eight to ten *calorics* (32 to 40 English equivalents of heat) per square metre (1·19 square yards) per minute.

CORRESPONDENCE.

CONVERSION OF CAST IRON INTO IRON OR STEEL.

Sir,—It will be interesting to your readers to learn that the re-agents used in my process of refining and converting cast iron (caustic soda and oxide of iron—see *Journal* of 26th November, 1873), have been recently again tried in the common puddling furnace with complete success.

I subjoin the particulars of the trials and their results.

As the heat generated by the complete combustion of pyrogen gas is a matter of certainty, the only point remaining to be settled is that of economy and cost, which I believe will not long remain in doubt.—I am, &c.,

F. C. Knowles.

Mayfield, near Ryde, 9th Nov., 1875.

Report.

The pig iron was carefully picked out of an uniform quality and borings taken from several pigs. Three heats of this iron were worked in No. 3 furnace (new forge), and three heats in No. 4 furnace. Both furnaces were in exactly the same condition. No. 3 worked in the ordinary way, and No. 4 had the soda worked in after the first rabble. A trial bar was taken from each heat of each furnace, and borings taken from them for analysis.

The pig iron contained—

Silicon	2·49
Sulphur	trace
Phosphorus	1.30

Puddled bar from No. 3 furnace (no soda)—

Silicon	0·172
Sulphur	trace
Phosphorus	0·350

Puddled bar from No. 4 (soda)—

Silicon	0·226
Sulphur	trace
Phosphorus	0·044

so that the metal chemically treated gave iron quite free enough of phosphorus to work in the Siemens-Martin process.

R. H. U. A.

September 27th, 1875.

N.B.—A pyrogen heated furnace of proper construction may be applied readily to the production of steel directly from the ore, with a scoria so pure as to be suitable to glass making.

F. C. K.

INDIAN AGRICULTURE.

Sir,—I was surprised and annoyed to see in your *Journal* of July last a letter I had addressed to the secre-

tary of your Society, which I had intended only for the perusal of the Committee.

The letter was not addressed to you, but to the secretary. I have the impression that I had marked it "private" but I suppose that I must have neglected doing this, or you would scarcely have published it. Yet it contained sufficient internal evidence to have justified you in treating it as a private communication. Under any circumstances, I think you ought to have omitted paragraph 2 and 3 of the letter, which dealt only with matters of a private nature. Had the letter been intended for publication, these two paragraphs would most certainly not have appeared in it. I wrote under the belief that I was addressing the Committee only, and deemed it to be my duty to state the grounds on which I claimed a hearing, seeing that Mr. Elliot had, in his paper, stated in so much detail the qualifications he possessed to entitle him to be heard; to avoid a loss of time, by a reference to this country, I gave numerous references to gentlemen living within easy reach of the secretary; and to these gentlemen I must offer my apologies for having (unwillingly) caused their names to be published.—I am, &c.,

William R. Robertson,
Member of the Royal Agricultural College.

Madras, October 22nd, 1875.

[The letter referred to appeared in the *Journal* of July 8th last. It was certainly not marked as being private. —Ed.]

BEER FROM ESSENCE OF MALT AND HOPS.

Sir,—I have long been intending to send you some remarks about "the beer brewed from essence of malt and hops," and an article in your number for 22nd October furnishes me with the data of Mr. Lockwood's invention, to compare with what I found perfect and in use, so far back as 1818. That was my first acquaintance with it; from one of the officers of the expedition on the Arctic exploration under Sir John Ross. Captain Beachy, who also served in that and the following expedition under Sir L. Parry, spoke highly of it, and I think we tried it in H.M.S. *Blossom*, 1824-9.

In 1830, referring to the supply notes of those officers, I took on board H.M.S. *Etna* a large supply for service on the coast of Africa, and to its daily distribution, after hard work of sixteen hours in the sun, I attributed the unprecedented freedom from disease, and especially of scurvy, not losing a single soul by death during three-and-a-half years.

The next occasion was the fitting of the *Erebus* and *Terror* for Arctic service in 1835 when I again demanded the supply, but the *Terror* only proceeded with Captain Buck. On my appointment to the command of H.M.S. *Sulphur* in 1837 I took out fresh supplies (*via* Panama).

In 1842 I took full supplies for four years in H.M.S. *Samarang*, and we were very successful in its manufacture. Ultimately the Arctic expedition under my command in 1852 took in a supply, and it was deemed a luxury.

Now as to the preparation. It was furnished, I believe, in nearly all these cases by the noted chemist, Mr. Hudson, of the Haymarket, not patented I believe. It was in separate cases, essence of malt, and essence of hops, with prepared yeast. We were able to brew to any strength, and in any proportion, to suit our object, beer, strong ale, strong porter, and on the coast of Africa found it fit to drink, indeed a luxurious beverage, in forty-eight hours. We kept two sixty gallon casks in constant use, so that on the return of our men nightly they were mustered at quarters, in clean dry flannels, and their pint of beer issued. On Arctic service our brewery was carried on in the hold, beside the stove for warming the air pipes, and it took several days to get up the first issue, after which it progressed satisfactorily.

On reading the explanatory letter of Mr. Lockwood, and having heard from my brewer-in-chief on the late Arctic expedition, Paymaster Lewis, of what he knew of that now supplied to Captain Nares, he was of opinion that "the old thing, sir, was the best." That remains to be proved.

Now, as a practical chemist, the explanation of Mr. Lockwood does not satisfy me. He brews beer to his taste. I know too well what I seek in any mixture simply presenting ingredients to meet the required draught. Excess of acid in critical cases might prove injurious, but excess of alkali of little moment. That is not the question. I wish to manufacture my own beer to the strength I require, or in plain terms, to give it excess of malt or hops, the latter specially in cases of scurvy. But this patent confines us to a beer of another man's fancy.

Patents in such cases are among the absurdities we hope to see swept away. In my own case at this present moment I am a great invalid. I cannot, it is well known to the faculty, use any beer that is sold in bottle. I have arranged to have my own strength supplied, and bottled myself. We might as well have a patent brandy. Of that I can buy none to suit my complaint. The press daily informs us that "the tricks played on beer are legion," and that they are beyond the power of chemists to detect. "Brew your own, and to suit your constitution" is the advice I give to my friends.—I am, &c.,

Edward Belcher (Admiral).

15, Dorset-street, Nov. 8th, 1875.

LIBRARIES OF INSTITUTIONS.

Sir,—Will you kindly allow me to announce by the medium of the Society's *Journal* that H.R.H. Prince Leopold has authorised me, as Director of the New Shakespeare Society, to distribute to the chief free libraries and mechanics' institutes 50 copies of Mr. Daniel's parallel text edition of the first two quartos of Shakespeare's "Romeo and Juliet," which edition the Prince presented to the New Shakespeare Society. Application should be made to me at 3, St. George's-square, London. The copies are posted to applicants.—I am, &c., F. J. Furnivall.

Egham, Nov. 11, 1875.

GENERAL NOTES.

Fires in New York.—Mr. James Harrison, superintendent of rates and surveys for the New York Board of Underwriters, has recently examined the hotels in that City. In the course of his report he says:—"Of the 69 hotels 24 have frame Mansand roofs, 39 have wooden cornices, 35 have unsafe gas brackets, 25 have unsafe steam pipes, 20 have unsafe flues or fireplaces, 49 have unsafe laundries or drying-rooms, 51 have uncovered lights in basements or wine-cellars, 25 have repair shops in the buildings, 32 have unprotected boilers, 26 open elevators. Stairways are all open. Thirty-three of these hotels have four of these several defects. Not one hotel exists of this number but has one or more of these defects. . . . I scarcely need call your attention to the fact that these buildings range from five to seven stories in height, with tortuous passage-ways or halls, confusing to strangers under the most favourable circumstances, difficult of access to our fire department, and but few of them provided with appliances for extinguishing a fire, while the sparse provisions that are made would in most instances be useless, having no organised body to use them in case of emergency. We are told that these buildings are carefully watched night and day by competent persons. A sad experience has taught the fire underwriters of New York the fallacy of placing entire dependence upon watchmen, however careful and trustworthy. I submit to you whether a danger removed is not preferable to a danger watched or guarded, however carefully? The corrections of many of these dangerous elements are clearly within the power of the owners or occupants. . . . Our surveyors can

only advise; no official power is delegated to them. The general reply to their suggestions is, 'There is no necessity for us to spend this money while we can procure as much insurance as we want at satisfactory rates.' The present building law is not retroactive, and can only affect such buildings as a re at present in course of construction or alteration, or may hereafter be erected."

Celluloid.—New York papers give an account of a destructive explosion recently at celluloid works at Newark, New Jersey. Celluloid is described as a mixture of gun-cotton and camphor, constituting, when pressed and dried, a hard elastic substance, susceptible of high polish, and so closely resembling ivory as to deceive skilful experts by its appearance. But it has this dangerous quality that it will ignite instantly from the fire or even an ordinary match, and burn more rapidly and with more flame than a piece of sealing-wax. The *Journal of Commerce* reminds its readers that it mentioned some time ago that ladies' jewellery will sometimes be found to be made of celluloid, in imitation of coral, and that they ought to be informed of its ready inflammability.

Girton College.—The Executive Committee of this College have lately issued an appeal for funds to enable them to provide additional accommodation for their students. They have now twenty-three in residence, though rooms for twenty-one only were provided, and a large increase is expected next October. The building was so planned at the outset, as to make it easy to add a considerable number of students' rooms without the necessity of enlarging the dining-hall or offices. It is estimated that rooms for nineteen students, two lecture-rooms, and a second staircase, could be added to the present building at a cost, including furniture and other contingent expenses, of about £6,000. It is thought that such an enlargement would supply the immediate need and a little more, while it is felt that to make an addition on a smaller scale would be inexpedient as increasing the proportionate expense of building as well as on other grounds. With the addition contemplated, the building would contain rooms for the mistress, two assistant-lecturers, and thirty-eight students; four lecture-rooms, and a small laboratory, dining-hall, prayer-room, reading-room, gymnasium, &c. In order that the new rooms may be ready for occupation next October, the work ought to be set on foot with the least possible delay. Contributions may be paid to the treasurer, H. R. Tomkinson, Esq., 24, Lower Seymour-street, London, W., or to the Girton College account at the London and County Bank, 21, Lombard-street, E.C., and its branches, or to Messrs. Mortlock and Co., Cambridge.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

The following arrangements for the Wednesday evenings before Christmas have been made:—

December 8.—"The Mode of Levying the Sugar Duties in France, and its Influence on the Sugar Industries of Great Britain," by Professor Leone Levi, F.S.S., &c.

December 15.—"Health, Comfort, and Cleanliness in the House," by Thomas Blashill, Esq., A.R.I.B.A.

December 22.—"A method of producing Pure Charcoal Steel directly from the Ore," by Henry Larkin, Esq.

Cantor Lectures.

The remaining lectures of the first course of Cantor Lectures for the present Session, "On the Discoveries and Philosophy of Liebig, with especial reference to their influence upon the advancement of Arts, Manufactures, and Commerce," by J. L. W. Thudichum, M.D., will be delivered on the following Monday evenings:—

Lecture III.—December 6.

Physiology of plant-life, chemistry of agriculture and natural laws of husbandry.—Works, and effect upon society.

Lecture IV.—December 13.

Physiology of animals, and the laws of their nutrition in particular.—Foods and food-extracts.—Works, and their influence upon professions and associations.

Lecture V.—December 20.

Therapeutic agents and collateral discoveries, chloroform, chloral.—The way from detailed labours to general scientific principles and laws.—Liebig's philosophy as influencing mode of thinking of present generation.

The lectures will be illustrated by selected experiments and demonstrations.

Special Lectures.

A series of reports has been prepared by Dr. Richardson, appointed by the Council to make special inquiry into the subject of "Unhealthy Trades." These will be delivered in the form of Lectures on the following Friday evenings:—December 3rd, 10th, 17th; January 21st, 28th; February 4th.

The subjects considered in this course will include:—

The influence of physical labour on individual and national vitality.

Injuries incident to physical labour. (1) By exposure to dust and other foreign substances. (2) By exposure to noxious gases and heated and impure air. (3) From mechanical concussions, peculiar postures of body, and excessive exertion.

Diseases incident to workers in the potteries, in trimming and furniture dressing, in sand-paper making, in flour-mills, amongst old rags, in fur dyeing, in walking-stick making, in hemp dressing, in patent leather dressing, &c.

Diseases of paviours, carpenters, blacksmiths, postmen, scriveners, &c.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Thudichum, "The Discoveries and Philosophy of Liebig, with special reference to their influence upon the Advancement of Arts, Manufactures, and Commerce." (Lecture III.)
Farmers' Club, Salisbury-square, E.C., 5½ p.m. Mr. J. J. Mechi, "The Treasures of the Air, the Soil, and the Subsoil."
Society of Engineers, 6, Westminster-chambers, 7½ p.m. 1. Adjourned discussion on Mr. H. W Pendred's paper "Screw Propellers, their Shafts and Fittings." 2. Mr. F. W. Hartley, "An Improved Method of Charging and Drawing Gas Retorts."
Medical, 11, Chandos-street, W., 8 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Rev. J. McDougall, "Present Day Materialism."

Tues. ...Women's Education Union (at the House of the Society of Arts), 6 p.m. Mr. Sonnenschein, "The Method of Teaching Arithmetic."
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on "The Pneumatic Transmission of Telegrams." 2. Mr. John George Gamble, "The Brighton Intercepting and Outfall Sewers."
Zoological, 11, Hanover-square, W., 8½ p.m.

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Professor Levi, "The mode of Levying the Sugar Duties in France, and its Influence on the Sugar Industries of Great Britain."

Thurs...South London Photographic (at the House of the Society of Arts), 7½ p.m.
Royal Historical, 11, Chandos-street, W., 8 p.m. 1. Mr. Sydney Robjohns, "The Siege of Quebec." 2. Rev. A. H. Wratislaw, "Two Bohemian Romances of the Fourteenth and Fifteenth Centuries."

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Special Lecture. Dr. Richardson, "Unhealthy Trades." (Lecture II.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,203. Vol. XXIV.

FRIDAY, DECEMBER 10, 1875.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The following are the rules for the admission of candidates to compete for the Society of Arts Scholarships :—

1. The Society of Arts has founded four Free Scholarships, two for males and two for females, and a competition for them will take place early in February, 1876.

2. Candidates to compete must be nominated by a Member of the Society of Arts, each Member having the privilege of nominating a male and a female candidate.

3. The nomination must be made on the form and in the terms given below. Copies of the form for this purpose will be supplied to Members on application to the Secretary of the Society of Arts.

4. The examination of the competing candidates will take place at the Society's House, John-street, Adelphi, early in the month of February. The date, when fixed, will be notified to each candidate properly nominated.

5. The subjects in which the candidates will be examined in the competition are as follows :—

(*a.*) Reading aloud and recitation with clearness of pronunciation; writing legibly from dictation.
(*b.*) Elementary knowledge of musical notation and knowledge of the principles of music.
(*c.*) Performance on some instrument or singing (at sight also if possible), or composition.

6. The attention of Members is specially drawn to the foregoing requirements, and it is particularly requested that they will exercise great care to nominate those only who they feel assured can fairly fulfil them.

7. Members nominating must send in to the Society of Arts with each nomination form—

(*a.*) A medical certificate, proving that the candidate is in good health and has no defect which would impede the practice of vocal instrumental music.
(*b.*) The copy of a register of birth.
(*c.*) The certificate of two well-known persons in a locality that he, or she, is of good moral character.

8. Previous to the competition an examination fee of 5s. must be paid by each competitor to the Society of Arts.

9. *Admission to the School after Competition.*—After a candidate has been successful in a competition, and has been named for a Scholarship, he or she will be admitted to the Training School upon the production of the above-mentioned necessary certificates of health, birth, and character; his or her continuance as a student in the Training School will depend on the report of progress by the Examiners and the Director of Studies.

Note.—On admission the student will be required to furnish the statement from the Society of Arts Examiner as to his or her capacity, previous musical studies, and antecedents.

10. All Scholarships confer the right of obtaining the best musical instruction in the School without payments of fees of any kind, or for instruments, music, and books, which are provided for use in the School. The School does not provide board or lodging.

11. The nomination paper for the competition, duly filled in and signed by the Member nominating, accompanied with the necessary certificates and the candidate's fee, must be sent in to the Secretary of the Society of Arts, John-street, Adelphi, London, W.C., on or before the 15th January, 1876.

EXAMINATIONS IN DOMESTIC ECONOMY.

These Examinations are particularly intended for women, but there is no reason against men taking certificates in them. The subjects are—

Clothing and its Materials.
Health.
Housekeeping and Thrift.
Cookery.

The Examinations will, in 1876, be held simultaneously with the Commercial Examinations, commencing on the 25th of April.

Programmes may he had gratis, on application to the Secretary,

INSTITUTIONS.

The following Institution has been received into Union since the last announcement:—

Monnow-road (Bermondsey) Science and Art Classes.

JUVENILE LECTURES.

Two lectures, suited for a juvenile audience, will be given on Tuesday, January 4, and Tuesday, January 11, by Dr. W. B. Carpenter, F.R.S., on "The Wonders of the Microscope." The lectures will commence at 7 p.m., and will be illustrated by the oxy-hydric and electric lights. As the number of seats is limited, Members can only avail themselves of these lectures for their families by obtaining tickets from the Secretary, and these will be issued in order of application. Each Member is entitled to a ticket admitting one adult and two children.

REGISTRATION OF TRADE MARKS.

The adjourned discussion on Mr. H. T. Wood's paper on this subject was held on Thursday evening, December 2nd. In the absence of Mr. Mundella, from indisposition, the chair was taken by Mr. H. M. Jackson, Q.C., M.P.

Previous to the opening of the discussion,

Mr. H. T. Wood said the suggestion thrown out at the last meeting by Mr. Ryland was intended to be adopted, and a resolution would be proposed, asking the Council to appoint a committee to consider what would be the

best code of regulations to be adopted under the Act. He felt sure that the Council would throw no obstacle in the way of such a committee being appointed, and several gentlemen competent to act upon it had already signified their willingness to do so. He would only add that he hoped gentlemen would endeavour to make the discussion as useful as possible, by confining themselves to practical suggestions rather than considering the advantages or disadvantages of registration, or any defects in the present Act as now passed, which defects, if any, could only be set right by an amending Act in some future session of Parliament if necessary.

Mr. E. Johnson said the matter had been dealt with so elaborately in the paper that little remained to be suggested. If the various industries of the country were represented on the committee it would no doubt have great weight with the Lord Chancellor, who had taken much interest in the question, and had already expressed a wish that rules should be framed and submitted to him by those interested in the question. It would be difficult in a desultory discussion to go into matters of detail, and he hoped those gentlemen who had not an opportunity of making themselves heard at that meeting, would communicate their views to the committee of the Society of Arts, who would have every opportunity of sifting all questions submitted. The question of registration presented great difficulties with respect to classification, as it was not easy to draw the line where one particular class of goods should commence and another end. He might take the case of a straw hat manufacturer registering a mark for his hats, and a rival maker registering the same mark for straw bonnets, and both manufacturers obtaining a reputation for their respective goods. If the hatmaker wished afterwards to manufacture bonnets, he would have to choose another mark, thus causing great confusion by having two marks in the same house. It was not to be expected that an Act of such importance could be administered immediately so as to meet all difficulties, because the registrar would have to consider not only the mark, but how it was to be used. The head of an elephant might be registered by one house, and the head of a donkey by another firm, and on a large scale it would be easy to distinguish the trunk of the elephant from the ears of the donkey, but on a small packet of pins and needles for instance, it would be very difficult to distinguish between the two. Until they knew the Lord Chancellor's views as to the way in which the Act should be carried into operation, he did not think they would be in a position to offer suggestions to his Lordship.

Mr. Charles Watkins agreed with the last speaker that there would be great difficulty in registering, so that the marks should not clash with one another in use. He had in his hand a specimen of two marks which were practically almost identical as they appeared there, though when they were enlarged, as they were in the price lists of their respective owners, there was such a distinction that no one would suppose there would be so much similarity in practical use. He thought, therefore, it would be very important, in framing the rules, that provision should be made that persons applying to register should not only send in a specimen of the mark of such a size as to show all the details, but also an example of the size intended to be applied to the articles; otherwise he did not think the registrar would be able to insist on such distinctiveness in the marks as he conceived it would be his duty to do. With regard to the index, he did not see the difficulty which some gentlemen did, and thought that though it would be a work of great labour, there would be no real difficulty in the matter. If a cutler had a particular mark no one else in the same trade should be allowed to use the same, although the first-mentioned manufacturer only made, as some did, two or three particular articles. He did not think this would create any hardship, or that any difficulty had been found in Sheffield on this point. With reference to the illustration which had been given of straw hats and bonnets, he did not think it would be just to allow the same mark to be applied by different firms to articles so nearly alike. The same with regard to needles and pins, though the manufacture was quite distinct. He thought it would lead to great confusion to attempt the classification of goods under such a title as hardware, because there would be numerous articles all coming under the same heading, which had no resemblance to each other, either in material or manufacture. The Act said that registration of a trade mark should be deemed equivalent to public user of such mark, but this he considered a very unwise provision; he thought that no mark should be registered unless it were actually in use, or unless a declaration were made that it would be used within a certain time. He had no particular interest in opposing this clause, but looking at the general good he did not think it would be right to create a property in a trade mark by simple registration; it would throw a great deal of work on the registrar, and would confer no corresponding advantage on the public. The Act did not provide for provisional registration, but he thought that something of that kind was required, otherwise one man might register a mark before another who was entitled to use it had an opportunity of so doing. He did not think colour should be admitted as an ingredient in any trade mark, which should be defined simply by the actual outline or words which it contained, however the mark might be coloured in actual use. The question of fees, the period of registration, &c., would be best discussed, he thought, in committee.

Professor Leone Levi said the technicalities which had been the subject of discussion hardly came within his province, but it was a great pleasure to him to look back and remember that seventeen years ago he first brought this subject before the Society, and that it was then comparatively a new one. It had not been brought prominently before the public, and the right of an individual to use a specific mark to distinguish his goods from those of other makers was hardly fully recognised. At any rate, there was no means then of dealing criminally with anyone who infringed the trade marks of another, and such a case could only be dealt with civilly by a suit in Chancery. Since then, however, there had been a considerable change in the law, for it had been made a criminal offence for any person to pass off his own goods under the mark of another maker. And this right of property in trade marks was now acknowledged not only in England, but in all European countries, and even in America, so that there was now the power of following a person who infringed that right even in foreign countries, and proceeding against him criminally. Formerly, a German cutler could with impunity sell his goods as those of Sheffield manufacture, and the English cutler had no means of enforcing his rights in the German Courts; but this right had now been conceded by international treaty with most European countries. In the reports of the Consular Legations on trade marks he found the right of property in trade marks had been recognised, whether by the Criminal Code or otherwise, in Austria, Belgium, Denmark, France, Germany, Turkey, the United States, Portugal, Russia, Spain, Sweden, Switzerland (in most of the cantons), the republic of Columbia, and Italy. This showed a great advance on the state of things seventeen years ago. He thought simplicity was a very important matter to be kept in view in all the regulations to be made for the registration and enforcement of the right to a trade mark. Inexpensiveness and ease of reference to the index at the registrar's office were also important, and where foreign interests were at stake, the clearer and less expensive everything could be made the better. He would not go to the length of all the minute details introduced in connection with the Patent-laws, because that would be unnecessary and cumbersome. They were much indebted to Mr. Wood

for bringing forward his paper before the Society, which had certainly a right to press this matter on the Legislature. On the occasion he had referred to, when he read a paper on the subject, he had the honour of having Lord Westbury (then Sir Richard Bethell) as chairman, who thought that the using of another man's trade mark was a robbery—a theft of another man's reputation, and that it ought to be made the subject of a criminal enactment, because it was utterly impossible in the great number of cases to obtain anything like an effective remedy by civil proceedings, whether in the shape of an injunction to restrain tho injury, or in the shapo of an ordinary action at law for damages. In conclusion, he would only suggest that possibly it might not be necessary to put the law into operation, owing to the development of public opinion and commercial morality, and they must not consider the law inefficient because they did not find many cases brought before the courts of justice. On the contrary it would be a proof of its efficiency.

Mr. Tracey said trade marks were certain marks put upon goods in order that they might be known as coming from certain individuals, and they only possessed a value in consequence of those goods having gone into tho markets of the world and obtained a reputation. Others then imitated those goods, and trade mark registration was simply a means by which the law could assist the owner to lay hold of these imitators. A mark attained a value in consequence of the skill, and integrity, and judgment of the original makers, and he contended it was improper to give a value to the sign when the parties who had conferred that value on it had passed away, and enable it to be sold to others, in order that they might take advantage of the reputation which had been obtained, and flood the market with trash before the difference was discovered. Such a thing was simply a fraud on the purchasers. They knew that trado marks had been bought, and high prices paid for them, though the goods supplied under them were not the same as they were when the marks were first used. The right to a trade mark was a strictly individual right, and with the individual the right should perish. Lawyers liked creating legal properties of this kind which could pass from one to another, because it mado more work for them, and commercial men liked to obtain trade marks, the value of which had been won by the good works of others; but such things tended to defraud the public, and, therefore, he contended that the present law went beyond the fair necessities of the case, the fraud being not in taking the mark, but in passing off an article for that which it was not.

Mr. Seymour Salaman wished to be allowed to add a few remarks to his observations at the previous meeting, especially with regard to the foreign question, for this, if attentively considered, would, he thought, be found to have some bearing on tho framing of the rules. On the last occasion Mr. Mundella called his attention to the fact that the treaty of commerce with Austria was about to be denounced, and suggested the importance of this as bearing on the rights of British trade mark owners in Austria. Representing the Trade Mark Protection Society, he had put himself in communication with several persons on the subject, and he had found it was the case that the treaty whereby British trade mark owners were allowed to register in Austria would be annulled after December 31, 1876. Now in connection with this arose the question of reciprocity, and he did not find that the present Act contained anything to show that foreign trade mark owners could register in England. This was a very important question, and he had called the attention of several members of the Legislature to it, as bearing on the right of British subjects to register their trade marks in foreign countries. Most foreign laws on the subject, including that of the United States Congress of 1870, contained a reciprocity clause, under which subjects of foreign States were allowed to register, provided the laws of those States allowed the same right to subjects of the State referred to. He knew several persons who were desirous of registering in America, but were unable to do so because, hitherto, there had been no provision for registering trade marks in England. This might perhaps be set right by the rules, though he was not prepared to say whether that was so or not. It was a great pity that some countries had no law of trade marks, for instance Switzerland and the Netherlands, for he had been informed by the British consuls that neither in those countries nor in Norway, Sweden, or Denmark, was there a law of trade marks. With regard to the question of registration being equivalent to use, he thought that was the gist of the Act, more particularly as it affected persons who wished to adopt new marks, and it was one of the principal points urged before the Select Committee of 1872. If a man invented a sign or symbol there was no reason why he should not go and register it provided it were a lawful trade mark, and take away with him his document of title. He did not see that there would be the difficutly with regard to classification which some supposeed. With regard to all existing marks there might be some difficulty in the office. Where marks were similar, if not identical, and where they were applied to goods of the samo class, he supposed it would be for the registrar to decide which should be used. The difference would not be so great in new marks, and he thought a person who invented a now mark or arbitrary name, such for example as "Ozokerit," should be permitted to apply it to any description of goods he pleased. He hoped there would be no such thing as an annual fee; in no other country was it introduced, and it would cause continual and great annoyance to owners of trade marks. In Lord Carlingford's Bill there were many most vexatious provisions, and heavy penalties connected with the proposed annual fee, non-delivery of the certificate, if a fee were not paid, &c., and he trusted the Lord Chancellor would see his way to dispense with such provisions.

Mr. Mercer thought it perfectly clear that the words of the Act contained no restrictions which would prevent foreigners registering any trade mark which was in common use in this country, such, for instance, as that of Farina, the maker of Eau de Cologne. A second point on which he differed from the last speaker was in regard to a person being allowed to register a mark and to have exclusive property in it, without regard to user. Without going to so great a length as a previous speaker, he thought there should be some limit, and that a person should not acquire exclusive right to a mark merely by registering it; there ought to be either a *bona fide* user, or a declaration that it would be used within a limited time, before it was allowed to be registered. A man ought not to be allowed to invent a trade mark on the 31st of December, and go on the 1st of January and register it without any declaration relative to user.

Mr. Salaman said the Act clearly laid down that registration should be deemed tantamount to user.

Mr. Mercer—Subject to the rules. He thought it would be quite within the power of the Lord Chancellor to make a rule that every person bringing in a mark for registration should accompany it by a declaration that he had used it for a particular period.

Mr. Ottley thought the wholo system of trade marks was a mistake. He considered the only guarantee for the quality of goods was the name of the firm who produced them, and whereas some trade marks dated back 200 years, and were considered all the more valuable for their antiquity, he thought their whole value was gone. The same thing applied to patents; patents were often sold, and the articles continued to be sold under the name of the patent, when they were wholly different from those described in the specification. It would, in his opinion, be very detrimental to the public if trade

marks were made marketable; and the manner in which they were thrust on one's notice everywhere was a perfect nuisance.

The Chairman said they were met to discuss, not the policy of trade marks, but how the Act which had just passed the Legislature should be carried out.

Mr. Hall thought Mr. Ottley's remarks had an important bearing on the subject in this way, that every trade mark might be required to include the name or monogram of the person claiming the right in the mark. It would really further the object they had in view if every trade mark contained something which showed the purchaser who was the actual manufacturer. It had been said that they should wait to see what the Lord Chancellor did before taking any action, but he believed the Lord Chancellor desired nothing more than to know the views of those interested in the question. There could be no difficulty in finding an abundant variety of trade marks, for if such objects as animals, crosses, and crowns were soon exhausted, a great variety could be introduced simply by the addition of a monogram. He did not quite understand Mr. Wood's suggestion that provisional protection was important and essential. Did he mean that for six months piracy should be allowed, because it seemed to him that what he proposed would tend to promote the possibility of there being an assumption of the trade mark after six months.

Mr. Christopher Cooke called the attention of those interested in this subject to an article in the *Builder* of November 13th last, containing much valuable information, and also to a book on trade marks, by Mr. Ewen, published in 1861.

Mr. Newton Wilson said various points had been suggested during the course of the discussion as to the difficulties presented by the question of the registration of trade marks, and one of them was very prominently before his own eyes, from the fact that at the commencement of the present year, he brought a suit to restrain the infringement of his own trade mark, which he had comparatively recently adopted. This mark was exactly copied by another person, but he also put his name around the mark. Thinking it impossible that two people could use the same mark, he brought an action, but the Vice-Chancellor Malins held that he had failed to prove a sufficient prior user, and also that the fact of the other manufacturer placing his name around the mark sufficiently distinguished it. Whether that was good or bad law it was not for him to say, although he was not quite satisfied with the decision. He should like to know if two people registered a trade mark on the same day whose it was to be in the future, and also whether the new Act would protect them in this respect more than in the past. Another difficulty was, supposing a firm had advertised a trade mark very prominently, say for a period of ten years, and that trade mark had come to be known and recognised, would the new Act in any way provide that another person was infringing that mark if he took a small portion, and applied it to another subject.

Professor Leone Levi said with regard to the suggestion that it might be necessary to introduce a clause in the rules providing that foreign trade mark owners might register in this country, he did not consider it was necessary. He had not before him the exact terms of the Act, but it seemed to him that the construction of the same would follow the construction of the Copyright Act, for by a recent decision of the present Lord Chancellor it was decided that a foreigner living abroad might have a copyright in a book published for the first time in this country. He thought that the construction put to that Act would also be applicable to the law of trade marks, and that therefore a foreigner using a trade mark would be able to get protection by registration for the first time in this country the same as if he were living here.

The Chairman said a great many subjects of the highest importance had been raised, and he sincerely hoped, as one interested in the successful working of an Act of Parliament, in the passing of which it had been his good fortune to have some little share, that the officials to whom would be committed the task of drawing the rules, might either have been present that evening, or might have a full report of the proceedings; because the success of the Act would to a great extent depend upon the nature of the rules which were to be promulgated for its operation. No doubt a more than usual discretion had been confided to the functionaries who were to prepare the rules; but he confessed he thought it was a favourable element in this legislation, as might be seen on looking at the Act, that those who were to prepare the rules had also the power of modifying them from time to time as occasion might require; and in that there was a safety and prospect of successful working which was not always to be found where the Act of Parliament itself drew hard and fast lines of practice. The Lord Chancellor had power to deal with every one of the points which had been discussed that evening: he had power to deal with fees, to make general rules for the registration of trade marks, power to prescribe the notices to be given by advertisement before registration, power to make rules for the classification of goods, for the registration of the first and subsequent proprietors of trade marks, and as to the removal from the register of any trade mark, so that practically the Act was little more than the declaration of a principle leaving the details to be worked out as the exigencies of experience might show to be desirable. Upon the question of reciprocity and the right which foreigners would have to register their trade marks, many might be aware that in the Select Committee to which the Bill was referred, a clause was moved by Sir Henry Wolfe, purporting to exclude from the operation of the Act the subjects of all States whose Government did not confer reciprocal privileges upon British subjects, and although that clause was not inserted in the Bill, the principle of it was carried on a division. It was not inserted in the Bill because it was not necessary, for the cardinal principle of the British legislation had been that of absolute free trade, and all they had to see was that no restriction was imposed upon foreigners. Remembering that before the Act came into operation the English courts conferred the same privilege upon all, he could not but think there was nothing in the Act detracting from that privilege, so that there would not be the slightest difficulty in a foreigner obtaining such protection as the Act gave him, and equally that a foreigner would be unable to put his trade mark in suit here unless he had complied with the Act of Parliament. He thought the clause enacting that registration should be equivalent to public user was a beneficial clause to all, because it would prevent the difficulty of proving in the case of a new trade mark sufficient user. On the one hand a manufacturer would be unable, after the Act, to invoke the protection of the Court unless he had registered, but the equivalent was, that for five years he had a *prima facie* title conferred by registration, that was to say, a title voidable by anyone else showing a better title to it; and at the expiration of five years a title good against every one. It was for the manufacturer to decide whether that was a full equivalent for the *quasi* restriction which the Act imposed. There had not been a single voice raised against the second reading of the Bill, and he believed the Act was the realisation of the hopes of thoughtful men. When one came to look carefully at the phraseology of the Act—especially the definition clause—he thought they would find there was a tangible line drawn which would remove the difficulty as to the possible injury the public might sustain from the too facile registration of new trade marks or protecting new trade marks, because clause ten stated that everything which was now a trade mark

established by user could be put upon the register without anything more; and it was unimportant to consider whether what was now a trade mark would be a trade mark under the old law. On the other hand, the committee had tried to limit, as far as possible, the number of articles which should become capable of being treated as new trade marks, so as to prevent such complication as would arise from the use of names. During the progress of the Bill it was suggested that it would be desirable that the definition clause in the Act should exactly correspond with the definition in the Act of 1862, but it was felt that the scope of the Act was so distinct that what was suitable for one would not be suitable for the other. He ventured to say that the Lord Chancellor would be deeply indebted to any practical men who would assist the proposed committee by giving practical suggestions as to the nature of the rules to be made, and he might say he did not believe there would be any insuperable difficulty with regard to the Act. He would answer the humorous suggestion which had been made as to the difference between straw hats and straw bonnets by saying that he would defy anyone to tell the difference at present, though, no doubt, the Lord Chancellor would find a way to make them distinguishable. He hoped the rules, in the first instance, would be as wide as they could be safely left, so as to leave room for alteration, and he believed that in the end there would be very beneficial results from the Act. He thought there should be no annual payment included in the rules. He had himself raised that objection in the Select Committee in the House of Commons; there was a strong feeling that annual payments would be vexatious, and that they were not at all necessary. A great deal had been said as to the policy of trade marks at all, and there had been a suggestion that the name was the real trade mark, and that trade marks were suggestive of fraud. The true answer to that was, that the public were not quite so foolish as people imagined, and the real value of a trade mark was, and ever would be, the public certainty that that trade mark covered really good articles. If the goods deteriorated, no matter what mark covered them, they would not sell; but if the goods kept up their reputation, it was a property for him who acquired the name, a right which the owner had to sell or leave to his children, the same as his consols or any other property; and the value of the property in the market would be in exact proportion to that in which it was held in public estimation. Its value would be enhanced by the new Act, for it would be free from the crushing and cruel necessity of continually proving the title. In his opinion people who stole trade marks deserved no mercy, though occasionally it happened that a person innocently appropriated a trade mark in use, and in such a case the person, although he had no intention of stealing the mark, and knew that he was in the wrong, had to fight the case to the end, or else he would be looked upon as having filched another person's mark. This would now be prevented by the new Act, because a person might inspect the register before taking a mark.

Mr. Johnson said he had much pleasure in proposing the following resolution:—"That this meeting desires to request the Council of the Society of Arts to appoint a committee to consider the regulations necessary for the proper registration of trade marks under the Act of last session."

Mr. Salaman seconded the resolution, which was carried unanimously.

Lord Alfred Churchill, on the part of the Council of the Society of Arts, said they would be very glad indeed to fall in with the views of those present, and appoint a committee. It appeared to him a trade mark was merely a convenient hieroglyphic, intended to mark the quality of the goods, and a person who used his simple name might equally use it as a trade mark, and was in the same position as one who used a hieroglyphic. A man could not sell his name and at the same time guarantee the public that the quality of the goods should be maintained any more than if he used a mark.

Mr. H. T. Wood said it was usual for the reader of the paper to reply, but as the Chairman had said everything that could be said, he must beg to be excused travelling over the same ground. It was a source of great gratification to him that his paper was likely to eventuate in such an important movement as the formation of a committee; and begged to express his thanks to those gentlemen who had taken part in the discussion.

Mr. Salaman proposed a vote of thanks to Mr. Wood for his able paper.

Professor Leone Levi seconded the resolution, which passed unanimously.

On the motion of **Mr. H. T. Wood**, seconded by **Mr. Starey**, an unanimous vote of thanks was passed to the Chairman for presiding.

The Chairman, in reply, said it had been a great pleasure to him to be present, and he hoped that the meeting would result in great good.

In accordance with the resolution passed at the meeting, the Council have appointed the following Committee to consider the rules and regulations which it is desirable should be drawn up, under the Act of last session, for the registration of trade marks, with power to ask for an interview with the Lord Chancellor, if necessary:—

A. J. Mundella, M.P. (Chairman).
Theodore Aston, Q.C.
R. Bartleet (Redditch).
Colin Minton Campbell, M.P.
S. Christy (Stockport).
Lord Alfred S. Churchill (Chairman of Council).
T. Coates (Paisley).
J. J. Colman, M.P.
Peter Graham.
H. M. Jackson, M.P., Q.C.
J. B. Jackson (Sheffield).
Edmund Johnson.
J. S. Mercer (International Trade Mark Association).
Arthur Ryland (Birmingham).
J. S. Salaman (Trade Mark Protection Society).
P. L. Simmonds.
Edward Tozer (Master of the Cutlers' Company).
E. M. Underdown.
E. Kempe Welch.
H. Trueman Wood.
P. Le Neve Foster (Secretary).

The Committee held its first meeting on Tuesday, December 7th. Present—R. Bartleet (in the chair), Theodore Aston, Q.C., S. Christy, T. Coates, J. B. Jackson, Edmund Johnson, J. S. Mercer, J. S. Salaman, P. L. Simmonds, Edward Tozer, E. M. Underdown, H. Trueman Wood, with P. Le Neve Foster (Secretary).

The Committee held its second meeting on Wednesday, December 8th. Present—R. Bartleet (in the chair), Theodore Aston, Q.C., S. Christy, T. Coates, Edmund Johnson, J. S. Mercer, J. S. Salaman, P. L. Simmonds, E. M. Underdown, H. Trueman Wood, with P. Le Neve Foster (Secretary).

The Committee held its third meeting on Thursday, December 9th. Present—R. Bartleet (in the chair), Theodore Aston, Q.C., S. Christy, T. Coates, Edmund Johnson, J. S. Mercer, J. S. Salaman, P. L. Simmonds, E. M. Underdown, and H. Trueman Wood.

FOURTH ORDINARY MEETING.

Wednesday, December 8th, 1875; The Right Hon. Lord Hampton in the chair.

The following candidates were proposed for election as members of the Society:—

Barker, William R., 143, Bond-street, W.
Berrow, Isaac, Clarendon-mansions, New Bond-street, W.
Bischof, Gustav, 4, Hart-street, Bloomsbury, W.C.
Dulcken, A. C., care of F. J. Angier, 79, Gracechurch-street, E.C.
Grinling, Charles, 35, York-terrace, Regent's-park, N.W.
Haynes, William, Vinter's-road, Maidstone.
Lumley, Joseph, 45, Upper Grange-road, S.E.
Mander, Samuel Small, 17, Gracechurch-street, E.C.
Seymour, Henry Danby, Athenæum Club, S.W.
Shepheard, Wallwyn Poyer Burnett, M.A., 18, Taviton-street, Gordon-square, W.C.
Sperling, Rochefort A., 22, Warwick-gardens, Kensington, W.
Thompson, Charles, Preswylfa, near Cardiff.
Young, Captain Allen, 1 St. James's-street, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Austin, Benjamin George, 143, Wool Exchange Central, Coleman-street, E.C.
Brewer, Richard, Suffield-house, Richmond, Surrey.
Burkinyoung, Henry, 85, Cornwall-gardens, South Kensington, S.W.
Chappé, Thomas Fletcher, 29, Stanhill-gardens, Kensington, W.
Hurwitz, Charles Benjamin, 3, Osnaburgh-place, Regent's park, N.W.
Hurwitz, Sidney John, 3, Osnaburgh-place, Regent's-park, N.W.
Jones, George Marsh, 147, Gleadless-road, Heeley, Sheffield.
Mann, Edward, 7, Pall-mall East, S.W.
Martin, James Thomas, 4, Vine-street, York-road, Lambeth, S.E.
Melliss, J. C., Kenilworth.
Reinecker, Captain G. H., East India United Service Club, 14, St. James's-square, S.W.
Ryland, Arthur, Birmingham.
Shattock, Thomas Foster, 7, Arlington-street, Piccadilly, S.W.
Tomlinson, Joseph, 160, Alexandra-road, St. John's-wood, N.W.

The paper read was—

THE MODE OF LEVYING THE SUGAR DUTIES IN FRANCE, AND ITS INFLUENCE ON THE SUGAR INDUSTRIES OF GREAT BRITAIN.

By Professor Leone Levi, F.S.S., &c.

For a considerable time past the price of sugar in this country has been exceedingly low, and the British consumer may be thankful, that if meat is dear, sugar and tea are decidedly cheap, and bread continues at reasonable prices. True, sugar has always been used by grocers as an article of attraction, its selling price being usually put sufficiently low to entrap the unwary housewife in buying well-mixed and more remunerative tea and other articles of daily consumption. Never, however, has sugar been so low as at present, and the question has been asked whence does it arise? Is it from the abolition of all duties on sugar in this country, or from extreme competition, or from excessive production? Some of these causes may doubtless have been in operation for some time past, but there is reason to believe that the low price, especially of loaf sugar, is mainly the result of the peculiar method of levying the sugar duties in France; the system pursued enabling the French sugar refiners to sell sugar in this country considerably cheaper than they sell it in France, thus underselling the British refiners in their own market. I am told that full three-fourths of the loaf sugar sold in this metropolis now consists of French beetroot refined sugar, and that, in consequence of the unequal competition, as many as fourteen British refineries have already been closed altogether. In these days of free competition no nation has certainly any right to complain, if another nation should succeed in greatly extending its trade from superiority of skill, advantage of position, or greater economy of capital. If it be true, however, that the sudden enlargement of the French sugar industry is not owing to any such advantages, but is simply the result of exceptional legislation, then the British refiners have good reason for complaining. Nor can it in the end prove satisfactory, even to the consumers in this country, to enjoy now the benefit of extraordinary cheapness if, under the operation of such exceptional legislation, and a fallacious system of bounties, one by one all the refiners in England and Scotland should be compelled to close their works, and so leave the whole British market for refined sugar a complete monopoly for the French refiners.

The production of sugar in France is on a vast scale. As an agricultural industry, the beetroot occupies a distinct place in the Departments of the Nord, Aisne, Pas de Calais, Somme, Oise, &c. As a manufacture, sugar refining gives occupation to large numbers in the Departments of the Seine, Bouches du Rhone, and Loire Inferieure. (See table in the Appendix.) The capital employed in the cultivation of sugar, in the sugar manufacture, and in the sugar trade, and refinery, is given at upwards of 270,000,000 frs., or £11,000,000, and the production in 1873 was stated to be 400,000,000 kilos. of sugar, and 300,000,000 kilos. of molasses, whilst the 45 refineries in France produced 300,000,000 kilos. of sugar, and 9,000,000 of molasses. These are large figures for such an industry, but what is more singular is the fact that their expansion has been very rapid within the last few years, and especially since the conclusion of the Sugar Treaty in 1864. In that year the production of native sugar in France was only 135,000,000 kilos.; in 1874, it reached 431,911,000 kilos. In 1865, France only exported 112,000,000 kilos. of refined sugar. In 1874, she exported as many as 184,791,000 kilos.

The mode of levying the sugar duties in England, France, Belgium, and Holland before the conclu-

sion of the treaty regulating the drawbacks on sugar, was exceedingly complicated. The sugar duties in France were charged first at distinct rates between refined and unrefined, and then with a difference on unrefined between sugar equal to the first standard and inferior to the same; besides which a sur-tax was charged as the sugar came in foreign vessels from French or foreign territories; whilst the drawback was not allowed on a certain fixed sum, but in sums proportioned to the duties paid on the importation of the raw material. In the other countries the method was equally complicated, and in every one the public revenues were sacrificed in order to encourage the exportation of sugar. In England the drawback was paid to the exporters in money. In Belgium and Holland it was allowed as a deduction of duties, for which credit had been obtained. In England the drawback was calculated with reference to the raw sugar generally used for refining, on the basis that for every 77lbs. of sugar exported, there should be repaid the amount of duty chargeable on 100lbs. of raw. In France the drawback was calculated on 76lbs.; in Holland, on 82lbs.; and in Belgium, on 83lbs.; for 100lbs. raw. In England the drawback was high, though comparatively small quantities of the higher sorts of refined sugar were used. In Holland it was probably as high though sugars were admitted as unrefined, which here would have passed as refined.

It was under these circumstances that the proposal was first made by Belgium during her negotiations with France for the Franco-Belgian Commercial Treaty of 1861, to enter into an international agreement for abrogating the bounties on the manufacture and export of refined sugar. The suggestion was taken up, and at the instance of the French Government an International Conference was held in Paris in 1863, between Great Britain, Belgium, France, and Holland, the express purpose of which was to consider the possibility of establishing in the respective countries some uniform regulations by which the drawbacks allowed on the exportation of refined sugar should not exceed in amount the duty paid on the raw material. The Conference was renewed in 1864, and the result of their deliberations was the Convention of 1864, between Great Britain, France, Holland, and Belgium, supplemented by the finding of the experiments made at Cologne, and confirmed by a diplomatic declaration* signed the 20th November, 1866, which resolved on the common adoption of certain standards with a system of assessing duty according to the strength of the juice after defecation by means of the densimeter. Doubtless the relation then fixed between the colour and the quantity of saccharine matter was conscientiously arrived at by the delegates of the four powers, though there is reason to believe that a liberal margin was allowed in favour of the refiners of each country. Since then, however, industrial activity and scientific research have enabled the refiners to get a much greater yield of sugar than they previously could obtain from the same samples, and it has been further found that some of the richest sugars may be made to have the poorest colour, and some of the poorest sugars the most excellent colour. In fact it has been found easy to colour the sugar so that it may pass at a lower rate of duty than its richness would subject it to, and strangely enough the artificial coloration of sugar has been found justifiable by the French tribunals. The Duc Decazes in a despatch to Lord Lyons with reference to an article in the *Produce Markets Review*, pointing out the fraud practised in the French refineries to the injury of the Treasury, and to the prejudice of foreign refineries, stated that as soon as the Administration discovered the fraud, which consisted in colouring the sugar by means of aniline brown, proceedings were taken against the offenders. But surely the French Government can not have been very vigilant if it ever had the intention to repress the fraud, seeing that in one way or another it has been committed ever since for many years past with almost perfect impunity.

As it is, a French beetroot sugar manufacturer will sell sugar of a colour which belongs to the standard known as No. 10 to 13, and the refiner will get it passed at the Customs as of the standard No. 7 to 9. But worse than this. The original French standards, made in conformity with those on which the Convention was based, are no longer in existence. Having been found deteriorated in value in 1869, the French Government, in accordance with the 18th Article of the Convention, conferred with the other Powers with a view to the preparation of fresh standards. There was not, however, a general accord as to the expediency of renewing the samples, and the French Government proceeded of its own accord in the preparation of the same. Soon after this the unhappy and destructive war between France and Germany occurred, and a considerable delay in consequence took place in their preparation. But when ready the new types were found to be no longer the same in colour as their prototypes. How it happened no one can say, but some irregularity must have taken place, and it was certainly strange that the new types were not communicated at the same time to the whole trade, for whilst the sugar refiners of Paris were contracting by the new types, the manufacturers of beetroot sugar in the provinces were still contracting by the old types.

Now this difference between the legal and real yield, which had the effect of enabling the refiner to withdraw so much sugar from the grasp of the revenue officer, proved especially profitable to French refiners, in consequence of the great rise in the rates of duties in France, at a time when in the other countries such duties were greatly reduced or removed altogether. The rates of duties in 1863 and 1873 in England, France, Belgium, and Holland, were as follows:—

	1863.
Belgium, per cwt.	18s. 9d.
France, ,, ...	17s. 1d.
Holland, per 100 kilos...	35 fl.
United Kingdom, per cwt.	12s. 8d. to 16s.

	1873.
Belgium, per cwt.	13s. 11d. to 19s. 6d.

* By this declaration the minimum of the yield of sugar in the process of refining was fixed as follows, per hundred kilogrammes of raw sugar:—

Numbers of the Series of Dutch Standards.	Refined Sugars in Loaf. Kilogrammes.
18, 17, 16, 15	94
14, 13, 12, 11, 10	88
9, 8, 7	80
Below 7	67

France, „ ...... 27s. 11d. to 29s. 2d.
Holland, per 100 kilos. .. 18 fl. to 25 fl. to 38 fl.
United Kingdom, per cwt. 1s. 9d. to 6s., subsequently 10d. to 3s., and now free.

Such a rise in the rate of duty as from 17s. 1d. per cent. to 27s. 11d. to 29s. 2d. gave to the French refiners an advantage from the differeuce of the yield, which none of the other powers possessed, and they utilised it of course to the maximum extent.

No better evidence could be afforded of the undue advantage thus obtained by the French sugar refiners, especially in the lower descriptions of sugar, than a comparison of the quantities entered at the French Customs of indigenous sugar in 1869 and 1874 of the qualities designated as under 13, and 13 to 20, the only gradations recognised at the Customs. At the two periods the quantities were as follows:—

	1869. Kilos.	Per Cent.
Under 13	95,268,000	70
13 to 20	38,318,000	30
	133,586,000	100

	1874. Kilos.	Per Cent.
Under 13	161,811,000	90
13 to 20	16,877,000	10
	178,688,000	·100

In the five years, from 1869 to 1874, a complete change took place in the descriptions of sugar which passed through the French Customs; the lower qualities showing an increased consumption to the extent of 69 per cent.; the higher an absolute diminution of consumption to the extent of 55 per cent. And if any more proof were required of the benefit accruing to the French refiners from the method of paying the duties, it may be found in the fact that, concurrently with the seeming increase on the consumptiou of the descriptions known as 7-9, there has been an enormous leap in the exports of refined sugar. The parallellism of these two facts is remarkable:—

Consumption of Sugar.

	Kilos.
1870	20,000,000
1871	70,000,000
1872	105,000,000
1873	140,000,000
1874	180,000,000

Export of Refined Sugar.

	Kilos.
1870	97,000,000
1871	80,000,000
1872	138,000,000
1873	149,000,000
1874	186,000,000

There is in truth not the slightest doubt that the present system of levying the duties in France does give to the refiners a very handsome bounty on exports, aud that such a system is injurious to the French revenue, unjust to the French refiners of this country, and, we might even add, most deceptive to the French refiners themselves, every measure of a protective character being sure to have the effect of turning the refiner or manufacturer from solid to fictitious sources of strength, and making him careless and extravagant.

The sum and substance of the whole is, that the French refiners have now for years been receiving a very considerable bounty, if not in the shape of direct money payment, at least in the shape of a larger drawback on their exports than they are entitled to. The British refiners put it thus. The duty is charged on the raw sugar in proportion to its estimated yield of refined sugar. That estimate is too low, to the extent of about 10 per cent. When the refined sugar is presented for exportation, the refiner is credited with the full duty on it, and as he has produced 10 per cent. more refined sugar than was estimated in charging the duty on the raw sugar, it is clear that the drawback returned to him on the export of refined is 10 per cent. more than he has paid. and that is the bounty, which amounts to about 3s. per cwt,, or £3 a ton. And what is the consequence? To secure this excessive drawback, the French refiners push their export trade to the utmost, and offer their sugars in other markets at prices considerably lower than they can be manufactured for, thus underselling all other competitors and gradually placing them one by one *hors de combat.*

When it became apparent in this country a few years ago that the income-tax was being grossly evaded by fictitious returns, the Chancellor of the Exchequer gave instructions to the Commissioners not only to be more than ever on their guard, but, if necessary, to double the amount returned for assessment. We all know, too, how effectively the Customs and Excise guard themselves against smuggling and illicit distillatiou. But here we have the French Administration, at the very time when the finances of the State are in a very straightened condition, allowing itself to be defrauded by few French refiners of nearly 20,000,000 francs (£800,000)* a-year. It is not from ignorance of the fact, for it must have seen its working for years, and it had been warned enough by the diplomatic agents of this and other countries. It is not surely from want of power of control, for surely the French Government has been wonderfully well supported by the whole people in its endeavour to place the finances ou a proper equilibrium. The reason of its reticence in the matter in all probability arises partly from a longing after protection in the minds of many French statesmen, and a disposition, too, of fostering, as far as in them lies, every branch of national industry against the clearest light of economic science, and partly, also, from the actual difficulties surrounding the question, the methods suggested for preventing the fraud being unsatisfactory in themselves, and alike expensive and restrictive. Most gratifying it is to find in the expression of nearly every one of the delegates to the conferences held at Brussels in May, 1875, a decided abandonment, in principle at least, of every shape of bounties. M. Grivart, the French delegate, said, "We think it desirable that competition should not be artificially dis-

* In 1874 the quantity of raw sugar exported after refining was stated to be 234,770,007 kilos, representing, at the "legal" equivalent, 185,874,883 kilos. of refined. But the refiners really produced at least 211,293,006 kilos., showing an exeess over the "legal" quantity of 25,418,123 kilos., and the duty on that excess, constituting the bounty on export, was 18,636,550 francs. If to the bounty there be added the *Detaxe* on *Poudres Blanches*, the total will amount to upwards of 20,000,000 francs or £800,000 sterling.

turbed. We wish bounties completely to disappear, especially with regard to sugar, which industry can be maintained without protection. The financial requirements of the country coincide on this point with the economic views of the Government." M. Le Baron Lambermont, the Belgian Minister of Foreign Affairs, complained that, whilst the work of the contracting parties in the Convention of 1864 was the suppression of protective duties and bounties, the placing of the industry and commerce of sugar on a condition of equality as regards competition, and at the same time the protection of the interests of the Treasury, those objects had not evidently been yet obtained." Are these expressions sincere? Is there a decided wish on the part especially of the French Government, from whose vacillation most of the evil has accrued, to put an end to the present anomalous state of things? If so, surely means will be found to attain the object.

In the present Minister of Finance of France, M Leon Say, we must have full confidence, being not only himself a political economist of no mean order but the son and grandson of great economists What did they say on bounties? M. Horace Say, in an article in the "Dictionnaire de l'Economie Politique," said "In a country accustomed to constant intervention on the part of the State, public opinion may be easily disposed to believe that it is the business of the Government to stimulate production, and they will ask for drawbacks on exports, without troubling themselves to inquire whether they are truly the returns of duties paid on the raw material; nay it has even been asserted that the tax-payers should pay part of the value of the merchandise consumed abroad in the shape of bounties. But a wise reform in the customs will soon cause all these abuses to disappear." In the same spirit, and still more luminously, J. B. Say said, "Governments have not been content to hinder the importation of foreign produce, persuaded that the nation should sell and not buy, as if this was possible. Besides putting all manner of trammels on imports they have also offered encouragements to exports. Surely if an English merchant cannot sell his goods in France at less than they can be bought in France there is no reason why he should have the preference. But if the British Government should grant a bounty of ten per cent. so as to enable the English merchant to sell his goods at 90 per cent. of the cost, of course he will then get a good custom. This, however, will be simply a gift made by the British Government to the French consumer. Doubtless the English merchant will profit by the transaction just the same as if the French people should pay for their goods at their full value. But the British nation will lose by the bargain to the extent of 10 per cent., for France will send in return no more then £90 for goods worth really £100. Nor is this all. When a bounty tends to foster the production of an article, whether for home or foreign use, which would not be produced without it, the result is always disastrous to the producer, for it encourages him to produce an article at more than it is worth." And precisely the same is the language of the late Mr. McCulloch, one of the ablest of our practical writers on economic science. "However injurious to the State," he said, "it has been generally supposed that bounties on exportation are advantageous to those who produce and export the articles on which they are paid. But the fact is not so. A trade that cannot be carried on without the aid of a bounty, must be naturally a disadvantageous one. Hence, by granting it, individuals are tempted to engage or continue in businesses which are necessarily very insecure, and are rarely capable of being rendered lucrative; at the same time that they are prevented, by trusting to the bounty, from making those exertions they naturally would have made had they been obliged to depend entirely on superior skill and industry for the sale of their produce. The history of all businesses carried on in this country, by the aid of bounties, proves that they are hardly less disadvantageous to those engaged in them than to the public."

Admit, however, that bounties are condemned by political economists and renounced by the State, that a fraud is being practised on the revenue, and that due consideration towards the interests of friendly States should demand an immediate remedy, it must be admitted that special difficulties stand in the way of a satisfactory policy on the subject. The British Government as well as the British refiners charge the French Government with procrastination and evasion in the matter. The treaty of 1864 bound France, as well as other nations, to establish a proper correlation between the duties on refined and raw sugar. She never fulfilled her obligations in this and other particulars.* The discoloration of the sugar standard has been pointed out for years, yet with all her professions France allowed the evil to remain untouched. In 1874 the French National Assembly, by a majority of 97, passed a law that refining in bond should be established at the latest on the 1st August, 1875. The operation of the law was suspended, and now it stands deferred until March next next. Can it be said that France gives any evidence of earnestness in introducing the necessary reforms?

Two methods have been suggested for remedying the evil. One is the use of the polariscope or saccharometer, which gives an accurate indication of the quantity of sugar contained in the sample, but can scarcely be said to be a safe guide to the yield of the sugar since it requires so much care in using it aright, and may in the hands of Customhouse or Excise officers afford ample facilities for evasion and bribery. The other method is refining in bond, pure and simple. In the opinion of the British Government and of the British refiners there is only one mode of solving the difficulty and that is refining in bond. And to

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* Art. XIII of the Convention of 1864, provides that the impor-duties on refined sugar in loaf and on sugars in crystal or powder assimilated to refined, imported from one of the contracting countries into another, shall not be higher then the drawback granted in the exportation of pure refined sugar. The French Government never carried the provision into execution, and after lengthened negotiation a compromise was arrived at, by a protocol signed 4th November 1868, declaring "That until the 31st December, 1869, the duty on the importation into France of the refined sugars coming from the other contracting States as fixed at 48 francs 85 centimes, an amount corresponding to the average duty on raw sugars, and a yield of 88 per cent." Again, however, the French Government signified that they could not carry out other provisions of the Treaty, and another conference held on the 2nd October, 1869, which agreed on a declaration to the effect that "The period granted to the French Government by the Declaration of the 4th November, 1868, for establishing an exact correlation between the duties to be levied on raw sugars and the yields fixed by the Declaration of th 20th of November, 1866, is extended to the 30th of June, 1871."

this the French Government is shut up, notwithstanding its extreme unwillingness to adopt such a course. The last recommendations of the superior Council of Commerce having been—1st. That the Government should seek earnestly to introduce refining in bond as an international *regime*. 2nd. That the Government should endeavour to extend the new convention to the European powers, which were not parties to that of 1864, especially Germany, Austria, and Italy. 3rd. That in case the foreign powers should not accept refining in bond, the Assembly should be solicited to revise the law, which established the same in France from the 1st July, 1875. 4th. And that in such a case, with the consent of the Assembly, the Government should endeavour to obtain the concurrence of the foreign powers upon using the saccharometer as a basis for the levying of the sugar duties." What an example this of dependence and vacillation; of dependence in making a matter of national finance and internal policy subservient to the policy of other countries; of vacillation in arguing once more in favour of the saccharometer, after having again and again decided upon refining in bond. The National Assembly having passed a law in June last authorising the prolongation of the time for the introduction of refining in bond, the French Government summoned an International Conference, to be held at Brussels, for the purpose of urging on the other powers also the establishment of refining in bond. But Belgium was not prepared to adopt it, and Holland would not commit herself to such a policy. Nevertheless, an International Conference was held, of the same four powers, parties to the Convention of 1864, viz., Belgium, France, Great Britain, and the Netherlands, on the 26th and 29th May, and the 1st and 2nd June, 1875, and the result was a Convention, by which France, the Netherlands, and England adopted the system of refining in bond, and Belgium agreed to alter the scale respecting the yield of sugar and to reduce the duties. The part taken by England is indeed exceedingly ambiguous and unsatisfactory. Article II. says:—" In the event of duties on sugar being re-established in England, supervison shall be applied to the factories and the refineries according to a method which will be the object of an agreement between the high contracting parties."* Why should Great Britain contract any such obligation, at a time when there is not the slightest chance that the sugar duties will ever be re-established, it is difficult to say. Has not the Committee of the House of Commons in 1862, definitively reported "That the evidence does not justify the committee in recommending the adoption of refining in bond;" and has not the system, when it was in force from 1833 to 1854, proved an utter failure so much so that scarcely any refiner refined in bond? To contract to establish refining in bond under such circumstances can only be empty talk and a delusive promise towards the other contracting parties. The Government of the Netherlands entered into an obligation to introduce refining in bond from the 1st of September, 1876, evidently with great hesitation. The Minister of Finance commended the adoption of the same by the States General, on the ground that by means of such Convention only was there any chance for inducing France to put an end to the protective policy. But the Dutch are adverse to refining in bond, and the position of the Netherlands Government is too weak to be able to resist. Belgium rejected refining in bond, but agreed to alter the mode of levying the duties by raising the yield of the different standards of sugar, and making a considerable reduction in the rates of duties, though no change appears to be made in the system of "abonnement,"* a feature not very creditable to the skill of Belgian financiers. France, as well as the Netherlands, adopted refining in bond, but in a manner which gives reason to fear that the system of bounties may not be effectually checked. Much indeed will depend on the law for carrying out the Convention. But the British Government and British sugar refiners are vigilant, and already Lord Lyons has called the attention of M. Buffet to the defects of the measure proposed. In a despatch dated 23rd August, he said, "So long as the system of control is rigorously carried out, and the duty paid on all yields in excess of those on which the preliminary duty has been charged, bounties on the exportation of refined sugars will be suppressed; but failing this, a system which admits of an empirical duty being levied on an estimated yield of raw sugar, and a fixed duty being returned on refined which may much exceed the duty levied, may be easily utilised as a means of granting bounties."

It would be unjust to charge the French Government with an absolute want of *bona fides* or deception in the whole of these transactions, but there is good ground indeed for not entertaining much confidence in the sincerity or good-will of France to abandon the system of bounties; and the British Government has been asked to put an end to the evil by a system of retaliation. Should the Convention be ratified, and refining in bond be finally and satisfactorily established, Art. IV. of the Conven-

* The circumstances which have led to the acceptance of this clause by the British delegates are as follows:—When this clause was first proposed, Mr. Walpole said: "We have now no duties on sugar. If they should be reimposed, it might be in case of war or for a short period. In that hypothesis it would not be possible to establish the system of supervision; it would be attended with great expense to the refiners." The French delegates, however, required an engagement on the part of England, and Mr. Walpole, having undertaken to obtain iostructions from the Government, the English Government, by telegram, accepted the principle of supervision. In the despatch dated 29th May, the British delegate said: "As regards the adoption of refining in bond by England, in the contingency of her reimposing new sugar duties, we take leave to state that this system was strenuously urged by Her Majesty's Government for acceptance by ali the powers to the Convention of 1864, at the Conferences of London, 1872, and Paris, 1873, and that we are not aware of any objections at the present time which would not apply equally at the time when the conferences above referred to were held, except that it would be difficult to apply this system at once if the duties were reimposed to meet a special emergency; but we propose to meet this difficulty by the addition of the words 'à un delai de six mois,' which will be readily conceded; but this is a matter upon which, previously to the ratification of the Conventoins, your Lordship may be pleased to obtain the opinion of the Commissioners of Her Majesty's Customs."

* The abonnement system is a legal composition for paying duty based on a sort of theoretical average. The manufacturer pays, not on the quality or type of the sugar really made (the Excise does not even see it), but on the presumed yield in sugar of the beetroot juice passed through the defecating pan. The legal *prise en charge*, or legally presumed yield, is 1,500 grammes of second-class sugar per hectolitre of juice, at 105 degrees of density, and at the temperature of 15 degrees Centigrade. The real result of course varies in practice *ad infinitum*, according to the qualities, seasons, and processes, but is always greater than the official figures. The real average yield of twelve factories during a term of five years has shown by careful examination a result of 1,634 grammes, being nine per cent. more than the legal *rendement*. In Holland, where the abonnement is optional, it is fixed at 1,635 grammes, and it is voluntarily accepted by 20 out of the 24 manufacturers in preference to manufacturing in bond. (Sir H. Barron's report on Belgium, 1874.)

tion provides that "the sugars imported from one of the contracting countries to another shall not be subjected to Customs or Excise duties higher than the taxes on similar sugars of natural production," or, in other words, that England will not, so long as she remains in the Convention, have the power of putting a surtax on sugar from countries granting bounties. What, however, if the Convention be not ratified? Would it be expedient or possible for the British Government to impose countervailing duties against French refined sugars to check the effect of such bounties? Would such a policy be consistent with the commercial policy of the country? Would it prove effective? Would it be desirable to enter into a war of tariffs with France? Would the consumers of this country permit the restoration of duties on any such grounds? The British refiners urge that the imposition by this country of countervailing duties on French sugars would not give any protection to British refiners, but simply restore the equilibrium between the exporters of refined sugar in the different countries. "Free trade," M. Martineau said in his paper read at the Social Science meeting at Brighton, "is only partially limited if another country, by imposing a protective duy, refuses to buy the commodities which we produce most cheaply; but it is entirely checked if another country, by giving a bounty on exports, prevents us from producing or procuring commodities where they are naturally produced at the least cost. In the first case, the protection only acts as a disadvantage to the country which adopts it, but in the second, the injury becomes general. A bait is held out, appearing at first to be simply a tribute presented to consumers in another country, but merely meant to force trade out of its natural channel, establish a monopoly which will more than repay the original outlay, and impose a burden instead of a blessing on those who accepted it." The argument seems sound enough, but the scope of the so-called free trade policy is not only the abandonment of the system of protection of native industry, but the unfettering of trade from the trammels of Excise and Customs duties. The adoption of retaliatory duties when such duties are not wanted for revenue purposes would certainly be antagonistic to the latter, if not the first, of these objects. Suppose, moreover, such retaliatory duties were imposed on refined sugar coming from French ports, will they not be evaded by causing such sugars to come through Holland or Belgium? In truth, the proposal does not admit of discussion, as it is wholly inexpedient and impracticable, and it cannot be entertained. What may be the result of the Convention recently signed it is extremely difficult to say. It may be rejected by the British Parliament or the States General in the Netherlands, or the National Assembly in France, or the Chambers in Belgium, and in either case the whole agreement comes to an end. Or the primary object of the Convention, the putting an end to the bounties, may be defeated by the regulations for refining sugar in bond, especially in France. Whatever be the issue, one thing is certain, that the present high duties in France cannot continue long in existence without defeating the interest of the Treasury. In 1872, with the duties at 70·50 francs, the revenue amounted to 172,000,000 francs. In 1874, with the duties at 73·32 francs, the revenue amounted to 149,000,000 francs. And so it must continue to fall, for the experience of the country has belied the expectation of the productiveness of high duties. Nor is it less certain that the operation of the bounties will, in the end, prove injurious to the French refiners, their effect being to give an undue stimulus to production and to engender carelessness of improvement, the sole and lasting guarantee for success in international competition.

For the present, the producers of loaf sugars in this country may suffer from the bounties granted to French refiners. Yet the sugar interest as a whole is great and prosperous. There are at present in this country 52 refiners, through whose hands 650,000 tons of sugar, worth some £15,000,000, annually pass, and their capital in buildings and plant is at least £1,500,000. But what is more, the British sugar refiners have the largest sugar market in the world in their hands. Compare the imports and consumption of sugar in Britain and any other countries. (See Appendix C.) The sugar trade in England has acquired enormous dimensions, and has not much reason to fear competition. In any case, whatever disposition may be exhibited by France and other powers to resort to bounties and protection, it does not become England to follow such a perilous and impolitic a course. However indignant we may be at the weakness and vacillation of France, let us not meet it by an empty threat of adopting a policy of retaliation opposed to sound economic principles, and certain in the end to produce nothing but loss and disappointment.

APPENDIX A.

STATISTICS OF SUGAR FACTORIES AND REFINERIES.

France.—Production of Beetroot Sugar, 1872.

Departments.	No. of Establishments.	Sugar.	Molasses.
		Quintals.	Quintals.
Aisne	89	870,000	535,250
Marne	6	540,000	34,675
Nord	175	1,200,390	657,836
Pas de Calais	81	598,545	393,932
Seine et Marne	11	107,200	28,000
Seine et Oise	8	60,500	20,000
Somme	60	452,444	264,723
Vosges	2	20,860	—
Other Departments	79	149,223	283,286
Total	528	3,999,162	2,217,702

REFINED SUGAR AND MOLASSES.

Bouches du Rhone	3	250,000
Gironde	5	120,000
Loire Inferieure	8	580,000
Nord	9	150,510
Saone et Loire	4	90,000
Seine, Sucre	5	1,004,000
„ Molasses	2	4,000
Other Departments.	9	863,252
	45	3,061,762

APPENDIX B.

Belgium, 1872.

Manufactories of Beetroot	174
Refineries of Sugar	41
	Kilogrammes.
Raw Sugar imported	18,183,349
Indigenous Sugar taken "en charge"	68,463,719
Do. do. exported	62,926,466
Do. do. remaining for home consumption	23,720,802
Total of Foreign and Indigenous Sugar remaining for home consumption	23,009,178
Estimated yield of the same in Refined Sugar and Treacle after deducting 3 per cent. for waste	23,009,178
Refined Sugar imported	5,372,067
Total produced and imported	28,381,215
Deduct Refined Sugar exported	8,781,514
Balance being thus	19,599,731

Official estimate of Home Consumption.

Estimated proportion per head of population —4,829,329	4·05

Revenue from Sugar.

	Francs.
Custom duties	2,746,872
Excise duties	4,769,509
	7,516,388
Ditto per head of population	1·55

APPENDIX C.

Consumption of Sugar.

M. Maurice Block, in his "L'Europe," gives the average annual consumption per head in the principal countries in kilogrammes in 1866 *and* 1867, *as follows*:—

United Kingdom	19·879
France	7·400
The Netherlands	7·030
Norway	5·522
Sweden	4·900
Switzerland	4·800
Belgium	3·063
Prussia and the Zollverein	3·780
Portugal	3·160
Italy	2·603
Austria	2·463
Spain	2·116
Russia	1·200

DISCUSSION.

Mr. W. Shepherd said Prof. Levi spoke in one passage of a countervailing duty being a policy of retaliation, but it seemed to him, after a study of the leading economists, that it was just what it was not; a retaliatory measure would be to give a bounty in return, at a similar expense to our own revenue. A countervailing duty would simply intercept the foreign tribute for the relief of taxation generally, instead of allowing it to pass on to the consumer. If it did not do that, it would stop the bounty entirely, which had been the object of all their diplomacy. If on the other hand they allowed it to take its course, it interfered with the ordinary process of free trade, the consumer benefiting by the foreign competitor being subsidised, in so far as he was able to get the amount of the subsidy from both the foreign and home manufacturer, though in the one case it came from a foreign Government, and in the other from the pockets of the free trader. This was most unjust, and contrary to the principles of free trade. If they wished to neutralise this artificial element in the sugar industry, it seemed to him they had simply to impose a corresponding import duty, and he believed that in the Treaty of 1874 this principle was agreed to by the Government.

Mr. Bourne took some interest in this subject as an old inhabitant of the West Indies, and as connected with the preparation of statistics upon it. Notwithstanding the existence of this system in France, it was somewhat remarkable that the exportation of British refined sugar went on increasing in a very great ratio, for in the accounts issued that day, for the last six months, he found that whilst the importation of foreign sugar was deducted, the total quantity exported was larger this year than last, but on looking at the accounts for the year he found the exportation of British refined sugar was fifty per cent. more than the year before. These were facts which seemed difficult of explanation, and appeared to indicate that the refining trade was not so injuriously affected as they were told. With regard to the policy of retaliatory duties, he thought it quite impossible to adopt such a system, being utterly foreign to the principles which had been adopted for many years, and he feared it would lead to fatal results. And assuming that the refining trade suffered to the extent stated, though they must sympathise deeply with such a state of things, and regret that British capital did not receive its full reward, still they must remember that the country in general benefited by it, since every penny extracted from the French revenue must go into the pockets of the English consumer, and he thought it would be impossible for the English Government to attempt to rectify the mismanagement of the French financiers. Besides, unfortunate as it might be that the English trade should suffer, he thought it would be unwise to attempt to bolster it up at the expense of those who consumed the produce of France, quite as much as it would be in the case of French wheat, say, if the French Government thought fit to relieve the French farmer of local taxation in order to encourage the exportation of his produce. He rather regretted that the sugar duties had been abolished, although, looking at the difficulties and complications arising out of the various Conventions, it hardly seemed possible to take any other course. Still, speaking as a revenue officer, he could not but feel that sugar was a very convenient article on which to levy a duty, seeing it was imported entirely from abroad, and was an article which entered into the consumption of every household, so that every class of the population bore a share of the duty. He himself looked upon the occupation of sugar refining in England as almost an unnecessary one, for speaking from observation of the growth of sugar in the West Indies, he thought the time would come when it would be imported in a state fit for consumption. It was quite a mistake to import the sugar raw, for the juice as it flowed from the cane was almost colourless, and with a proper system of manufacture it would be perfectly possible to produce an article fit for consumption direct from the plant. It was simply the ignorance and inefficiency of the manufacturer there which created the necessity for the refiner at home, and therefore he considered it highly inexpedient to do anything to foster a trade which would in time cease to exist.

Mr. George Martineau said the last speaker was evidently not very well up in the subject. He had alluded to fostering the British sugar refining industry, but it must be understood that those gentlemen did not want fostering, they simply wished to be defended against an unfair competition, which gave foreign manufacturers 3s. per cwt., and thereby enabled them to undersell the British refiners. He also thought the British sugar refining was unnecessary, but this could hardly be the case so long as 650,000 tons of raw sugar came annually to this country. He also alluded to the consumer, who he said was to be considered, which was perfectly just, but Lord Derby

had completely overturned that argument. Some time ago, when a deputation of British refiners and colonial producers waited on him last spring, when he stated most distinctly that in his opinion it was not to the interest of the consumer or of the English nation that the French bounty should continue, because in the end sugar would be sure to be dearer instead of cheaper; and he repeated the same views in a memorable speech in the House of Lords when he showed himself completely master of the subject. And Lord Aberdare used the same argument at the meeting of the British Association at Bristol. Mr. Bourne said that every penny of the bounty found its way into the pockets of the British consumer, but the answer to that was, that the smallest possible amount, say ¼d. per cwt. below the cost price, would be sufficient to shut up every refinery in the kingdom. If the bounty of 3s. a cwt. was distributed amongst the consumers it would not amount to a ¼d. a lb., and of course it went, not to the consumer, but to the retailer and the refiner in France, except the infinitesimal amount necessary to undersell the British refiner. It was asked how it was that the exports of British refined sugar were constantly increasing; he might answer broadly, because of the mistakes of the statistical department of the Board of Trade. The exports, in fact, consisted of the refuse of the refinery, which the British consumer would not take, and which were sent to Canada and other places where a lower article found a market. In fact, although this country was, or ought to be, the great central depot of the world, we had no export trade in refined sugar properly so called. He knew there was an error in the returns, because it appeared from them that the imports of foreign refined sugar were falling off, whereas they were increasing immensely; a good deal that was calculated under the head of foreign refined sugar ought really to come under the category of the highest class of raw. France exported in 1872, 141,000 tons of refined sugar; in 1873, 153,000 tons; in 1874, 186,000 tons; and in the first ten months of 1875, 178,000 tons. Taking the first ten months of the previous years, the exports were in 1873, 128,000 tons, and in 1874, 153,000, thus showing an immense increase, the quantities coming to England being — 45,000 tons in 1873; 58,000 in 1874; and 74,000 in 1875. The number of loaves imported into London alone were, for the eleven months ending December 2nd, 1875, 2,532,000, and for the same period last year, only 1,632,000, being an increase of nearly 50 per cent. Into the whole kingdom the import was in 1874, 4,193,000 loaves; in 1875, 6,436,000. Professor Levi said that this question affected only the sugar refiners, but the Blue Books showed that this was hardly the case, since it appeared that colonial producers and English importers as well as refiners had memorialised the Government upon the subject; though of course the latter class were the largest sufferers. Mr. Shepherd had very ably stated the argument in favour of a countervailing duty; and it appeared to him that the question of principle had been rather avoided in the paper, which dealt rather with the expediency or policy of such a measure. Mr. Bourne said it was contrary to all the principles of free trade, but with this question of principle the Professor had not dealt. He would also say that the opinions quoted from himself were not his own, he having simply collected together the various arguments used in the discussion, and the particular one referred to was first put forth by Mr. Shepherd. With regard to refining in bond, he might say that the Dutch refiners sent up a petition to the Government in March, 1873, in favour of it, and from the discussions on the question in 1872 he did not think the statement was warranted that it was a failure in that country, and the proof that it could be carried out was that in Holland every ounce was manufactured in bond. During the inquiry instituted by the Superior Council of Commerce in Paris, in 1872, evidence was given by the manufacturers that they found it advantageous in every way, and not in any respect injurious. Article II. in the Convention had been criticised, but he thought it was absolutely necessary; and France, Holland, and Belgium could hardly have waived it with a due regard to their own interests. If it was impossible that England should re-impose the sugar duties no harm was done, but if there were a possibility of her doing so, it would have been ridiculous in the other Governments to allow her to be a party to the Convention without such a stipulation, especially as we were the first to propose refining in bond. The French evasions had been referred to, but hardly sufficient force had been given to them. The French Government had made repeated promises that they would establish refining in bond, irrespective of what other countries might do, but they continually put off doing so. The point to be complained of was that they made these promises in order to prevent the British Government insisting on their carrying out the Convention, as was apparent from the diplomatic communications which passed, some extracts from which he might read. After quoting several passages from despatches, Mr. Martineau urged that these extracts showed that the failure to carry out their promises was a more serious thing than even Professor Levi represented it, and fully bore out the statement at the beginning of the paper that there was in France an ingrained policy of protection with regard to sugar. There had been a striking instance of this within the last few days, in the report of the commission of the National Assembly, to whom the Convention had been referred, which stated that "when the National Assembly decided that Excise supervision should form the basis on which duties should be levied, a number of members might have supposed that this method might enter without difficulty into the conventional arrangement, but if this expectation should be falsified the Assembly would recover its liberty, more especially the right to preserve by new arrangements the prosperity of the sugar factories and refineries." There was a strong under-current of protection discernible there.

Mr. Bourne desired to explain that he did not mean to say that English refiners were unnecessary at present, but that he hoped and believed the time would come when refined sugar would be produced direct from the cane in the West Indies. With regard also to the statement that the returns of refined sugar really referred to refuse, he had been reminded that this only showed what a large quantity of really good refined sugar must be produced for home consumption, and sold in this country notwithstanding foreign competition, which would seem to prove that trade was not in so bad a state as was represented.

Captain Ritchie, M.P., as representing a large constituency deeply interested in this question, desired to confirm the statement of Mr. Martineau, that English refiners did not want to be fostered or bolstered up, but simply fair play. When English sugar refiners were unable to compete fairly with others, or when they were no longer required, they would of course cease to exist; but while they were required, they ought to be fairly treated. He could confirm Mr. Martineau as to the views of several members of the Government with regard to this being a consumers' question, having been in communication with them on the subject, and he believed they were every one persuaded that this was not a consumers' question; and it was not to the consumers' interest that this state of things should continue. The trade must, under such circumstances, cease to exist; indeed, the process had already begun, and then the trade being wholly in the hands of their continental rivals they would demand their own prices. He believed the best course would be for English refiners to close their works at once, and then the inevitable result would be seen. This question could not be confined simply to

sugar; any other manufacture must be treated in the same manner, and then the consequences would be very serious. His understanding of the political economy of the matter was that no country should or could continue to manufacture anything which could be produced cheaper elsewhere, and the manufacturers must then turn their attention to something else; but it was not a question of that kind, but of an artificial bounty being given to the foreign producer in order to close our refineries; and he put it to Professor Levi whether it was not in accordance with the true principles of political economy that any Government was justified in taking some strong steps to check any measure which a foreign Government adopted for the purpose of destroying a home manufacture.

Mr. McComber said this matter seemed somewhat anomalous, but it might perhaps be explained by going one step farther back and inquiring whether the climate and soil of France were not better adapted to producing the sugar beet than that of England. Under the first Napoleon large bounties were given to establish this manufacture, and if it were to be extinguished, it would doubtless be a great misfortune to France. In the same way England by her natural advantages in coal and iron had become the manufactory of the world. Some portions of his own country (America) had been growing beet, and others the sugar cane, but there was no comparison between the produce of the two when they came into competition.

Mr. Liggins thought they were greatly indebted to Professor Levi for his able paper, but he could not agree that the question affected only the British refiner, for the colonial sugar grower should also be considered in any legislation which it might be necessary to introduce. He had many friends in the West Indies, and in the sugar trade, and it was most unjust that they should have to compete with a powerful Government, going out of its way to offer bounties to its own subjects. It ill became a great country like France to enter on such a course, and much as he approved of free trade he thought fair trade equally necessary. He differed entirely from Mr. Bourne as to English refiners being unnecessary, and, from an experience of some 30 years in the West Indies, considered his views upon it quite chimerical. From some particular varieties of cane, a colourless juice might be obtained, but generally speaking it ran off of a dark greenish colour, and required skilful refining to make it fit for the market. Even if it were refined in the West Indies, the voyage home would destroy the beautiful bloom which was so much prized in England. The only refinery in the West Indies, on a practical scale, was in Barbadoes, and he believed even there the export had ceased for some time. Facts known to everybody showed that the figures given in the returns must be inaccurate, and he preferred to rely on the figures given by Mr. Martineau. It was evident that if the English refiners were driven out of the market, the foreigners would charge what they pleased, and he had lately, when in Wales, been surprised to see in all the grocers' shops sugar labelled from Paris, or Rouen, but none with the names of London firms, or even from the magnificent refinery of Messrs. Finzel, of Bristol. It was time the Government should be up and doing, and that the solemn treaties already in existence should be enforced. It was not for them to tell the Government what to do, but the object of a Government was to protect its subjects, and seeing the jeopardy in which the sugar trade appeared at present to be placed, he thought a wise Government would soon find some means of putting matters straight.

The Chairman, in moving a vote of thanks to Professor Levi, said this subject was not only one of great interest, but also of great complexity and difficulty. He saw great force in what had been said, but it was a great mistake to suppose that the interest of the consumer turned solely on a low price for the moment; and he remembered Lord Derby expressing very clearly in the House of Lords his view that of course it was to the interest of the consumer to buy low-priced sugar, so long as he could rely on a continuance of that low price, but if the result was so to injure the refineries of this country as to drive them out of the market, it must very soon turn out that the interest of the consumer had been injured rather than advanced. This question had been discussed for many years, especially between France and England, before they arrived at what they hoped was the settlement in 1864, but that settlement had not been adhered to with the good faith which England had a right to expect. He could hardly concur in the statement that the course taken by England had been ambiguous and unsatisfactory, for he thought England had been plain and straightforward throughout, and had great reason to complain of the part taken by France, which actually gave £800,000 a year to the sugar refiners. In another passage Professor Levi said it would be unjust to charge the French Government with want of *bona fides*, but at the same time British refiners had good grounds for not entertaining much confidence in the sincerity of France abandoning the system of bounties. That seemed to him rather contradictory, and being obliged to choose one alternative, he felt inclined to subscribe to the latter. He admitted it would be very difficult for England to adopt a retaliatory policy, but Parliament was bound to take care of English interests, and he saw no security that a new National Assembly might not again defer the fulfilment of the pledge for refining in bond in March next.

Professor Leone Levi, in reply to the various observations which had been made, said he did not coincide in the view that it was inexpedient to abolish the sugar duties. As soon as the revenue permitted, he thought it would be to the advantage of the country to abolish as many of the duties which hinder the imports as possible, and therefore he was in favour of the abolition, not only of the sugar, but of the tea duties, and any others which could be done without. He did not agree with the observation that English sugar refineries would ere long become unnecessary, because in this matter there was a division of labour; the colonists had enough to do to produce the raw material, and they had not either the capital required or promptitude enough in introducing improvements, or a population sufficiently instructed to enable them to compete with British refiners. He quite agreed that other interests besides loaf sugar refiners were affected by this question—the West Indian sugar producer, and also the beetroot sugar grower in France; because every measure which reduced the number of buyers and restricted the market was injurious to producers. There was only one market now for the raw material, viz., France, and therefore the growers were injured. It had been said that British refiners were in favour of refining in bond, but the Excise had always been considered as interfering with trade; one by one, every industry formerly under the Excise had been liberated, with great advantage. After all it was only suggested as the least of two evils. With regard to the article of the Convention binding England to introduce refining in bond should the duties be ever reimposed, he was against the British Government entering into any such obligation; he did not think they had anything to do with the treaty on this subject, now that there were no duties to enforce, or with entering into obligations which might never be carried into effect. The only and best check on the bounty system was that it affected materially the revenues of the country giving such bounties. France suffered by it, and they could not continue in the same course with their eyes open. As to the seeming inconsistency alluded to by the Chairman, what he meant to convey was, that he believed the French Government was acting *bonâ fide* in the matter, but they were hampered by the difficulties in their way, and they did not quite see how to act. He would not charge them with the intention to deceive this country, but at the same time we could

hardly trust them to carry out their promises immediately and efficiently.

The vote of thanks having been passed, the meeting separated.

MISCELLANEOUS.

IRON AND STEEL BY THE KNOWLES PROCESS.

In a communication to *Iron* respecting the "Production of Steel from the Ore," Sir Francis Knowles says, "It occurs to me that your readers may wish to know in what manner I propose to practically effect the fusion of such steel in large quantities so as to evade the cost of melting once or oftener in pots. I shall suppose for this purpose that we have obtained our metallic sponge from ore originally free from phosphorus, and calcined, if need be, to expel sulphur. The reduction to this state may be effected by charcoal, but I much prefer, when it can be had, reduction by a current of light or heavy carburetted hydrogen gas,* as this reduction takes place at a much lower temperature and is very complete. (Properly managed, the gas given off in this reduction ought after pasing through cold water to be pure carbonic oxide.) This sponge is then to be ground up with the proper flux, and compressed into small cakes. A basis of richly carburetted pure pig-iron in fusion having been run out into the converter, the current of burning pyrogen gas, as described by me in former papers, is to be let on for a few minutes, after which the prepared ore is to be gradually added to the bath, the gas current being continued until the exact degree of cementation of the metal required in the aggregate is attained. The weight of sponge being known, and the degree of its carburation, if any, as well as that of the original metal bath, the proper proportions are easily attained. If the flux have been well adjusted, the cinder or scoria ought to be a perfect glass, free from metallic oxide (save where manganesiferous materials are present), and suitable for glass-making. The heat evolved by the complete combustion of pyrogen is sufficient for the fusion of the prepared ore in a proper furnace without metal; but I hesitate to advise it, because as it seems to me, it would render more difficult the due degree of cementation, and might corrode the lining of the furnace. In all cases the finery, furnace, or converter must be gradually heated up to the point at which the bath is to be run in, as sudden contractions by heat may injure the lining. The ores which I prefer are the best magnetic or spathose, well calcined, and the same may be generally said as to the metal of the bath; but a splendid basis may be obtained in metal produced from pure brown hæmatite, such as the ores of the Duc d'Arenberg, which are rich in oxide of manganese.

"In the above, I contemplate the production of a high-class workable steel, such for example as would require in the old method of cementation, Russian or other charcoal bars at £20 a ton and upwards. If to this we add the cost of cementation and melting in pots, we get a pretty good margin for the above operations, raw materials included. This steel may be used also for casting articles in moulds, as proposed in my previous letter. Axes so made could be worn down to the 'eye' itself, to the joy of the backwoodsman."

Messrs. Morris, Tasker, and Co., of Philadelphia, are shipping a large amount of machinery to be used in Louisiania in a new process of manufacturing cane sugar. The method is known as the diffusion process, as distinguished from the maceration process.

* Described in my patent of 1851-2.

NOTES ON BOOKS.

Specifications as Bases of Patents. By W. Spence. Second edition. London.

In this re-issue of his pamphlet on Patent Specifications Mr. Spence goes rather deeply into the questions of the proper drawing of these documents, and the objects which ought to be attained by them. He considers that the specification should fulfil two main objects, first, defining accurately the ground covered by the invention, and, secondly, so describing the invention as to enable the public to reap therefrom the benefit in return for which the privilege is granted to the first inventor. Those most conversant with the mass of existing specifications best know how little the second principle is considered by inventors. This is not unnatural, considering that there is no means at present of examining the specifications at all, and, therefore, no practical check on the inventor, who is too often apt even to study obscurity, and to make his claims as vague as possible, in the hope both of concealing his invention from rivals and of covering as much ground as possible. Besides a discussion of this important question, Mr. Spence gives a number of suggestions as to the various points to be observed in preparing specifications, and his ideas as to the general scheme to be followed in drawing them up.

GENERAL NOTES.

Demolition and Erection of Buildings in Paris since 1870.—The following table, compiled from the report by the Prefect of the Seine to the General Council, shows the number of buildings demolished and also erected in Paris and the Department of the Seine since the year 1870:—

Years.	Demolitions.		Erections.	
	Seine.	Paris.	Seine.	Paris.
1870	5,341	1,418	8,579	4,230
1871	2,415	1,012	4,496	1,901
1872	1,521	1,092	5,310	2,457
1873	1,556	1,111	6,097	2,699
1874	1,857	1,460	5,524	2,628

Disinfectants for General Use.—Of disinfectants sufficiently inexpensive for general use—cheapness being an important desideratum—next to carbolic and cresylic acids are placed zinc salts, and after them magnesia and iron salts. The action of these substances upon putrid material has been the subject of much study, since by that means it has been hoped that the true nature of infection may be discovered. Those substances found to be most efficient have been observed to be agents which coagulate albumen, and hence, as an outgrowth of the germ theory, combined with the fact that contagion and putrefaction, if not identical, require exactly similar conditions, the assumption was made that the germs causing infection or contagion contain albumen, which is essential to their existence. Hence, that which coagulates albumen disinfects. This theory was promulgated by Dr. Hirsch, in 1869, but it will not account for all the phenomena of infection, and is therefore open to serious objection. It has been shown that cresylic acid, which is a more powerful disinfectant than carbolic acid, has not so much power to coagulate albuum. Dr. Angus Smith has also demonstrated that the coagulation of albumen, though it retards, does not absolutely prevent putrefaction. Moreover it is stated that a solution of carbolic acid one in one thousand may be made, which, though too dilute to coagulate albumen, may yet disinfect.—*Engineer.*

Self-adjusting Shot-hole, Rivet-hole, and Leak-stopper.—Amongst the plans brought forward of late to satisfy the demands for means of safety at sea, is an invention of Mr. J. W. Wood, the collector of Customs at Harwich, whose paper in 1870 on means of saving life at sea may be remembered by the members. It consists of a means of repairing damage to iron ships, buoys, and boilers afloat, by means of a self-adjusting purchase from the inside or outside, as may be required, upon which a patch may be fixed. The apparatus may be described as follows:—To a bar of iron slit entirely through half its length there is jointed in the middle a screwed spindle, half the length of which lies flush in the slit in the bar, the remaining portion forming a handle. If this is taken in hand with the tip of the thumb on the slit end of the bar, all will be in a straight line; but if the bar is thrust forward through a hole, at the same time removing the tip of the thumb, the bar will immediately adjust itself across the hole on the other side, and afford a certain and secure purchase; while the screwed spindle at the same time remaining in the hand, it is easy to slip on to it the iron plate faced with layers of thick felt padding, in which any jags or irregularities are embedded, and following up with the lever spanner, all is screwed up tight, the jags nearly screwed home, and the leak stopped. For boilers, steam packing instead of felt pads is supplied. If the hole happens to be near a ship's framework or other protection, the advance washer projects the plate forward, so that the celerity afforded by screwing up with the lever spanner remains the same, whatever the angle may be. One of the sizes is specially adapted for rivet-holes either in ships or boilers, so that if one or more rivets start, the plates may be drawn together and kept secure.

NOTICES.

SUBSCRIPTIONS.

The Michaelmas subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to Mr. Samuel Thomas Davenport, Financial officer.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

The following arrangements for the Wednesday evenings before Christmas have been made:—

December 15.—"Health, Comfort, and Cleanliness in the House," by Thomas Blashill, Esq., A.R.I.B.A.

December 22.—"A method of producing Pure Charcoal Steel directly from the Ore," by Henry Larkin, Esq.

Cantor Lectures.

The remaining lectures of the first course of Cantor Lectures for the present Session, "On the Discoveries and Philosophy of Liebig, with especial reference to their influence upon the advancement of Arts, Manufactures, and Commerce," by J. L. W. Thudichum, M.D., will be delivered on the following Monday evenings:—

Lecture IV.—December 13.

Physiology of animals, and the laws of their nutrition in particular.—Foods and food-extracts.—Works, and their influence upon professions and associations.

Lecture V.—December 20.

Therapeutic agents and collateral discoveries, chloroform, chloral.—The way from detailed labours to general scientific principles and laws.—Liebig's philosophy as influencing mode of thinking of present generation.

The lectures will be illustrated by selected experiments and demonstrations.

Special Lectures.

A series of reports has been prepared by Dr. Richardson, appointed by the Council to make special inquiry into the subject of "Unhealthy Trades." The remaining lectures of the series will be delivered on the following Friday evenings:—December 10th, 17th; January 21st, 28th; February 4th.

The subjects considered in this course include:—

The influence of physical labour on individual and national vitality.

Injuries incident to physical labour. (1) By exposure to dust and other foreign substances. (2) By exposure to noxious gases and heated and impure air. (3) From mechanical concussions, peculiar postures of body, and excessive exertion.

Diseases incident to workers in the potteries, in trimming and furniture dressing, in sand-paper making, in flour-mills, amongst old rags, in fur dyeing, in walking-stick making, in hemp dressing, in patent leather dressing, &c.

Diseases of paviours, carpenters, blacksmiths, postmen, scriveners, &c.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Thudichum, "The Discoveries and Philosophy of Liebig, with special reference to their influence upon the Advancement of Arts, Manufactures, and Commerce." (Lecture IV.)
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. W. D. Gardiner, "The present state of the Law as to the Right to Light."
Royal Geographical, Burlington-gardens, W., 8½ p.m.
British Architects, 9, Conduit-street, W., 8 p.m.
Medical, 11, Chandos-street, W., 8 p.m.

Tues. ...Women's Education Society (at the House of the Society of Arts), 6 p.m. Mr. Sonnenschein, "A Method of Teaching Arithmetic."
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m.
Photographic, 9, Conduit-street, W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C. 1. Mr. Bertram F. Hartshorne, "The Weddas of Ceylon." 2. Mr. J. H. Walhouse, "The Belief in Bhutas—Devil and Ghost Worship in Western India." 3. Mr. C. O. Groom Napier, "The Localities from whence the Tin and Gold of the Ancients were derived."
Royal Colonial, Pall-mall Restaurant, Waterloo-place, S.W., 8 p.m. Mr. Edward Wilson, "Acclimatization."

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. T. Blashill, "Health, Comfort, and Cleanliness in the House."
Meteorological, 25, Great George-street, S.W., 7 p.m.
Geological, Burlington House, W., 8 p.m.

Thurs...British Scandinavian (at the House of the Society of Arts), 8½ p.m. Mr. George Browning, "The National Life, Manners, Mode of Travelling, &c., in Iceland at the present day."
Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. Parker, "The Structure and Development of the Bird's Skull." (Part 2.) 2. Mr. Moseley, "Plants Collected at the Admiralty Islands." 3. Mr. King, "A Sport in *Paritium tricuspe.*"
Chemical, Burlington House, W., 8 p.m.
Zoological, 11, Hanover-square. W., 4 p.m.
Numismatic, 13, Gate-street, W.C., 7 p.m.
Philosophical Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri. ......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Special Lectures. Dr. Benjamin W. Richardson, "Industrial Pathology, or the Influence of certain Injurious Occupations on Health and Life." (Lecture II.)
Philological, University College, W.C., 8 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,204. Vol. XXIV.

FRIDAY, DECEMBER 17, 1875.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The following are the rules for the admission of candidates to compete for the Society of Arts Scholarships :—

1. The Society of Arts has founded four Free Scholarships, two for males and two for females, and a competition for them will take place early in February, 1876.

2. Candidates to compete must be nominated by a Member of the Society of Arts, each Member having the privilege of nominating a male and a female candidate.

3. The nomination must be made on the form and in the terms given below. Copies of the form for this purpose will be supplied to Members on application to the Secretary of the Society of Arts.

4. The examination of the competing candidates will take place at the Society's House, John-street, Adelphi, early in the month of February. The date, when fixed, will be notified to each candidate properly nominated.

5. The subjects in which the candidates will be examined in the competition are as follows :—

(*a.*) Reading aloud and recitation with clearness of pronunciation; writing legibly from dictation.
(*b.*) Elementary knowledge of musical notation and knowledge of the principles of music.
(*c.*) Performance on some instrument or singing (at sight also if possible) or composition.

6. The attention of Members is specially drawn to the foregoing requirements, and it is particularly requested that they will exercise great care to nominate those only who they feel assured can fairly fulfil them.

7. Members nominating must send in to the Society of Arts with each nomination form—

(*a.*) A medical certificate, proving that tho candidate is in good health and has no defect which would impede the practice of vocal and instrumental music.
(*b.*) The copy of a register of birth.
(*c.*) The certificate of two well-known persons in a locality that he, or she, is of good moral character.

8. Previous to the competition an examination fee of 5s. must be paid by each competitor to the Society of Arts.

9. *Admission to the School after Competition.*—After a candidate has been successful in a competition, and has been named for a Scholarship, he or she will be admitted to the Training School upon the production of the above-mentioned necessary certificates of health, birth, and character; his or her continuance as a student in the Training School will depend on the report of progress by the Examiners and the Director of Studies.

Note.—On admission the student will be required to furnish the statement from the Society of Arts Examinaas to his or her capacity, previous musical studies, and antecedents.

10. All Scholarships confer the right of obtaining the best musical instruction in the School without payments of fees of any kind, or for instruments, music, and books, which are provided for use in the School. The School does not provide board or lodging.

11. The nomination paper for the competition, duly filled in and signed by the Member nominating, accompanied with the necessary certificates and the candidate's fee, must be sent in to the Secretary of the Society of Arts, John-street, Adelphi, London, W.C., on or before the 15th January, 1876.

JUVENILE LECTURES.

Two lectures, suited for a juvenile audience, will be given on Tuesday, January 4, and Tuesday, Jan. 11, by Dr. W. B. Carpenter, C.B., F.R.S., on "The Wonders of the Microscope." The lectures will commence at 7 p.m., and will be illustrated by the oxy-hydric and electric lights. As the number of seats is limited, Members can only avail themselves of these lectures for their families by obtaining tickets from the Secretary. These will be issued strictly in order of application, and only to the extent of the accommodation available. When sufficient tickets to fill the room have been ordered the issue will be discontinued. Subject to these conditions, each Member is entitled to a ticket admitting one adult and two children.

EXAMINATIONS IN FINE ARTS APPLIED TO INDUSTRIES.

These examinations are intended to apply to subjects which are not at present to be included in the general Art Examinations of the Science and Art Department, and especially to test a literary knowledge of the decorative arts. Candidates must have taked a second-grade certificate (Art) of the Science and Art Department.

The examination will be held in 1876, on Tuesday evening, the 25th of April.

Programmes may be had *gratis* on application to the Secretary.

FIFTH ORDINARY MEETING.

Wednesday, December 15th, 1875; Robert Rawlinson, C.B., member of Council, in the chair.

The following candidates were proposed for election as members of the Society :—

Angus, Robert, Lugar, Ayrshire, N.B.
Bartleet, R. S., Redditch.
Eassie, W., C.E., F.G.S., Child's-hill, N.W.
Harding, Douglas Hamnet, 54, Wood-street, E.C., and 37, Burton-road, Brixton, S.W.
Harker, the Rev. William, the Vicarage, Milton, near Sittingbourne.
Knight, John Mackenzie, 2, Lansdowne-terrace, Bow-road, E.
Lawrence, W. F., New University Club, St. James's, S.W.
Mason, Thomas, 2, Westminster-chambers, S.W.
Salomons, Sir David, Bart., 46, Upper Berkeley-street, W., and 1, Oriental-place, Brighton.
Stewart, Charles, M.A., 50, Colebrooke-row, N.
Vallé, Burton H., Nether Swell Fields, Stow-on-the-Wold.
Woolnough, Charles Alfred, 22 Percy-circus, W.C.

The following candidates were balloted for and duly elected members of the Society:—

Hall, J. A., Toxteth-park, Liverpool.
Hall, John G., 8, St. Margaret-street, Canterbury.
Mercer, John Sharp, 1, Copthall-court, E.C.
Monson, Edward, High-street, Acton, W.
Rae, James, 32, Phillimore-gardens, Kensington, W.

The paper read was—

HEALTH, COMFORT, AND CLEANLINESS IN THE HOUSE.

By Thomas Blashill, Esq., A.R.I.B.A.

The selection, furnishing, and daily routine of the place which we call Home, are matters deeply interesting to the best part of mankind, and every detail of them ought to be well and commonly understood. Yet in every age those who have carefully thought upon the subject have declared that those things about a house which are most essential to comfort, and more especially to health, have been ill understood, being made subordinate to questions of mere fashion or caprice. Bacon begins his essay on building by saying "Houses are built to live in, and not to look on," and however the observation may be qualified, we shall do well to accept it for the present in its literal sense.

The English, with all their energy and activity, live mainly and more than ever indoors. Brain-work and the handicrafts of cities flourish best under cover, and machinery diminishes the labour of the field. Alone amongst neighbouring nations we are dispensing with the outdoor work of the female half of our people. Apart from business we are short of outdoor meeting places, where we might live a regular part of our life. On leaving home we like to be provided with an excuse. Sports and games are for exercise. A walk is for fresh air. Our holiday is for change; travel is for improvement or for health. In these two last reasons we convey some censure on our domestic arrangements. Comfort, a word which we seem to have made, is kept chiefly for indoor use. It marks such conditions as to warmth, dryness, cleanliness, ease, and freedom from worry as we like to find about us. If we retained under domestication our five senses with all their natural acuteness and in equal measure, comfort might be a more reliable index to point the road to health. But of these, feeling alone becomes more sensitive, and indicates more readily the uncomfortable conditions. Sight we voluntarily baffle by the darkness of our houses. Hearing is dulled by habit, mercifully dulled. When we compare the townsman with the dweller among green fields, the sense of smell, our great guide in sanitary matters, appears always deficient and sometimes lost,

"And wisdom at one entrance quite shut out."

Taste naturally suffers in a measure with the sister sense. None of them convey to us ideas of things in their true position. They need to be corrected by the help of those branches of science which specially deal with questions of health.

My desire in this paper is to apply our senses, so corrected, to the investigation of certain conditions in our homes, the homes of people who are supposed to be above public sympathy, who have to pay for what they require, and if necessary, can pay for a little more. I expect to show that, to an extent of which few people have any suspicion, an ordinary house is deficient in the essentials of comfort and of health, and its daily management is hampered by these deficiencies.

Although, instead of giving a catalogue of defects, I use for the most part the pleasanter form of indicating what ought to be the condition of our houses, I mean generally to imply that this is not their usual condition, and it may be useful to bear in mind some of the main causes of this. The typical English house is a whole house; we will not cramp ourselves into a set of rooms on a flat, though this might be better for many. The mere work of cleansing the surfaces of an entire house in the damp and dirty atmosphere of a town, and of seeing that it is properly done, is a serious burden, irrespective of the cost. Then our house was not built to our measure, we have hired or bought it ready made, and if it does not fit us we have to fit ourselves to it. It was probably built to sell, and the ingenuity of an ingenious craft has been exercised in order to give us the most, and the showiest, and the worst for our money. If built by contract, the system tends to force not only the contractor but every person under him to stretch his conscience further than he likes in order to make bad work fill the place of good. The house is not even the property of the man who has it built, the freehold being in another. To do his duty to himself he must build it just so well that it will hang together for ninety-eight years, and shew only the marks of "fair use and wear." If I seem to forget the man who really lives in his own house standing upon his own land, I beg pardon, but it was very possibly built by people educated in these vicious systems, and will suffer from their vices. Indeed, to build a good house requires not only skill in the workman but perfect honesty, clearness of business arrangements, and reasonable confidence amongst all parties concerned. With such a combination the work will usually be satisfactory; without it the house will be subject to most of the evils which I shall have to indicate.

If our house is an old one, much may be done to improve it, and as some millions of houses exist in this country which must continue to be used, this matter is for the present generation of greater moment than the question of new buildings, therefore we should specially remember it. Our subject will then comprise the following general heads:—

The site and approaches.
The fabric generally.
Lighting, warming, and ventilation.
The kitchen and its dependencies.
Removal of dust and refuse.
Drainage.
Miscellaneous observations.

Site and Approaches.—I shall not repeat at any length the ordinary and obvious hints on the choice of a site. The few who have any range of choice will of course look for a dry soil, a dry atmosphere, shelter from cold winds, sufficient exposure to sunshine, freedom from offensive neighbours and noxious trades. Towns, except those built for pleasure, for retirement, and for health, and the favourite suburbs of large cities, do not spring up with much reference to these conditions. They rise at the bidding of commerce,

and with it they flourish and decay. Although modern facilities for locomotion have made it seem less necessary for us to pass our lives "in populous cities pent," they have vastly increased town populations. For business purposes men must be brought close together, and strange as it may seem, cheap postage and the telegraph have tended to pack them closer. Even for pleasure and of choice people will congregate in particular quarters. If Art does not aim at rendering the close proximity of houses and places of business consistent with health, it misses its duty, which is to face the difficulties of the age and not waive them aside. Where nuisance exists from bad neighbours, the law has given increased powers to local authorities, and an application to them will usually abate the nuisance.

Clean walks and smooth turf should immediately surround the house. For paths the best kinds of liquid asphalte are superior to gravel or stone pavements. Asphalte is smooth and dry, makes no noise, is easily cleaned, durable, and not very costly. The dirt upon our feet should be left at the entrance to such a path, and not close to or within the house.

The Fabric generally.—A house should have, first, some slight shelter or porch to protect persons while waiting at the door. Within the entrance door should be a vestibule having another door between it and the house, so that the hall, staircase, and principal rooms have each two doors placed between them and the open air. The first great object with regard to the fabric is that it be dry, and the first step is to see that the soil is drained to a level much below the lowest floor. On all soils a layer of concrete should be spread over the whole surface, and a bed of hard dry rubbish or gravel should be put beneath the concrete. All walls should have a damp-proof course built into them just above the level of the ground. Both these things can be done to an old house, and there is not one old house in fifty that would not be perceptibly improved by them, besides which we shall be told by medical men that a cold and damp subsoil does infinite mischief, although the unaided senses may not be acute enough to notice its defects. These expedients keep down the damp, resist the cold, and prevent foul exhalations from imperfect drains and impure soil. Owing to malpractices as to drainage, the soil under all old houses may be taken to be charged with impurities. In new houses, built to sell, the layer of concrete, which would cost very little, is always omitted. The walls should not be less than a brick and a half in thickness. If built of a good, hard, well-burnt brick, like the London stock brick, and not too dense in structure, laid in good ordinary lime mortar, such walls will not be damp except where they are unusually exposed to driving showers. In a house that is badly warmed moisture may frequently be found on the inner surfaces of the walls in cold passages and on stone floors. When children see this moisture on the window-pane they think it has come through the glass, and full grown persons are hard to convince that the water which streams down a smooth wall may really be condensed from the air within the house, much of which proceeds from our breath or from excessive consumption of gas. The inner face of the thickest wall, built of granite set in cement, will be abundantly wet in certain states of the weather, the water streaming down upon the floor. On the other hand in a timber house plastered inside and outside, or having weather tiles on the outside, the walls, although not more than seven inches thick, will be dry. Stone walls lined with wainscot or with battens and plaster, will be dry. Where the materials are hard, and there is fear that a wall of stone or brick will be wet on the inner face, it should be built hollow, but unless great care is taken in construction it will fail to be quite dry. The only material generally available for the inner face of walls is plaster: when made of good sand and lime, and smoothly finished, it is in practice more free from objection than any substitute that has been introduced. In 1871 I saw in all the burnt buildings of Paris and St. Cloud that the plaster had resisted the fire much better than the stone, but the plaster must be really good. For ceilings there is an opening for a light material made in slabs of good thickness, having an ivory surface, and of moderate cost. In certain parts of our suburbs the substitute for plaster is the filthy siftings from dustbins mixed with a little lime. We will think of this when we deal with the removal of dust. In an ordinary brick wall, plastered and papered, a considerable quantity of air passes through and some moisture along with it. A wall of hard materials with glazed surfaces stops this transmission of air, conducts the heat rapidly, making the weather inside the house changeable, and requires extra means of warmth in the house. But tiles with a smooth, dead surface may be used on the lower parts of walls in halls and passages and rooms which require to be more frequently cleaned. If paper be used on the walls, and I do not recommend it except for its cheapness, the house must be most carefully kept warm and well aired. Paper with a dead surface is much better than glazed paper, which attracts moisture, or than flock paper, which attracts dust. A painted flock paper may be used, and a passage or the lower portion of a room may have an unglazed, washable paper. In case of infectious disease the paper should be cleaned off, and new papers should not at any time be put over old. Paint, when necessary, should have a dead surface; but doors and lighter fittings, which are subject to much wear, may be varnished or polished, as they will not become cold and wet, like woodwork attached to walls. Not only are these glazed surfaces very wet when a house is neglected, but I often find the glazed walls of a house which contains a large gathering of friends moist or actually streaming with water. In such cases there is great want of ventilation or of warmth.

The basement or lowest floor may have a covering of asphalte over the concrete in all cellars and store-rooms. In kitchens, where the floor is likely to be wet or greasy, asphalte will be slippery. There the floor may be of large, smooth tiles; if of wood the boards should be $1\frac{1}{2}$ in. thick, jointed with hoop iron, and with good ventilation under them. This thickness of floor-boards much increases their warmth to the feet. The floor of the vestibule should be of smooth, unglazed tiles, with marble borders and a marble step at the door. Marble for these purposes, which saves much labour in cleaning, and costs very little, is abundantly used on the Continent; here it is seldom seen. The hall floor may be of parquetry, or of ordinary floor-

boards covered with one of the materials of the kamptulicon class, and the other floors of the house of similar floor-boards, always jointed with hoop iron. A border of kamptulicon may be put to sitting-rooms and bedrooms sufficiently wide to take the furniture, while the centre may be covered with a thick carpet, easy to remove, so that the whole may be readily cleaned. If the floor is covered up with an air-tight covering before it is perfectly dry, the timbers may be destroyed by dry rot within one or two years. Brightly glazed and polished floors are cold to the eye and to the feet, unpleasant to walk upon, and dangerous to a person who steps upon them from a carpet. They are quite unnecessary for purposes of the most perfect cleanliness.

In roofs the rafters should be covered with boarding and felt under the slates or tiles, in order to keep the house of an even temperature. In towns I should usually make a flat roof, covered with lead, or concrete and asphalte, and having always a hollow space within its thickness, for the sake of warmth.

It would be possible to extend these details considerably, but, in a word, the house should be well and not cheaply built, while the tendency now is to build cheaply and not well.

In respect of the fittings of rooms, flat ledges, where the dust will lodge instead of finding its way to the floor, should be avoided; shelves that are not enclosed in cupboards, and cupboards that do not go quite up to the top of the room, afford harbour for dirt. The simpler the form of the articles of furniture the easier they are to clean, and I would add that these forms are more elegant and in better taste.

Lighting, Warming, and Ventilation.—If any man whose occupation is not chiefly out of doors will notice the time actually spent by him in the open air, he will be surprised to see how small a portion of his whole time it is, and how much he depends for light, warmth, and a pure atmosphere upon the conditions which exist within the house. Townsmen will spend 20 to 22 hours per day indoors, women and children 22 to 23 hours, even in fine weather; sick persons, 24. With the climate of weather reports and topographical descriptions they are, then, only indirectly concerned, for it is but the raw material of the climate in which they really live. The lighting, both natural and artificial, the warming and ventilation of the house, thus become of great practical importance.

In this country sunshine is generally so precious that the house should be so placed, the windows so arranged, as to invite it into every room. The windows should rather be too large than too small. When the sun is too hot we can shade it by shutters and blinds, and as the air of winter is too keen some of the windows may have double sashes, between which a fern case may be put, or they may open into a small conservatory. Thick plate glass is much warmer than common glass, is cheaper in the end, and can be insured. I shall have occasion to observe on the importance of light in the working departments of the house. Broad daylight shows up dirt everywhere, facilitates work, saves gas; sunshine freshens the air, keeps it moving, and keeps it dry better than fires.

For artificial light candles and lamps, when we can afford the cost of them, are better than gas. Gas is always burnt in excess, so that unless there be very good ventilation the foul air from it may be actually smelt, and together with the heat becomes oppressive. I believe no notion exists of the extent to which gas burning is a source of damp. If we light an Argand burner, the glass chimney will in the first moment become clouded with moisture, the next moment the moisture will disappear, driven off by the heat of the glass. But this formation of watery vapour really goes on as long as the gas is burning, being caused by the combination of the hydrogen in the gas with the oxygen of common air. In many houses all the gas burners are lighted at nightfall, and allowed to burn till bed-time; some being kept alight through the night. In a large house which structurally was dry, a client of mine complained of damp within the movable wardrobes, where the silk dresses had become actually wet. Suspecting the gas, I found they were burning as much of it as would generate over two gallons of water per day, much of which must settle on smooth surfaces in any unwarmed, ill-ventilated parts of the house. A friend who went abroad during the cold of last winter, found the servants had aired his drawing-room by burning the gas night and day, till the walls were made thoroughly wet and the decorations spoilt. I once saw gas burnt for two or three weeks in order to dry some obstinately wet plaster until the condensed water covered the ceiling and dropped plentifully upon the floor. Where much gas is burnt, some effectual mode of carrying off the products of combustion is essential. Where the air in the room is not changed rapidly by means of a suitable fireplace, the ventilating globe light may be used as the best substitute, but it is difficult to apply it so as to ensure durability and continued perfect action. I may mention here that the Parisian Building Act does not permit the concealment of any part of a gas pipe, any leakage can therefore be detected easily and at once repaired.

From the condition of our climate the questions of warming and ventilating the house can best be considered together. During those long months when artificial warmth is most needed, artificial ventilation is also most needed; warmth supplies the necessary force, and may therefore be first considered.

There are habits, I might say fashions, as to warmth which override individual instincts. The houses of the middle class have in my recollection become colder except as to the unwholesome heat given out by gas. The roaring fire has dwindled, lighter clothing is worn indoors, soft feather beds with close hangings and other luxuries are discouraged, as well as hot stimulating evening drinks. Habits of personal cleanliness also involve increased coolness. Accepting these changes as improvements in themselves, we must admit that the general climate of the house needs more than ever to be ameliorated.

During the winter months, the temperature of passages, staircases, and bedrooms not specially warmed will range from 50° down to 40° and even much lower. At such temperatures out of doors, and while in active exercise, men put on their overcoats and thick gloves, women wear warm cloaks and furs. At these temperatures indoors we go shivering in thin clothing, change the warm

for the cold, and allow children to run about more nearly naked than they would do in the warmer climate of France in August. It is as if a whole section of the population were training for an Arctic voyage, although they may be confident that the vast majority of them, all except the idle, the extravagant, and the unfortunate, will be more able to keep themselves in comfort as time goes on. Victims of this infatuation plead that they were always taught when young to harden themselves, and to avoid "coddling" in the house. But the ancestors of these townfolk were countrymen, sportsmen, Highlanders, tillers of the soil, who lived out of doors, and would have despised our sedentary habits, small fires, and evening dress. Now the middle, or perhaps the middling, class stands alone in doing these things, for neither the rich nor the poor submit to them. The former try to warm their houses throughout, making every part habitable. The latter spend a large part of their money on the fire, papering up every hole and crevice, and almost stifling themselves, not, as is absurdly said, because they hate fresh air, but because they hate draughts.

In a comfortable house the inhabited parts of it are kept at a regular temperature throughout of nearly 60°, where you can sit in any part of a room, and be free from draughts. A draught is an artificial east wind, more dangerous than the natural wind, against which when out of doors we know how to protect ourselves. A comfortable house is also perfectly free from damp. Out of the house we guard against damp by suitable clothing, but if we get never so wet we do not suffer from it as we do from damp within the house. There must be a gentle movement in the air to give it freshness. We must be able to turn at moments of unusual discomfort to the glow of an open fire. Beds, and all articles of clothing and furniture must be of a genial temperature, and articles of food and drink that are not hot should be served at the temperature of the room. On going out of the house our extra clothing should be of the same moderate warmth, and not at about the freezing point. There are diseases of the organs of breathing which require care in passing suddenly from such an atmosphere into the cold air, but no fairly healthy person suffers from such a change. Cold ablutions, which are pleasant and invigorating when the air is genial, fail to be so when we are already chilled by exposure to a raw air, and when everything we touch is cold and damp. The question is how to produce this regular warmth along with perfect ventilation.

France, Germany, and America are the countries most like ours in climate and in the habits of the people. The Frenchman burns wood upon fire dogs; a pleasant, but expensive and insufficient mode of heating in very cold weather. The German burns wood or coal economically in a close stove, that warms—overwarms—the room, causing little draught, but not bringing in the fresh air. The American lights the fire in his underground heating apparatus in November, and keeps it going till May, supplying fresh air, too warm and too dry, to his principal rooms. Our own system is that of the open fire of coal, admitted to be a wasteful contrivance, but one which, I think, we shall not discard. The love of it is no mere prejudice; we do not regret it when the weather is dry and warm, we do not circle round it much even in winter when the drawing-room is comfortable, but on coming fresh out of the raw cold air nothing warms us so quickly and pleasantly; and in the family circle there are many little offices we require of it. At the season when sunshine is scarcest with us it gives up to the atmosphere of our homes the sunshine which long ago nature stored in the mine, and we rejoice together in its glow.

In seeking for some system which will do for us what we want, we may first state what we do not want, what we are rather tired of being teazed to buy. We do not want—

Those which make things little better than they are.

Nor those which warm the house but do not ventilate it.

Nor those which ventilate but do not warm.

Nor those which neither warm nor ventilate.

Schemes which make things little better than they are.—Of this class are the numerous small improvements of the common fireplace, which reflect a little more heat into the room, or save a little of the fuel. In this direction the great harvest was reaped long ago by Count Rumford, who taught us the best form for the grate and its adjuncts; but, while not refusing to accept any small additions to his improvements, they should not divert attention from more thorough reforms.

Schemes which warm but do not ventilate.—This class comprises all stoves which resemble the German stove, in simply warming the air in the room, while they are usually inferior to that stove in carefulness of arrangement for the purpose. The action of the Gurney stove is superior, in that it supplies moist, warm air, which quickly travels over the house, but much of the moisture which it carries with it must, at the end of its journey, be deposited somewhere as damp.

Schemes which ventilate but do not warm.—These are schemes for admitting cold fresh air into the room at particular parts, the best of which is a valve fixed in the outer wall near the ceiling, such as Sherringham's ventilator, which causes the fresh air to travel along the ceiling until it gradually mixes with the air of the room. This ventilator, or a simple *louvre*, may also be fixed over the door of a room to admit air from the passage, and so prevent its coming from the lower parts of doors and windows. For this plan there may be a certain limited use for rooms that are often crowded, and for admitting additional air to rooms during warm weather. An old plan for admitting fresh air, by means of an upright tube rising from the floor and projecting a column of air to the ceiling, has recently been successfully employed in hospitals, but does not seem to be necessary for an ordinary room.

Schemes which neither warm nor ventilate.—I notice those which consist of plans for bringing fresh air by a tube to the front or bottom of the grate and so feeding the fire with it, chiefly for the purpose of noticing what pains people will take to just miss the thing that is wanted. For while all the expense of introducing pure air is incurred, it is simply used for feeding the fire, so that the air of the room is even less changed than with a common fire. The two schemes last named aim at the prevention of draughts and smoky chimneys.

For a large house it is necessary to admit warm air into the hall and larger rooms, either through coils of iron pipes fixed in or close to the rooms, or through a heating chamber near the furnace, whence it is conveyed by tubes to the several rooms, and is usually admitted through a grating in the skirting. The gratings should be large, as a sharp current of air, which, though much above the temperature of the room, is below that of the body, will have all the qualities of a decided draught. The gratings should not be put in floors, where they will admit dirt to the warm air channel.

For warming and ventilating an ordinary house the first step is to place in the entrance hall a good slow combustion stove, or an open fire with a heating chamber, amply supplied with fresh air from the outside of the house. This will bring a large portion of the house to a genial temperature; it will prevent cold draughts from windows and outer doors, foul currents from closets, and undesired smells from the kitchen department. The result should be to make the atmosphere in the hall not less sweet than that in the rooms, and nearly as pure as in the open air. In an old house a gas fire could be much more readily fitted, as the flue for carrying off foul air from it would be more easily constructed than the flue required by a fireplace or stove.

Every room should have a ventilating open fireplace, which may be of the class to which the Galton stove belongs. In this, fresh air is brought to the air-chamber at the back of the fire, is warmed and discharged into the room, not at the level of the mantelshelf, nor still less below that level, but quite close to the top of the room, so that it will travel along the ceiling and become gradually dispersed. The fire draws away cold air from the level of the floor, but a much smaller fire is required to raise a room to a given heat, and the current towards the fire is slight. I should prefer to see these stoves so constructed that the air-chamber at the back may be easily examined without disturbing the setting, and filtering materials, disinfectants, or means of generating ozone introduced when thought necessary. There would be little difficulty in utilising the waste heat from the fires of kitchens and lower rooms by making their flues pass through the fresh air chambers of the bedroom fireplaces, and so causing a constant current of warm, dry air to those rooms, regulated by a valve. Indeed, all the heat produced by the fire may be utilised in this way, except so much as is necessary to keep up the ascending current in the chimney.

Another plan is to use Jennings's ventilating chimney tubes, in which the smoke flue is surrounded by fresh air flues, and which, when carefully fixed, produce the same results. Both these schemes do for every separate room of a house, all that has been mentioned in the case of the hall stove. By isolating the atmosphere of each room they render it more easy, in case of infectious disease, to keep the air of the sick room from mingling with the domestic atmosphere and carrying with it the active principles of disease.

The expense of fitting up these ventilating fireplaces in a new house is inconsiderable. Their introduction into an old house would generally be practicable at greater expense. Where this cannot be done, pure warm air should be introduced into the passages and the rooms supplied with it from thence.

Thermometers should be placed in many parts of the house, as well as outside one or more windows, to indicate the external temperature. Tolerably good ones cost two or three shillings, and cheaper instruments may be fairly accurate, but should be tested with one of the better sort or they are a delusion. I have one which is inaccurate to the extent of ten degrees. It is an error to suppose that the use of the thermometer demands greater intelligence than is usually possessed by the family and by servants.

In the summer, when there is no fire to induce a rapid change of air, there will be a gentle current up the chimney, and fresh air will enter the room. If the weather be damp a fire should be made, occasionally throwing open the doors of cupboards, moving the furniture from the walls, and filling the room with warm air, is the most efficient plan for airing the house in the absence of bright warm weather.

The best way to keep a house dry and healthy is to use it, living in all the rooms either every day or by turns. A spare room is usually a damp ill-ventilated room, and an empty house deteriorates much faster than one that is occupied. When we leave home for a time, ventilation and warming should be carefully kept up.

The Kitchen and its dependencies.—The chief purpose of this department is the storing and preparation of food. We very commonly, and in towns generally, put it underground, in the darkest, worst ventilated, and therefore the most unwholesome part of the house, a place where master and mistress go as seldom as possible, and visitors never. Thus our food, upon which considerable art has been expended in order to tempt the purchaser, and which will presently be brought to table with a great show of niceness, has a "middle passage," during which it is subject to very imperfect supervision, while it requires the greatest care to keep it sweet and clean. Vast numbers of houses inhabited by families quite above the labouring class have actually no place provided in which to keep perishable food. Many houses of a better class, often handsomely decorated and furnished, have the pantry near the centre of the basement storey, with no direct light and ventilation. Meat which is waiting to be cooked cannot be kept sweet in such places, nor can the portions of our large joints which remain after meals be kept nicely so as to render it probable that they will be used as food. The smell of the dinner which is actually preparing in such a house is as nothing—the whole of the lowest part of it is pervaded with the smell of to-morrow's dinner and yesterday's dinner. A perfectly light and well ventilated larder is essential. The shelves should be chiefly of slate, and better if of marble, the walls being lined with tiles. The prevention of waste by such means would repay the expense many times over. The kitchen is usually much too large. It should be used for no other work but cookery, except that in moderately-sized houses it must be used as a servants' sitting-room, and in that case the whole of the arrangements for cooking should be together, well within reach, and all arrangements for washing up in a separate scullery, to which every article that has been used goes directly for cleansing. The common kitchen range is a disgrace to the nation; it is excessively wasteful of fuel, and monstrously dirty; with some

hours' notice it will roast a joint, beyond this there is nothing that it will do with any certainty or that other contrivances will not do better. A good kitchener should be fixed in a perfectly light place, burning coals that do not produce much soot and seldom require the attention of the sweep; several cooking vessels should be able to be used on it at once without becoming foul; they should be kept within reach, and upon clean shelves and hooks. Plates and dishes should be kept near the kitchener.

Where gas is laid on, a gas-stove with a proper flue should be added, as being useful for many purposes, available in a moment, and cleaner in all respects than a coal fire.

I have assumed that coal fires will be generally used in the house. This involves a place for storing the coal, commonly a dark, subterranean place; in fact, a coal pit reproduced, where the operation of coal getting is as closely as possible imitated from the operation of coal mining. Coals should be kept in a dry and very light place. I would willingly see the use of them diminished. For the present it will be found very useful to fit up in bedrooms and bath-rooms a gas fire in a common grate, in which a Bunsen burner is placed under a mass of asbestos. In a minute the glow of a coal or, let us say, a coke fire, is produced, and it can be extinguished the instant that it ceases to be required. The use of coal is the greatest source of dirt in the house. Fire making, stove cleaning, and the dusting and sweeping up of sooty deposits from the smoke, are a heavy tax on the exertions of servants, who have plenty of other work.

The scullery, as the spot towards which all the refuse of the culinary department and other places goes, deserves particular attention. In the first place, what is the legitimate refuse of the kitchen? Under any good system we should buy of the butcher exactly as much meat as we want—enough and no more. Cook it in some one of the many ways which we might select, serve, and, as a rule, consume it on the same day; put away any that is left, and use that on the next day. This is what is aimed at in the continental *ménage*. Under a good system our vegetables should always be bought as they may be bought in the country, and as a good gardener will bring them to the kitchen of a gentleman's house, free from all superfluous matter and quite clean. Foreigners who visit us now notice that about our domestic commissariat which was recorded by foreigners centuries since. We buy large joints, cook them wastefully, although the last ounce cost as much and was as good as the first. Poverty has taught our continental neighbours their economy. Is it necessary for us to wait till we have the same instructress?

Removal of Dust and Refuse.—The solid refuse consists of two sorts. That which is dry, as ashes and dust, and that which is moist and perishable—as the remains of cooked and uncooked food. In a country house the first goes to the ash-heap and is useful for different purposes, the second goes to the wash-tub and is the natural food of the pig. In towns we first mix these different articles together and put them into a dust-bin near the door, where they spoil each other. When the mass has become unbearable, men, who from their occupation must be exceedingly dirty, come through the house, fetch it away in baskets, tip it from a ladder into a very high cart, and take it away. At the dust-yard the mass has to be separated again into its several parts, each of them being by that time considerably damaged or quite spoilt for its legitimate use. We have seen that the finer portions of the dust mixed with the finest portions of the vegetable matter are used for plastering, which the London Building Act permits, though it is strong enough to forbid this stuff being used as mortar. Everybody admits the unsatisfactory character of the whole arrangement, and as public bodies gain strength and organisation, they are taking the matter into their own hands with a view to its amendment. In the city of London, and I think some other places, the daily removal of dust can be secured by putting it out at a certain hour in a pail at the edge of the pavement. In Paris, where its daily removal is enforced, you must throw your refuse into the street every morning between the hours of six and seven in summer and seven and eight in winter, and not at at any other time, What I should wish to do as a householder is to keep the different kinds of refuse in separate pails and get them emptied every day. In a country house these two pails should stand upon a small truck, and be drawn off, emptied, cleaned, and returned early every morning. In a town they might be fetched from the door and emptied into a low-bodied truck each morning at an hour at least as regular as that of the postman's visit, perhaps by boys dressed and organised like the rag collecting brigade. If the separate collection would not pay, I give that up, for as a householder, I am utterly indifferent as to what becomes of refuse so long as I get well rid of it, but the daily collection at the door I hope to see. I am aware that the vegetable refuse is often burnt, a mode of disposing of it which does not seem quite satisfactory.

Drainage.—Liquid refuse may at present be defined as anything that can be forced into the pipe of the sink. The sink should stand close to an outer wall and in full light. The old-fashioned sink of a farm-house has no bell grate, and is not connected with any drain, but the pipe is carried through a hole in the wall and discharges into an open channel made of channel bricks; the end of this channel is not always satisfactory, but it is at least quite clear of the house. Our sink-pipe may discharge over an open grating beneath which is a trap leading into a well-ventilated drain, and instead of the bell-grate it may have a common brass grate either loose or fixed. A cottage sink should discharge upon the open brick channel, which can be kept clean by daily flushing. I am not now dealing with the question of where the sewage is to run to—that is equally a question whatever mode we adopt of getting it out of the house. In towns it goes as straight as possible, by glazed earthenware pipes, into the nearest sewer. This pipe drain must have a ventilating pipe carried up quite above the highest windows of the house and away from the chimneys. The rule in Paris is that this ventilating pipe shall be carried above the highest chimney. There must be no second trap or other obstruction in the whole course of the drain or the ventilating pipe, and no hanging flap where the drain enters the sewer, so that the air from the sewer can pass freely up the drain, up the ventilating pipe, and into the outer air. This

applies to every house drain, and if it be objected that the result is to bring foul gas from the sewer through the house, the answer is that sewers as now constructed by a competent engineer are ventilated, and do not produce foul gas. Foul gas is produced in close unventilated house drains; it is in fact not sewer gas, but drain gas, and the air of the sewer is at least much more pure than it. The water supply, if obtained from a shallow well near the house, is almost certain to be contaminated by the accumulated impurities in the soil. It is worth while to have it analysed in case of doubt, and indeed in the absence of doubt, for water is liable to many sources of contamination. A common source is the draining away of foul water from the scullery sink along the side of the pipe which brings up the water from the well.

Every water-closet should be a valve closet, for though a common pan closet will keep longer in good repair, it is never clean, owing to the large surface exposed to impurities; and it is better to have an article that requires attention at rather long intervals than one which keeps its condition longer, but in which the condition is never quite satisfactory. The soil pipe from the apparatus to the drain should be so fixed as to be easily accessible for examination; it should be connected with the drain without the intervention of any trap. No hot water should be turned into it from the housemaid's closet or elsewhere, for when this is done the lead pipe will crack. The pipe must be ventilated by being continued up above the roof, as described for sinks. All cisterns should have separate means of discharge for surplus water, and should not discharge into the soil pipe. In fact, too much care cannot be used to make the passage of impure air from this pipe into the house impossible, as each fresh opening to it is a fresh source of danger.

The water must be supplied direct from the main or the house cistern to a small cistern used for the closet only. There must be no "waste preventer" or other obstacle to the regular action of the apparatus, or interrupted action will be frequent. The "waste preventer" is, however, made necessary by Act of Parliament in London, but the Act is deficient in not pointing out the particular contrivance which will perfectly carry out the object. The closet, when of the best quality, and so long as all parts of it, with its cistern and drain, are in good condition, leaves nothing to be desired in respect of cleanliness and freedom from trouble. It is the chance of the apparatus being of inferior quality, the extreme likelihood that some part of the system has been stupidly arranged or carelessly fitted, the certainty that some part of the work will sooner or later get out of repair, and the uncertainty as to whether any of these things have happened or not, that cause a desire for some kind of substitute. There are, besides, a vast number of cases in which it cannot be employed, and there seems to be a prospect that difficulties in the disposal of large quantities of sewage may increase in number. A perfect system would be one in which all liquid refuse should be drawn off by exhaustion—the reverse of the delivery of water to the house by pressure. The difficulties in the way of such a scheme are probably mechanical, not financial.

Of all suggested substitutes the earth closet is the only one that is satisfactory, and it is only applicable where there are facilities for frequent attention and perfect means of ventilation. Wherever it is put there must be means of access for bringing and for clearing away the earth without entering the habitable part of the house even by a back door. For cottages and country gardens the earth closet would be a vast improvement upon the existing out-door arrangements. Earth only must be used and not ashes, which are not a perfect deodoriser. The earth after being used must be dug into the garden as soon as possible, and not used several times over, our object not being to make manure but to get rid of dirt. Although more has recently been said on the subject of closets, sinks, and drains, than on any other subject relating to the sanitation of houses, few persons pay the slightest heed to what is said. I may say, that being in the constant practice of surveying house property, I hardly remember a single instance of a house, however good, and occupied by people of whatever position and degree of intelligence, that did not prove to be void of the most important precautions for preventing the access of foul air. The closets are constantly badly trapped, and so arranged that in houses otherwise good the closet has no direct light or ventilation, and the inhabitants of the house get accustomed to the smell and the smell of chloride of lime which they constantly keep and use. I exhibit a drawing showing the arrangement of the closet drainage in a house which is one of a row of handsome, well-built, well-tenanted houses, in which the drainage was supposed to be carefully arranged. Judging by this sample every house of the row has a large deposit of the foulest matter immediately under the floor, and the poisonous gases emanating from this matter must escape not only up the staircase, before the doors of the family bedroom, dressing-room, and nursery, but into the space over the water supply, stored up in a carefully covered cistern. In this house the whole of the family and servants were made seriously ill, and on examining the short branch by which the closet was joined to the soil-pipe, the upper portion of it was found to be quite decayed, and of necessity discharging the whole of its foul air into the house. The smell noticed was the faint sickly smell to which townfolks grow accustomed, not the strong odour of recent sewage. Being called upon by the intending purchaser of a new and well-built leasehold house on some country property of a nobleman, I found that the builder had in perfect innocence so arranged the cast-iron soil pipes, as shown by the drawing, that drain gas must discharge into the house. It would be tedious to multiply examples; neither of these is worse than may be found in any house, the drainage of which has not been made a matter of careful study quite recently, and since the danger of foul gas was more clearly recognised.

Miscellaneous.—In the routine of the house, it is the business of some responsible person to see that all locks and fastenings upon outer doors and windows have been made right before retiring to rest. Some one should also look to those parts of the house where neglect of precaution may lead to the admission of impure air during the hours of night, when change of air is not so readily effected as in the active

hours of the day. Every sink should be left clean at night, and flushed with water. In scullery sinks hot water should be frequently poured down, in order to cleanse the entrance to the drain from deposits of fat. Every closet should be flushed at night by the discharge of water, in order to clear away from it the foulness which remains in the trap below the apparatus, which trap, few persons know, usually retains the contents of the pan of the closet until the next time the apparatus is used. On all occasions of a visit to that locality the flushing should be done not once only, but two distinct times. When a house is left for some weeks while the family are away, the person in charge should, besides regularly cleaning and ventilating, and, if necessary, warming the premises, regularly flush all the sinks and closets; for when a house has been for some time unoccupied, the condition of these places often becomes very foul. In all respects it is best to let the premises be kept as much as possible in their ordinary condition of use. Closets in the house that are only used occasionally are sure to become inefficient in action, and they require particular attention by flushing them every day.

I have included as one of the elements of comfort "freedom from worry." We know what it is to have work hastily and inefficiently done, even when all the annoyance of getting it done has been suffered. At this moment the daily troubles of nine-tenths of the houses in this metropolis and the country, where servants are kept, is their scarcity and their inefficiency for useful work. I believe the cause of this to be the discomfort of the parts of the house where they have to live, and the dirty nature of the work that is expected from them. There is a London newspaper, having a circulation chiefly local, which contains every day 200 advertisements for female servants, and as to two-thirds of these it would be fair to say that it is an essential though an unprinted condition for the applicant that she should be a slut. Those who are neat, cleanly, fairly educated, intelligent, active, can get their livelihood in what they think to be better ways. The female members of the family having been driven from occasional work in the culinary department by its increasing incompatibility with a cheerful existence, the best of the class from which servants ought to be derived have left it too. There is nothing in a household, properly arranged, which need necessarily be so repulsive; that which makes the home cleaner and sweeter will tend to restore the work of the house to a more satisfactory condition.

I have endeavoured in this paper to keep the subject confined as closely as possible to matters within the house—to turn the lantern, which we sometimes use with good effect upon our neighbours' business, for a moment upon our own. Little if anything that I have said is new, and much that might have been said is necessarily omitted. I fear that in many places the blanks are too obvious, but I trust that this question, which so closely concerns every person, will by means of this discussion be brought before a wider audience. I hope that questions of health and comfort will stand forth more and more prominently amongst the items of education, the subjects of common talk and the objects of our aim, both publicly and in the daily routine of private life.

DISCUSSION.

Mr. Hale thought more attention ought to have been paid to the legislative side of the question, and that more stringent measures were required to ensure houses being properly built. He had found a very efficient means of ventilation was to place a slip of wood underneath the lower sash of the window so as to allow a small passage for air between the two sashes. He quite agreed in the remark that almost universally too much gas was burnt.

Mr. Bartleet would be glad if the lecturer could point out any gas stove which would give as much warmth as a coal fire, and at the same time be free from offensive vapours. He feared we should never get thoroughly fresh air until it was laid on from Brighton or some seaside place, like gas and water.

Mr. Christopher Cooke expressed his concurrence in the views enunciated in the paper, and referred to a new method for warming artisans' houses by means of hot water, recommended by Mr. Eiloart.

Mr. A. Payne could not agree in the statement that there was no gas which could be the cause of danger in a well constructed sewer. He considered sewer gas always dangerous, and that it should be kept out of houses at any cost. There should never be direct communication from a sink to a sewer, but it should pass through the outside wall to an open drain. He feared it was almost impracticable to remove dry refuse from houses daily, for he knew a town in Lancashire of 100,000 inhabitants, where, there being no sewers, the refuse was removed weekly, and there the cost was £5,000 per annum; if that were multiplied by seven it would be a very serious matter. He had lately seen a most effective and economical method of warming a house by means of a stove, arranged as follows:—The house consisted of two rooms, one above the other; the stove was placed in the lower, and the fire passed up through the upper one and out at the roof; surrounding the flue was an outer casing supplied with fresh air from outside, which passed up and opened against the ceiling of the upper room, where it diffused the air which had been warmed by contact with the flue. The great difference between English and German fireplaces was that the former wasted all the heat of the chimney.

Mr. Charles White expressed himself rather disappointed that the arrangements of artisans' dwellings had not been referred to.

Mr. Botly said the effects of gas on furniture, pictures, and plate was most prejudicial. With regard to house refuse, a friend of his lately told him that he had lived in one house fourteen years, and during all that time had not had a single load of rubbish taken away. Kitcheners would be a great improvement in most houses, and it was a matter of primary importance that the cistern supplying the water-closet should be distinct from the one supplying the water for drinking purposes.

Mr. H. H. Collins thought the paper an admirable one; he believed the less law there was on the subject the better, but the true way to improve matters was that which Mr. Blashill had adopted, to try to educate the public in true principles. There was one point in connection with water-closets worse than the sewer itself, and that was the D-trap almost universally in use, which formed in reality a small cesspool under each closet, for it was always coated with fæcal matter, the emanations from which were discharged into the house every time it was used. Mr. Banner, an African merchant, having his attention directed to this point, had devised a system which removed all possible annoyance, and he could speak from personal observation as to its perfect success. Having roughly sketched on the black board the plan adopted, a main feature of which was the introduction of

a pipe from the outer air into the sewer pipe so as to cause an upward current, he referred to a new system for covering walls by means of wood veneer; this had the appearance of parquet work, but at much less expense, and could be very readily cleaned; and concluded by saying that he never allowed any kitchen or scullery refuse to find its way into the drain, but intercepted it by a tin cup in the trap, which might be emptied at intervals.

Mr. Swale said he had been for a long time engaged in trying to carry out the principles laid down in the paper, which he thought might be usefully studied by medical officers of health, who were constantly telling people what they should not do, but rarely informed them what they should. He was now engaged in removing the refuse from the city of London, and should like to know the secret of the gentleman mentioned by Mr. Botly, for in London they had to remove from 600 to 800 tons of rubbish per week, and the amount was constantly increasing, although not many people lived in the city. He should be very glad if the daily removal could be effected, but thought more legislation was required. The public, especially the richer classes, were very difficult to deal with, and did not by any means thank you for your impertinence in pointing out any sanitary defects. It was too much the fashion to entrust all matters connected with the removal of refuse to the lower classes, whereas there was hardly anything in which it was more important that educated and intelligent persons should take an interest.

Mr. Hall was pleased to hear the Paris system of daily removal recommended, though it was not quite accurate to say that the deposit of refuse took place in the early morning. It was placed in the street at night, and removed in the morning. A similar system was adopted in Scotch towns with perfect success, the removal being more than once a day, and the refuse being deposited in receptacles at the edge of the footpath. Whenever cholera prevailed in London the same system had been adopted, but on the departure of the epidemic the old plan of keeping the refuse in the houses was again resorted to. The suggestion for making a separation between the different kinds of refuse was an admirable one, and much of the vegetable matter might be burnt and would prove useful as fuel. He considered it a serious defect in Mr. Cross's Act that there was no provision made for the regulations of the new buildings to be erected, the result of which would be, he feared, that the existing defects would be repeated. Besides, it was a great mistake to enact that all the inhabitants displaced from the area treated should be accommodated in the same area or its vicinity, which was impossible if proper approaches were constructed and sanitary conditions complied with. He did not think, therefore, that very much good would be accomplished by the Act. A great deal might be learned from Paris, where working men could find accommodation within a convenient distance from their employment much more easily than in London.

Mr. Botly said that was quite true what he had before stated, and he himself had lived 15 years in one house without having a load of refuse taken away. Everything was reduced in the kitchener to fine ashes, which were spread on the lawn.

The Chairman, in proposing a vote of thanks to Mr. Blashill, said his paper was in fact but a text, upon which a much longer sermon might have been preached. The question of house accommodation lay at the root of civilisation, but it had been sadly neglected. He quite agreed with what had been said, that people did not as a rule thank you for pointing out the defects of their habitations. If you pointed out the defects in a house, you got no thanks for your pains, unless by chance you met with a person of common sense who valued his health more than his pocket. Health, comfort, and cleanliness were the most important feature in every home, but they were sadly neglected, from the meanest cottage up to the palace. In ordinary houses, before the flooring was laid down, all the bricklayers', carpenters', and plasterers' rubbish was swept in between the rafters, and the condition of the basement was generally abominable. If no concrete was laid down you had the native subsoil giving off its emanations, besides all this accumulation of dirt and rubbish, and he need hardly say, that whatever was the atmosphere of the basement, the same would be the condition of the whole house right up to the roof. No amount of grand furniture, or beautiful decoration, would make up for a filthy basement. He had lately examined the residence of a gentleman, containing pictures, furniture, &c., to the value, probably, of a million sterling, and found the whole basement ramified by drains of the foulest kind. There were upwards of forty water-closets in the house, and yet, from the basement, no particle of refuse, fluid or solid, had ever passed since the house was built. It had soaked away, been absorbed, accumulated in the great drains, or evaporated upwards; and he ventured to say that that was the condition of many large houses which had not been examined and put to rights within the last 20 years. Whatever might be the law in France and continental towns, it was not carried out; for during the last autumn he had visited the Continent with the express purpose of examining into these matters, and he found that refuse was brought out at all hours of the day, in some cases left in boxes, and in others tipped over into the street, where it remained until it was carried away by the dust carts, and in some cases the contents of the water-closets were included. He had seen this both in Belgium and in Paris. In this world there was no value but in human life. Remove human life from this mighty mass of wealth in London and it would become a vast heap of rubbish; and if human life were the only source of wealth, healthy human life must be the highest kind of wealth, and nothing could be expensive which tended to improve and to keep that life healthy. Of what value was £10,000 a year to a man if he lived under conditions which created disease? Unfortunately Englishmen seemed bent on blindly accumulating wealth, under the idea that the great aim and end of all was to have a large sum to bequeath by will at death, but no greater mistake could be made. After all it was a question of education. The rising generation must be taught to take care of their own health, for without that all legislation would be futile. Health and its true conditions could not be disregarded, and many persons, as he knew by personal experience, afflicted with what was termed delicate health, owed their prolonged life to the care which they took of themselves; and he himself had seen scores of men apparently possessing three or four times his strength, go to their graves simply from the reckless way in which they chose to live.

The vote of thanks having been passed,

Mr. Blashill, in reply, said he had been compelled to omit many points for want of space, and amongst them was that referring to legislation. He was, however, of opinion that much stronger measures were required for the inspection of houses, even of the better class. He did not see why any house should not be inspected when it was vacant. He had avoided the subject of working men's houses because they were separately dealt with, and could not be treated with the same freedom as those occupied by the wealthier classes. The best thing for a working man to do was as they generally did, to buy their food from hand to mouth, and next to get as soon as possible into a better house. And he was thankful to say that in this country every working man had a chance of getting into a better position. With regard to Mr. Cross's Act, which had been referred to by Mr. Hall, he had had occasion to study it carefully, and it would be found that it was not absolutely indispensable to locate all the inhabitants of a given area in the same spot. There was a loophole left in case of necessity. As to the

kitchens, they should be put at the back of the house, or if they must be in the basement it might, by the aid of reflectors and other appliances, be made as light and as well ventilated as any other part of the house, as was frequently done in the City.

After the end of the discussion, a machine was exhibited intended to enable persons to write, or rather print, without using a pen. The machine in appearance somewhat resembles an ordinary sewing-machine, being mounted on a stand of the size and appearance of a sewing-machine stand. In front there is a key-board with the letters of the alphabet, numerals, &c., upon it; and on pressing any one of the keys a small lever bearing the corresponding letter is caused to strike against a ribbon saturated with a prepared ink over which the paper is held on a roller. Each letter strikes in the same spot, but the roller with the paper moves a space forward after each letter, so that they appear on the paper in their proper place. The mechanism is very simple, the levers carrying the letters being actuated by a similar arrangement to that of a piano, and strung on a circular wire so that they all strike into the centre of the circle. By the action of a treadle, as soon as a line is finished, the roller is traversed back to its original position, and at the same time it is revolved one tooth of a ratchet wheel, so as to bring a fresh line under the operations of the apparatus. The type is all "small capitals," and the printing is perfectly regular and even. It is stated that after a little practice, any person can work twice as fast as an ordinary writer, and that a skilled operator can gain a very much greater speed. The machine can be used for "manifolding" with the ordinary thin paper and carbon paper, some nineteen or twenty legible copies being obtainable. It is an American invention, and has been brought out by the Remington Sewing-machine Company.

MISCELLANEOUS.

ENGLAND AT PHILADELPHIA.

The following remarks are made by *Engineering* on the present condition of the Exhibition and the new changes in the staff of the British department:—

In the *London Gazette* of Friday last was published a list of the intending English exhibitors at the International Exhibition to be held at Philadelphia next year. This list does not include any exhibits of fine arts, horticulture, or live stock, and it is exclusive of contributions from the colonies, but otherwise we presume it may be regarded as practically complete, since those few exhibitors who will be admitted at the eleventh hour, will probably take the places of those who will fail to exhibit at all. About 700 of all classes—with the exception of those above-named—are included in the list, but we observe with regret that by far the great proportion of this number propose to send to Philadelphia objects of very minor importance, samples rather of special trade produce, than types of representative industry. The number of exhibitors of machinery is under thirty, and only a part of these propose to send objects of much real interest. Steam engines are to be sent only by Messrs. Aveling and Porter, who propose to send a traction engine, crane, and road roller; by Messrs. Appleby Brothers, who will exhibit a steam crane; and by Davey, Paxman, and Co., who have entered a small steam engine and boiler for exhibition; while Ransome, Sims, and Head have applied for space for their straw-burning portable engine. Steam boilers will be represented only by Messrs. W. J. Galloway and Son. Agricultural implements are to be shown by two firms, Davey, Paxman, and Co., with their corn dryer, and J. P. Fison with thrashing machines and ploughs. Railway signals will be contributed by three or four manufacturers, and Mr. C. W. Siemens' name is entered as an intending exhibitor of a metallurgical furnace. Mr. E. Green will show his economiser, and Messrs. Cammell and Co., and Sir John Brown and Co. will exhibit samples of armour plates. Several important printing machines will be sent to Philadelphia, amongst others the Walter and the Victory presses, while small arms will be represented by numerous makers. Three or four coal-cutting machines, and a few textile machines practically complete the list of mechanical subjects. On the other hand scientific and horological instruments will appear in fair numbers, as well as artificial manure, building materials, fire and other clays, carriages, fabrics, photographs, and food preparations; but the whole list is a very poor and unsatisfactory one, and leads us to expect but little of the English display. That the contributions are so meagre is much to be regretted, because although, at the present time, the United States offer but a poor and partial market by reason of prohibitive import duties, the Exhibition of Philadelphia will be crowded by wealthy visitors from all countries, where such duties do not exist, and with whom English exhibitors would secure large and profitable business, which must now of necessity be tranferred to American manufacturers, who could not compete in the open market with English makers. For every reason, therefore, it is to be deeply regretted that in so great an exhibition as that will be next year, this country will take so small a share. At Vienna it was far different, for there amidst numerous difficulties which will not be known at Philadelphia, we made a most successful if not a very large show, and the British Section, both as regards its exhibition and Commission, took a leading place. How well that Commission performed its arduous work, in spite of the greatest pecuniary and other difficulties, and how Mr. P. C. Owen devoted himself incessantly to the interests of exhibitors, is now almost a matter of history, and it was hoped that at the coming Centennial celebration, England would be as well represented, if not by her manufactures, at least by her official Commissioner. A liberal money grant has been awarded to the Commission, and the feeling on the other side of the Atlantic, from the first one of warm friendliness, had been kindled into something very like enthusiasm, thanks only to Mr. Owen, who brought the Commission at Vienna satisfactorily through its difficulties, and who had been prevailed upon to accept an equally onerous post at Philadelphia.

It is with a feeling therefore of deep regret that we find Mr. Owen has resigned the position he had thus undertaken. Why he has done this, it is not our province to inquire, but we know that his resignation will be at once a disappointment to the exhibitors, and a loss to the country, whilst this feeling on the other side of the Atlantic has been already made public. We think we state the belief of all those exhibitors who had experience at Vienna, that Mr. Owen is the only man in whom perfect confidence could be placed for this work, while the unknown and untried delegates who step into his place appear to have no special qualification for the position. Setting aside his administrative capacity, he had learned those lessons which are indispensable for a thoroughly efficient commissioner, and which can be only acquired by experience. The joint commissioners who succeed him, no doubt possess the raw material out of which the requisite administrative qualities and sound judgment may be fashioned, but their names carry no weight, their past positions bring not a shade of influence to help them in their coming duties, they are utterly without the needful experience, and we fear they will be found wanting in those characteristics essential to a successful completion of the work intrusted to them, and which Mr. Owen possesses to so marked a degree. It is true that their duties at Philadelphia will probably

be comparatively light, and so may possibly be performed, if the assistant staff be efficient, without actual dissatisfaction to the exhibitors, but the English Commission at Philadelphia should have a higher aim and wider scope than mere routine work—the establishment of firmer and more mutually beneficial relations between the two countries. Had Mr. Owen not resigned we feel sure that this aid would have been achieved, but now we fear it will not be even attempted.

The morning papers of Wednesday contained the following notice :—The Lord President of the Council has been pleased to appoint Mr. A. J. Trendell to the post of Secretary to the British Executive Commission. Mr. Trendell, from his connection with previous exhibitions, is well and favourably known to British exhibitors.

CORRESPONDENCE.

PRODUCTION OF STEEL.

Sir,—I see in the programme of the Society's proceedings that a paper is to be given on the production of steel, by means of "pure carbon" directly from the ore.

In my memoir read to the Society in November, 1873, I touched only incidentally upon this subject, and I exhibited some samples of steel so produced; but, of course, no report was given of this digression.

I do not presume to anticipate a gentlemen who is about to lecture on this interesting subject, but, having made many laborious and costly trials of the same kind, it occurs to me that even to them an attempt to define the exact conditions of the problem itself, and the difficulties attending its complete practical solution, may not be without its use.

All the ores of iron contain in addition to the peroxide or the protoxide of iron, or both, a certain quantity of earthy matters, principally silica, alumina, lime, and magnesia, one or more as the case may be, and some of them more rarely a notable percentage of an oxide of manganese or of titanium.

Now, these foreign matters it is indispensably necessary to reduce into the form of a cinder or scoria as free as possible from any oxide of iron. It will seldom happen that this can be done without the addition of a flux, but, done it must be if we are to have a clean metal free from scoria, and therefore of maximum density. For, if the scoria in virtue of its contest of protoxide of iron (a silicate) be heavy, it will be inevitably entangled in the mass of the ingot, and thus, when this ingot is cogged down and tilted into a bar, the bar will be found to contain "shells," or "cracks," and be quite unsuitable to its principal destination, the fabrication of edged or cutting instruments, and of other forms requiring perfect continuity of mass. The method which I adopted was to examine carefully the analyses of different kinds of glass, selecting as the model for my scoria that which was the most fusible, and the most free from metallic oxide, which I found to be a glass analysed by Dumas. Then, knowing by direct analysis the average earthy composition of my ores and fluxes, I so combined them that the aggregate earthy compound should agree in its composition with that of the model glass selected. (The computation requires only simple algebraical equations of three or more unknown quantities.)

The next point was to determine quantities of pure carbon respectively required.

1. To deodorise the ore.
2. To cement the metal up to the requisite degree of hardness or temper.

The first condition is readily fulfilled when we know accurately the degree of oxidation of the metal, and the percentage weight of the oxide in the ore, for we have only to calculate how much carbon is required to combine with the oxygen, so as to form carbonic oxide or carbonic acid, by means of the heat employed.

For the second condition, as we know the weights of iron in a given weight of the ore, we have only to calculate how much carbon is required to produce the given degrees of cementation, temper, and hardness. In both cases allowance must be made for the contents of the charcoal other than carbon, and the nett weight of the latter employed. These contents, however, are only beneficial additions to the flux.

According to the authority of Mr. Fremy, nitrogen is always present in good steel; and certainly the sprinkling of the charcoal with a solution of ammonia has a beneficial effect, a conclusion supported by the practice of exposing charcoal to the air for some time previously to using it in the cementing furnaces, during which time it absorbs ammonia.

As the result of the above arrangements, in the first trial which I made in a large pot (crucible) filled with the materials so mixed, I obtained the most perfect ingot I ever saw. Its "skin" was mooth as silk, and so perfect was the metallic reduction that the scoriæ floating on the top of the ingot, presented an almost transparent glass, containing not .05 per cent. of oxide of iron.

The ingots so made were treated as usual, and drawn into bars, from which (acording to temper) files, razors, knives, surgical instruments, tuning and other tools, taps and dies, &c., of surpassing excellence were made. Yet, sometimes, quite unaccountably at the time, the bars would not "stand tho hammers," though made from the self-same materials, in the self-same proportions, and melted in the very same manner. Having my suspicions as to the cause, I determined to see the stuff mixed, the pots filled and put into the furnace, and I remained in the melting-house until I had seen them drawn, and their contents poured into the ingot moulds. Such ingots always "drew well." I had occasionally surprised my smelter on his back, and in a decidedly comatose state, in the production of which that fine aromatic, the hop, had evidently had a large share. This and the subsequent disclosure of the practice of "rattening" have enabled me to form a very decided opinion on the subject, and remembering what effect a few lucifer matches would produce, which contain both phosphorus and sulphur, I advise my brother inventors to look sharp lest any moral elements should enter the smelting-house during their experiments, and so enter their crucibles in such company : they cannot act with too great precaution and vigilance in conducting operations so critical; for they cannot exaggerate the desperation and absence of all scruple with which invested capital clings to old methods.

"Incedis per ignes
Suppositо cineri doloso !"

One very severe test to which this ore steel was submitted was the casting of cams for the rings of driving wheels, which was done in cast-iron moulds in the first melting from the raw ore. These cams worked for years heavy machinery, standing admirably the shocks against the tails of the hammers. There is, I believe, now a new and superior mode of making moulds; with such an appliance I have no doubt but that a great variety of useful articles may be made from the ore, which would requiro only grinding, tempering, and polishing. This would save the cost of converting, wetting, cogging down and tilting the bar, and of finally forging the article itself, on the whole a large sum per unit.

In any other form I would not advise this direct process, unless it be for the finest steel, wherein quality is everything, and price is little or no object; the same applies to the more costly refining and conversion of cast-iron. In all cases, ores free from phos-

phorus must be selected and well calcined to expel sulphur.

For large castings, to be used in heavy work, steel of sufficiently good quality may be produced by the refining and conversion of suitable cast-iron.—I am, &c.,

F. C. Knowles.

Mayfield, near Ryde, Nov. 30, 1875.

SUGAR DUTIES.

Sir,—Will you permit me to correct a very natural error in the report of my remarks in the *Journal* of December 10.

In defending the system of refining in bond, I said that the very best proof that it could be carried out with success, and without vexation to the manufacturer, was the fact that every factory of beetroot sugar in France, of which there are between 500 and 600, producing 450,000 tons of sugar annually, is worked under the bonded system, that is, under the constant supervision of the Excise; and that the fabricants, far from complaining of the system, gave most emphatic evidence before the Superior Council of Commerce, in 1872, that it was a security and not a hindrance to them. I then pointed out that the fact of the 450,000 tons of indigenous sugar produced in France being manafactured in bond, made the resistance to refining in bond the more unreasonable, since the elaborate organisation necessary for carrying out the system was already in existence, and in the full perfection of working order in above 500 factories, and the evil now complained of could be effectually got rid of by simply extending the same system to about a score of refineries which receive the sugar after it leaves the factories.—I am, &c., George Martineau,

Secretary, British Sugar Refiners' Committee.

21, Mincing-lane, Dec. 11, 1875.

NOTES ON BOOKS.

Introduction to Experimental Physics. By Adolf Weinhold. Translated by Benjamin Loewy, F.R.A.S. London. Longmans, Green and Co. 1875.

It may certainly be admitted without much question that the most successful teachers of physics are those who have succeeded in introducing into their course of teaching the greatest possible amount of experimental work. The number of minds so constituted as to be capable of appreciating readily the mathematical side of physical studies is much smaller than that which includes the perhaps lower, but certainly more common type of mind which requires the concrete phenomenon itself to be brought before it, before it can grasp it and realise it to itself. And even to students whose minds are trained by previous mathematical work, there is great gain from a course of experimental investigation. It sharpens and defines ideas generally somewhat vague and uncertain, and it lends a fresh interest to the work, which it also impresses on the mind in a way no abstract study can ever impress it. The absence of any complete text-book for the experimental study of physical phenomena is the want Professor Weinhold has endeavoured to supply by the present work, while M. Loewy, in translating the *Vorschule der Experimental-Physik*, gives it an extended usefulness by thus placing it in the hands of English students and teachers.

Following the usual practice of this *Journal*, and declining to express any opinion, favourable or other, on the merits of the book, the reviewer may best accomplish his task by attempting a brief account of its contents. The chief characteristic of the book is that from first to last there is scarcely one, of the long series of experiments described, for which minute directions are not given as to the construction of the apparatus employed. In the descriptions of the first-mentioned pieces of apparatus, directions are given for soldering, cutting and drilling metal (including methods of making, tempering and sharpening drills), cutting glass and working in glass (such as manipulating tubes and putting up the simpler sorts of apparatus), and an infinity of the other various devices which the practical chemist or experimentalist must of necessity learn in one way or another, either by the instruction of some most skilled worker, or from his own experience. From a pinch-cock for india-rubber tubes, or an electrical binding-screw, to a spectroscope (of a simple character of course), no piece of apparatus is introduced without minute and full instructions for its construction.

The book commences with an introductory chapter on "General properties of matter." Then comes "Mechanics, or the equilibrium of bodies (statics) and the motion of bodies (dynamics);" this is divided into the following heads: "General Mechanics, and mechanics of solid bodies," "Hydrostatics and Hydrodynamics," "Aerostatics and Aerodynamics." Chapter three is devoted to Acoustics. Chapter four to Optics. Then comes Electricity, "Frictional," "Contact-Electricity," "Electro-Magnetism, Magnetism, Induction by Currents." The last chapter is on Heat. Besides numerous woodcuts, the book is illustrated with a coloured view of the spectra of some of the metals, a Geissler's tube, and a "Newton's disc" for showing the composition of white light by the union of the prismatic colours. This last is in duplicate, so that one may be cut out and used for the actual experiment.

GENERAL NOTES.

Meat Preservation.—M. E. Ador has submitted to the members of the *Académie des Sciences* some samples of fresh meat from Buenos Ayres, preserved by M. Herzen's method, which consists of soaking the quarter carcases for from twenty-four to thirty-six hours in a solution containing two parts bi-borate of soda, two boric acid, three saltpetre, and one muriate of soda, to 100 parts water. After soaking in this pickle a sufficient time, the meat is packed in barrels with a small quantity of the solution; and all that has to be done to prepare it for use is to soak it in fresh water for twenty-four hours. Another method is adopted by M. Regnoso, who makes use of the compressed gases, oxygen, nitrogen, hydrogen, &c.; and he appears to have been perfectly successful, as he says that he has seen the blood run from joints of beef carved after having been subjected to his process for forty days.

Printing Ink from Gas Tar.—Two French chemists, Mons. Persoz and Jeannolle, have taken out a patent for making ink for letterpress printing, lithography, and autography from the refuse of the gas works, from other tar, and the heavy oils of petroleum, resin, wood, &c. The inventors say that these substances present valuable qualities for the purpose, that they mix readily with lamp black and other dry colours in powder, and that the ink made from them has the grand advantage of neither penetrating the paper, nor spreading, and, lastly, that it may be mixed in any desired proportions with the fatty oils for certain classes. For black ink for typographic printing the inventors use what they call evaporated tar, or liquid pitch, with lamp black and Prussian blue in the following proportions:—

Tar	100 parts
Lamp black	36 ,,
Prussian blue	10 ,,
Glycerine	10 ,,

For coloured inks they nse the heavy oils, purified as far as possible from the tarry matters, which give a brown tint, with the colouring matter in powder.

The Flax Trade in Russia.—The Commission charged by the Russian Government with organising at St. Petersburg an exhibition of plants suitable for textile manufactnre, and of machines for weaving, has addressed to the Government a report which contains the latest statistical information as to the cultivation of flax and tho production of the woven fabric in Russia. The following figures give in kilogrammes (1 kil. = 2·2lb.) the yearly production of flax in the different countries of Europe:—

Russia	192,000,000
Austria	43,952,000
France	38,096,000
Belgium	19,056,000
Great Britain	17,088,000
Italy	12,208,000
Bavaria	8,800,000
Saxony	3,424,000
Other European countries	7,328,000
Total	341,952,000

It will be seen that Russia is not only the largest producer of flax, but also that her products alone exceed those of all other countries put together. Notwithstanding this enormous production of the raw material, the manufacturers of linen fabrics are far from occupying in the textile industry of the country that preponderance which it would seem they ought to have acquired. In fact, the cotton mills, and those for the manufacture of stuffs which have this substance as their base, are much more numerous then the flax works. There are 759 cotton mills, employing 122,000 hands, while not more than 111 flax works exist, giving work to only 2,000 hands. The commission attributes this state of things, in the first place, to the defective means adopted by the growers for gathering in the plant itself, and to the rude appliances still in vogue for its preparation, and, in the second place, to the inconvenient situation of the works, which are often very far from the place of production. The commission recommends that good methods of cultivation be popularised, that the improved machines and processes employed in other countries for treating the stalks be introduced into Russia; and, lastly, that money inducements be offered for the establishment of new works in the centres of production.

NOTICES.

THE LIBRARY.

The following works have been presented to the Library:—

Bamboo, considered as a Paper-making Material, by Thomas Routledge. Presented by the Author.

Milk in Health and Disease, by A. H. Smee, F.R.C.S. Presented by A. Smee, Esq.

The Origin of the Stars, by J. Enniss, A.M. Presented by the Author.

Timber and Timber Trees, native and foreign, by Thomas Laslett. Presented by the Publishers, Messrs. Macmillan.

Reports of the Inspectors of Factories, for the half-year ending 30th April, 1875. Presented by A. Redgrave, Esq.

Théorie des Vibrations et Considerations sur l'Electricité, par Frédéric Kastner. Presented by the Author.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

The following arrangements for the remaining Wednesday evening before Christmas have been made:—

December 22.—"A method of producing Pure Charcoal Steel directly from the Ore," by Henry Larkin, Esq.

Cantor Lectures.

The remaining lecture of the first course of Cantor Lectures for the present Session, "On the Discoveries and Philosophy of Liebig, with especial reference to their influence upon the advancement of Arts, Manufactures, and Commerce," by **J. L. W. Thudichum, M.D.**, will be delivered on the following Monday evening:—

Lecture V.—December 20.

Therapeutic agents and collateral discoveries, chloroform, chloral.—The way from detailed labours to general scientific principles and laws.—Liebig's philosophy as influencing mode of thinking of present generation.

The lecture will be illustrated by selected experiments and demonstrations.

Special Lectures.

A series of reports has been prepared by Dr. Richardson, appointed by the Council to make special inquiry into the subject of "Unhealthy Trades." The remaining lectures of the series will be delivered on the following Friday evenings:—December 17th; January 21st, 28th; February 4th.

The subjects considered in this course include:—

The influence of physical labour on individual and national vitality.

Injuries incident to physical labour. (1) By exposure to dust and other foreign substances. (2) By exposure to noxious gases and heated and impure air. (3) From mechanical concussions, peculiar postures of body, and excessive exertion.

Diseases incident to workers in the potteries, in trimming and furniture dressing, in sand-paper making, in flour-mills, amongst old rags, in fur dyeing, in walking-stick making, in hemp dressing, in patent leather dressing, &c.

Diseases of paviours, carpenters, blacksmiths, postmen, scriveners, &c.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Dr. Thudichum, "The Discoveries and Philosophy of Liebig, with special reference to their influence upon the Advancement of Arts, Manufactures, and Commerce." (Lecture V.)
Medical, 11, Chandos-street, W., 8 p.m.

Tues....Women's Education Union (at the House of the Society of Arts), 6 p.m. Mr. Sonnenschein, "A Method of Teaching Arithmetic."
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Annual General Meeting.
Statistical, Somerset House-terrace, W.C., 7¾ p.m. Mr. John Dun. "Analysis of the Joint Stock Banks of the United Kingdom."
East India Association, 20, Great George-street, S.W. The Rev. James Long, "The Present Position of Turkey in Relation to Indian Interests."
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. Henry Larkin, "A Method of Producing Pure Charcoal Steel directly from the Ore."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Thurs...Civil and Mechanical Engineers, 7, Westminster-chambers, S.W. Mr. A. T. Walmisley, "London-bridge and its Traffic."

Fri.......Quekett Club, University College, W.C., 8 p.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,205. Vol. XXIV.

FRIDAY, DECEMBER 24, 1875.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The competition for the four free scholarships given by the Society will take place in London in February next. The competition will be restricted to nominees of members of the Society, each member having the privilege of nominating two candidates, one of each sex. Forms of nomination, and all information as to the terms and conditions of the competition, may be had by applying to the Secretary.

INSTITUTIONS.

The following Institutions have been received into Union since the last announcement:—

Christchurch Working Man's Institute, Hants.
Islington Youths' Institute, St. George's-hall, Richmond-road, Barnsbury, N.

REGISTRATION OF TRADE MARKS.

Since the last announcement, the Committee has held two meetings: on December 10th and December 15th. Present, December 10th—R. Bartleet (in the chair), S. Christy, Edmund Johnson, J. S. Mercer, J. S. Salaman, P. L. Simmonds, E. M. Underdown, and H. Trueman Wood. Present, December 15th—R. Bartleet (in the chair), Theodore Aston, Q.C., Edmund Johnson, J. S. Mercer, J. S. Salaman, P. L. Simmonds, E. M. Underdown, and H. Trueman Wood.

The Committee at its various meetings considered in detail the question of the rules for registration, and concluded by approving the following draft scheme, which was forwarded to the Lord Chancellor, who had previously expressed his readiness to receive them. The letter accompanying the resolutions of the Committee is appended at foot.

Suggestions applicable to Rules proposed to be made under the Trade Marks Registration Act, 1875, drawn up by a Committee of the Society of Arts.

1. Any person desiring to register a trade mark shall apply for registry as follows:—

He shall deposit at, or transmit to (by post or otherwise), the office of the Commissioners of Patents, a statement in writing, containing, the following particulars:—

(*a*) His name in full.
(*b*) The name under which he carries on business.
(*c*) The style of the firm (if any), and the names of the partners thereof.
(*d*) The place of business of such person or firm.
(*e*) A statement as to the particular goods or classes of goods, to which the trade mark is intended to be applied.
(*f*) A description of the mode in which the trade mark is intended to be applied or used.
(*g*) A statement as to whether such mark is a new one, or, if not, how long the same has been in use.
(*h*) A statutory declaration that, to the best of his knowledge and belief, such trade mark is not identical with any one already lawfully used or registered with respect to such goods or classes of goods, or so nearly resembling a trade mark already on the register with respect to such goods or classes of goods as to be calculated to deceive, and that he believes himself to be the only person entitled to use the same in respect of the aforesaid goods or classes of goods.

If, in the case of trade marks already existing, the same trade mark shall have been lawfully used by more than one person or firm, it shall be lawful for any one of such persons or firms, on stating the fact in the declaration as above, to submit the said mark for registry, notwithstanding the claims of the other said persons or firms, and without prejudice to such claim.

He shall also deposit or transmit (as above stated) two facsimiles of the trade mark in question, as used or intended to be used. These facsimiles shall be drawn, printed, or otherwise represented in the centre of a sheet of paper 13 inches in length by 8 inches in breadth [the size of a half-sheet of foolscap], and shall not occupy more than a space of 6 inches square in the centre of the said sheet; if embossed, the relief shall not exceed one-sixteenth of an inch. In the space below such representation of the trade mark the applicant shall inscribe his name and address, and shall state to what particular goods or classes of goods the trade mark has been or is intended to be applied; and in the space above, the Registrar shall stamp the date of receipt, and a number (such numbers to be consecutive in order of application), and shall also sign his name at the proper time for such signing, with the date of such signature. One of these facsimiles shall be preserved in the office, the other returned at the proper time to the applicant with the certificate below mentioned.

He shall also at the same time pay, or transmit by Post-office order, the sum of [ ] which sum shall not, in case of refusal to register the trade mark from any cause whatsoever, be returned, and shall moreover pay for the advertisements as hereafter mentioned (according to the scale to be agreed upon).

On receipt of the aforesaid statement and the said facsimiles, the Registrar shall enter the particulars thereof in a book or books to be kept by him for the purpose, which said books may be appropriated to such general classes of goods to which trade marks are applicable as may from time to time be determined, and with respect to such trade marks as are intended to be applicable to more than one class of goods, separate books may be kept.

Such entries shall conveniently set forth in their order the applications hereinbefore mentioned.

Such book or books to be styled "Memoranda of Applications for Registry of Trade Marks," and to be open for inspection on payment of a fee of 1s.

The Registrar shall thereupon advertise the application with the facsimile, and other particulars as furnished by the applicant in an official or authorised publication.

Not less than [ ] months from the date of such application, the Registrar shall (unless he think fit to refuse to register the said trade mark for any of the reasons hereinafter particularly mentioned) proceed to register the said trade mark, and shall notify to the applicant, at the address given by him, that the trade mark is duly registered in the said register of trade marks, and the applicant shall therefore be entitled to a certificate to that effect.

Such registration shall then be deemed and taken to date, and to have taken effect, from the date of the application.

The Registrar may refuse to register such trade mark on the grounds mentioned in the Act, or, until he shall be ordered to register by the Court, on any of the following grounds:—

1st. If he shall have discovered any trade mark previously registered, which shall appear to him to resemble the trade mark submitted so closely as to be likely to deceive.

2nd. If there shall be more than one person applying for the registration of the same trade mark as applicable to the same goods, or classes of goods, in which case he may call upon the respective applicants to establish their legal claims to the registration of such trade marks.

And in case he shall not see fit to decide upon registering one or more of the said trade marks, he may direct the parties to apply to the Court.

3rd. In case he shall receive a notice of objection against the registration of any trade mark lodged by a person considering himself aggrieved by the proposed registration, in which case the Registrar shall have the power, on the application of the person against whom the notice of objection is entered, to require security for costs.

4th. The Registrar shall prepare, and keep up from day to day, the following indexes:—

(a) An index of the names of applicants and proprietors.

(b) An index of the goods, or classes of goods, in respect of which trade marks are registered, with the trade marks thereto belonging.

(c) An index of the trade marks themselves arranged in classes.

These indexes shall be printed and published in yearly volumes, and a fresh volume shall commence with each year. At the end of every tenth year the indexes of the preceding ten years shall be amalgamated, each set into a single volume.

The word person in these rules shall be held to mean any person, corporation, company, firm, or other body, and whether English or foreign.

Proposed Form of Notice of Objection.

Registry of Trade Marks.

In the matter of the Trade Marks Registration Act, 1875.

I, A. B., of (having reason to believe that C. D. hath made, or is about to make, application to register a trade mark belonging to goods), hereby declare that I have (or claim to have) [set out the interest the objector has, or claims to have, in the trade mark aforesaid].

And I do require you to refuse to register the same in the name and as the property of , for the reasons following:—

(a) That the said C. D. is not the sole proprietor of the said trade mark.

(b) That the said C. D. is not entitled to the exclusive use of the said trade mark, I having lawfully used the same in respect of goods for the space of years, to wit, from .

(c) That the use of the said trade mark is an infringement of my exclusive right to use the same, for the registration whereof I have duly applied on the day of , 187 .

And I bind myself to appear and support this my objection before you, the said Registrar, and before any Court of competent jurisdiction in the matter within such time as you or the said Court may direct.

Dated..

My address for service of notice is ....

Signature of objector or his Solicitor ....

[Copy.]

Society of Arts,
16th December, 1875.

Sir,—Acting on the permission given in your letter of the 10th instant, I beg leave to enclose for the consideration of the Lord Chancellor the result of the deliberations of the Trade Marks Committee in reference to the rules and regulations to be made for carrying out registration under the Trade Marks Act.

The committee, as you are aware, consisted not only of members of the legal profession, but also of traders largely interested in the question, and they desire respectfully to place their views before the Lord Chancellor.

These views have been in the main adopted unanimously, though there were a few points on which a difference of opinion existed. A small minority dissented from the proposal that the trade mark should be registered "as used," and think that colour should in no case be considered as an element of difference, but that configuration alone should be taken into account.

The committee have not ventured to suggest a schedule of fees, but would desire it to be understood that the fees should be only such as to render the registration office self-supporting.

They are also very decidedly of opinion that in no case should any annual payment be demanded.

I enclose a list of the committee, and am directed to add that if the Lord Chancellor would desire any explanations a deputation will wait upon his Lordship for the purpose.

I have the honour to be, Sir,
Your obedient servant,
(Signed) P. Le Neve Foster,
Secretary.

To H. L. Graham, Esq.

CANTOR LECTURES.

The first Lecture of the first Course of Cantor Lectures for the present Session, "On the Discoveries and Philosophy of Liebig, with especial reference to their influence upon the advancement of Arts, Manufactures, and Commerce," by J. L. W. Thudichum, M.D., was delivered on Monday, November 22nd, 1875, as follows:—

Lecture I.

Introduction.—General Sketch of Life and Labours.

The science of the present age is distinguishable from the learning of past ages by many important features.

By these it has indeed somewhat altered the sense originally attributable to its name, and science has become a word of greater precision, and therefore of a less broad significance than what may be termed mere knowledge. This is so little understood, that when lately a great statesman and orator met some of his constituents in a south-eastern suburb of this metropolis, he informed them amongst other things that science was merely another term for knowledge. Even if it had been so originally, and the Latin word *scientia* had been merely the equivalent of the Saxon word knowledge, it would have to be admitted that the relations have changed by one of those conventions which are silent and convenient. We hold that the systematic enunciation of mere knowledge is doctrine; that science is a kind of knowledge, but that not all knowledge is science. Science is that kind of knowledge the correctness and truth of which can be proved by evidence convincing to all healthy understandings. Science is a series of potentialised axioms, which when once mastered are as evident as the simple axioms in mathematics, which are said to be so self-evident as to require no proof. By this definition a very large amount of human knowledge or doctrine is at once excluded from the domain of science. The learning of past ages was mainly imitative, little observant of new phenomena. Those ages had too much work on hand, first in the development of their languages, in which they used imitations countless in number, next in the shape of securing the conditions of social life in the form of communities and states. But even where these may be said to have been secured, *e.g.*, at the height of power of the Roman Empire, science was not developed, and it may be said that this absence of scientific treatment of the common problems of life has been one of the principal causes of the downfall of that, and of many other States. Famines, epidemics, amongst men and cattle, and wars, are made possible or necessary only by the absence or faulty application of the principles taught by science. Science, by teaching that, and how, these evils are to be avoided, has a field in this generation, of which the past had not even a distant conception. Imitative learning shows itself mainly as art, buildings, sculptures, paintings; all the mass of temples and gods which fill the world's history and imagination are of this kind. There is no science about a Greek or Egyptian temple, simply because there is no value in it; it does not satisfy to our present mode of thinking one single demand of the understanding. There is no science about our present homes, or how could they get filled with sewer gas, be devoid of arrangements for ventilation, and have square chimneys. Architecture, so called, is not a science, but an imitative art, beautiful but blundering. Manufactures have, too often, been carried on with great disregard of science, with the result that either empiricism was, for the time, successful enough, or that the manufacture went simply out of existence. It is the same with commerce. These arts have worked by tradition, by prescription, by precedent. They all wait for an infusion of the scientific method, the method of principle based upon natural laws immutable and indestructible. While not often scientific themselves, these branches of human knowledge, administering all the time for a consideration of gain to be paid by the recipient to important human wants, have yet indirectly advanced science by either finding and bringing, or by producing some of its materials.

Antiquity then possessed no science, except alone the results of meditation, which have been termed metaphysics, and which, if allowed to include ethics and logic, have no doubt attained in the treatment of philosophers a high degree of development. The contemplation of nature, however, in its inorganic and organised shape, and of the causes determining all motion and development was not greatly developed. The power of distinction, the mother of all knowledge, was not applied to all things, and consequently they termed a process such as fire an element, and allowed some all-pervading material to exist under the name of the quintessence. Bodies fell to the ground because they possessed weight; but that the falling was a reciprocal action between the earth and the body falling upon it, escaped their observation, and was only found by science.

Mere observation is not science, but only the beginning of science. When a person sitting in the railway train, beholds the travelling shadow, he makes an observation. He begins a scientific inquiry, when he asks whether the shadow travels as quickly as the train, so as to be in a line falling from the sun past the train or whether the shadow is not a little later. If once the question has arisen, it is immaterial where it is solved, whether upon the railway train, or the satellites of Jupiter—the question must lead to the idea that light requires time for travelling; exact science determines this time by measuring space. Science began its development with the elucidation of celestial phenomena, and became astronomy, or the doctrine of the laws according to which heavenly bodies move. Copernicus is from this point of view the father, the creator of science. Kepler, Galileo, and Newton reduced the observations of these phenomena to expressions of regularity which we call laws. The method once found was applied to other branches of knowledge; then arose the physiology of the animal and vegetable world, based upon anatomy as a science. Harvey made physiology a science, and so on in all branches of knowledge.

Now, let us see what was the method by which these results were obtained. Meditation had of course the inciting share, but furnished no materials. Observation accumulated the materials of which reflection might weave a tissue, the test was experiment. If from a knowledge of conditions a result can be predicted, then there is certainty. Such certainty is science; it consists of observation, meditation, knowledge of conditions, knowledge of their results, and therefore of the connection between results and causes; these being regular, immutable, within the time accessible to our perceptions, and coercing everything under their sway, are called natural laws.

Of science, it is allowed that no part comes out of the human brain alone, not even the ideas of God and Immortality, which Kant claimed as innate ideas, while allowing all others to be the result of observation and reflection. The celebrated joke, that if an Englishman and a German were asked to produce a camel each, the Teuton would evolve one out of his inner consciousness while the Briton would produce a camel of flesh and bone, is a good satire upon innate ideas. Science did not progress until it rejected all innate ideas or phantasies, and applied itself deeply to its proper methods, to observation, to meditation on the correlation of forces, and to experiment. Work, work, and again work, were the three main features of its success. The search for the philosopher's stone, for the medicine that should make young, healthy, happy, and rich, was also work, enormous in amount and extension, but it was not based upon observation. It left results which science gathered, the main result being that we cannot prolong our lives forward, but we can, as Kopp has beautifully said, prolong them backwards indefinitely, and see the changes of enormous spaces of time pass before our admiring eyes and minds.

There are three kinds of history, that of our planetary system in the theory of Laplace, that of our earth in geology, that of living things in the theory of Darwin. No serious person doubts now that the teachings of geology deserve the title of an exact science, and that compared to its coercing character upon the mind of man the convictions derived from written history are feeble in the extreme, and all contradictory writings, however old, mere nullities. The youngest of the sciences or branch of science is chemistry, founded by Lavoisier and Dalton; developed by thousands of clear heads and nimble hands it has in half a century become a recognised power in the affairs of man. It has

materially improved his estate, and enlarged his mind to conceptions of an elevating nature; it has become a ready test of his reasoning and working power. It has become the handmaid of almost all the elder sisters of astronomy, teaching the composition of distant stars; of geology, teaching the composition and changes of strata and minerals; of physiology, vegetable and animal, teaching about food, nutrition, growth, changes, death, and decay; of the healing art, teaching the nature of evils in the shape of disease, and the means of curing or mitigating them. This science, too, was developed by work, work, work—physical and mental; its ways were often rugged; its endeavours misapprehended, opposed, suppressed. And the great men whose names are inscribed upon the roll of its principal promoters will be considered by posterity as benefactors akin to Hercules, removing evils, establishing the good and true. If we cannot now inscribe their names and likenesses amongst the stars, and transfer them to an Olympian abode, yet we can honour them by admiring their works and lessons, by sharing and continuing their work, by, as it were, living their lives with them over again, and thus prolong their memory forwards while we prolong our own in the inverse direction. We ought to honour them out of gratitude no less than out of the desire to benefit continuously man's estate. Such feelings have been instrumental in the cases of those who described the greatness of your Davy, of your Faraday. Such feelings shall now be the guiding principle in the consideration of the life, works, and philosophy of Justus Liebig. Lest the subject suffer by my imperfect treatment, I shall endeavour to keep closely to the subject which it is capable of raising. But I must beg you to understand that I shall proceed by a severe process, that of analysis, for nothing less than the results of analysis of work done can establish as proved what many feel as a sentiment. You will understand both the censure and the acclamation of what we will call the world; you will see the necessity for a reform in the philosophy of many of us; you will see how the life and labour of one man has produced vast applications and industries, improved or created a large commerce, and enhanced or engendered art; how it has soothed the pain and anguish of hundreds of thousands under the most severe trials of human organisation, and how it has left a growing harvest in the hearts and minds of men all over the world.

Justus Liebig was born on the 12th of May, 1803, at Darmstadt, in the Grand Duchy of Hesse. His father was what in this country we should term a wholesale druggist and drysalter, a trade which is in Germany designated by the name of materialist. There is no doubt that the opportunities which he had of collecting chemical reagents and of witnessing the preparation of many products which were the objects of his father's trade, early excited in him that curiosity which soon became an insatiable thirst. It is related on creditable testimony that at the age of fourteen years he had performed all the experiments of which he could get knowledge from books, or for which within his means he could obtain the materials, and it is related by himself that about that time there was not a work in the library of the Grand Duke of Darmstadt on chemistry which he had not read. Looking at his early days by the light of that information, we cannot doubt that the anecdote ordinarily told of his having been a dull boy is a mere mistake. He was abstracted by other pursuits, and therefore, no doubt, neglected his school work, but that he should have been less gifted than others cannot, under the circumstances, be believed. It is related by a credible person that in 1817, when he and his school-fellows were speaking to each other as to what pursuit they were to select, he said that he was going to be a chemist, whereupon the other boys laughed at him and told him he was a great fool, for a chemist was nothing. However, times have changed, and what at that time was considered as no pursuit is now an honoured profession.

In the year 1818 he gave a distinct direction to that early bent of his mind, and he followed almost the only way which at that time existed in Germany for studying chemistry; he became an apprentice in an ordinary apothecary's establishment. An apothecary in Germany is a more scientific person than perhaps many would believe. He has had a thorough training, he has passed examinations, and he represents, therefore, the scientific side of chemistry, pharmacy, and the science of drugs in perfection. To such an apothecary, residing at Heppenheim, near Darmstadt, Liebig went, and remained there about ten months, but in that occupation as an apprentice his mind soon became wearied, he saw that he could not attain his object; and when, while continuing some of his early experiments on the fulminates, on one occasion he had the misfortune of producing a great explosion, this fact quickly terminated his apprenticeship, and he returned to Darmstadt. These explosions in the early days of great chemists are not uncommon. It is related in the case of Scheele, that when he was apprenticed to an apothecary, he once had a great explosion, in consequence of which his landlady expelled him from the house.

Liebig returned to his father's house in the year 1814, and read for six months in order to prepare himself for visiting the University of Bonn. He there listened to the lectures on theoretical chemistry of the well-known Professor Kastner, and he also studied the other natural sciences and some languages, and what is very characteristic of his great genius and perseverance, he formed a society amongst the students for the purpose of teaching oneanother, and for discussing subjects connected with chemistry and physics. Kastner being called to Erlangen, Liebig followed him there, and we are told that there he read all the new chemical publications, established another students' society for the same object as the first, and made many friends amongst the students, of whom several continued that friendship up to their death. Thus the celebrated poet, Count Platen, correspondedwith him to the time of his death in 1830, and of this friendship we can see many congenial influences in the writings of Liebig, for there is no doubt that in his "Familiar Letters on Chemistry," the language, although always prose, frequently rises to the highest beauty, such as can only be produced by a mind of a poetical turn. The same influence of the classical period of German literature you will also perceive for example in the writings of Humboldt, particularly in his "Views on Nature," which are therefore considered as examples of classical German diction. Liebig also made the acquaintance of Bischof, the botanist, and of Engelhard, later Professor of Chemistry at Nuremberg. He went in for the severe study of what at that time was called philosophy, that is, he listened to the lectures on metaphysics and philosophy in general, of the then great Schelling. Now, let me give you the words of Liebig on that period of his life. He says: "I myself studied for some time in a university where the greatest philosophers and metaphysicians of the century carried the studying youths away to admiration and imitation. Who could at that time resist the infection? I, too, have lived and participated in this period so rich in words and ideas, so poor in true knowledge and solid studies: it has robbed me of two precious years of my life. I cannot describe the terror and dismay which I felt when I awoke from this giddy dream to consciousness. How many most gifted and talented men have I seen perish in this vertigo, how many wails about life objects completely missed have I been obliged to hear afterwards." Thus he spoke in his work on the study of the natural sciences, which was published at Brunswick in 1840.

Now, in order that you may be able to apprehend what this kind of philosophy was, and to understand more fully the position from which he had to emancipate himself, even at that early time of his life, I will quote to you a very few passages, and I will make them as short as possible, compatible with illustration, from one of

Schelling's works, from the periodical for speculative Physics—mark the term "Speculative Physics." I will quote the following passage: "Nature strives in the dynamical sphere necessarily to absolute indifference, not by magnetism nor by electricity is represented the totality of the dynamical process, but only by the chemical process. With the third dimension of the product the two other dimensions are opposed. In nature itself there is one and inseparate, what is separated for the purpose of speculation." That is almost enough, but I will give you another passage which will be more striking because of the contrary itself being known to you. Here he says of the composition of water: "Water contains just the same as iron, but in absolute indifference as yonder in relative indifference, carbon and nitrogen, and thus all true polarity of the earth is reduced to an original south and north which are fixed in the magnet." Now, in order that you may believe that he did not merely speak of an admixture or impurity of carbon or nitrogen, but that he meant to say that it was the essence of water, and that it was really composed of these two elements, and not of any other, he goes on to say: "The animal is in organic nature the iron; the plant is the water, for nature begins with the relative separation of the sexes, and then ends in this separation. The animal decomposes the iron, the plant decomposes the water. The female and the male sex of the plant is the carbon and the nitrogen of the water." These are two examples of the philosophy of Schelling, which was believed at that time to be the science by which Germany could be regenerated, by which the generation which had then only just recovered its independence would be put on a firm mental basis. The followers of this system were called to the Court of Prussia, and there Hegel, the philosopher, continued in a similar manner to teach doctrines which nowadays seem to be but a farrago of nonsense. Hegel says, for example, on the chemical process:—"If electricity was the broken magnetism, because the opposite poles are independent bodies upon which the positive and negative electricity is distributed, and if the point of indifference is the explosion of an indifferent light by itself, then is the chemical process, on the other hand, the totality of the shaping. We have two independent bodies which belong more to the one or the other extreme; to the metal on the one hand, or the sulphur on the other, which meet in an indifferent medium, and by abandoning their abstract one-sidedness in which they decompose the medium combine to a third body which is the totality and the neutrality of the opposites, the dynamical process in its highest perfection."

When a young man of seventeen or eighteen years of age is capable of freeing himself from the trammels of such a chimera termed philosophy, which had taken such a deep hold of a whole nation as to cause to flock to the university where it was taught the selected youth of the whole country, you may give him credit for great power of mind and for great independence of judgment. Do not forget that this development of the philosophy of Schelling and Hegel was a consequence of the latter part of the philosophy of Kant. Kant's philosophy was great as long as it was based on the exact sciences, upon physics, and upon mathematics, but when he left that basis and went into the speculative philosophy he gradually went away from that basis which had made his early philosophy so sound and so full of meaning for the perfection of the human understanding. On the other hand, when you come to a further development of the same philosophy, namely, that of Fichte, there the speculative part vanishes entirely into insignificance, because that which Fichte taught was not such kind of nonsense as that which I have read to you, but it was a kind of moral philosophy which spoke to the youth of Germany, and taught them this one great proposition, which everyone of them ought to feel, and which is the first condition of self-consciousness in man, namely, "I am I;" this was the great teaching of Fichte, by which he brought home to men their own value and their own powers, which cannot be said was the result of the other philosophy from which I have quoted.

In 1822, Liebig having emancipated himself from this kind of teaching took the degree of Doctor of Philosophy at Erlangen, when he was nineteen years old. In the autumn of that year he returned to Darmstadt; his researches and endeavours then became known, and he attracted the attention of the Grand Duke Ludwig I., of Hesse Darmstadt, who conferred upon him a State stipend, to enable him to continue his studies at Paris. To Paris, therefore, he went. Now let us for a moment consider what was then the condition of chemistry at Paris. Lavoisier, the great reformer, who had established what was then called the anti-phlogistic chemistry, had thirty years before died on the scaffold; Guyton de Morveau, Fourcroy, and Berthollet, whom the first Napoleon called the *plus brave des Français*, because he gave him chlorate of potassium, by which he hoped to overcome the want of nitre for his gunpowder; the great Société d'Arcueil, which worked through the whole of the war times zealously at science, and published its memoirs; all these men had passed away. But there remained their disciples in the persons of Proust, Chevreul, Vauquelin, Gay Lussac, Thénard, and Dulong. Chevreul is the only one of these celebrated men who now lives, and he has lately published, in the *Comptes Rendus*, a very remarkable paper on the changes which are produced in the power of thinking and observing by age. Fourcroy, the great animal chemist, who, in connection with Vauquelin laid the foundation of that physiological chemistry on which the modern science is based; then Gay Lussac, Thénard, and Dulong, men of the new science, who continued the work in a most glorious manner which in this country had been carried to such a glorious issue by Humphrey Davy—these men were at that time teaching at Paris, and at the laboratory which the liberality of the first Napoleon and his envy of English discoveries had established at *L'Ecole Polytechnique*. They continued to study and shape the new science which was destined to give to the modern science of chemistry precision.

Liebig then worked with Thénard, listened to Gay Lussac's lectures, and he met there the young German chemists, Runge, well known by his many researches on tar, and the tar products; Mitscherlich, the discoverer of isomorphism and polymorphism; Gustav Rose, the representative of the perfection of analytical and inorganic chemistry. In 1823, he brought his first paper on the fulminates of silver and mercury before the Academy. And now, let me quote to you what he says of that event in the first work, which he ever published. In the preface, which is a dedication to Alexander von Humboldt, he says that at the meeting of the Academy on the 28th of July 1823, he had read his paper, and was just engaged in packing up his apparatus and preparations, when a man, one of the members of the Academy, approached him, entered into conversation with him, and in an incredibly short space of time knew how to elicit from him all his hopes, schemes, and intentions. He did not dare to ask, either from shyness or from accident, who the gentleman was who spoke to him, and he disappeared again amongst the academicians. But he says, "from that day all the doors of society, and of all institutions were open to me. I did not know until many years afterwards to whom I owed this introduction and favour." It was to Humboldt, who had so well recommended him to the great French chemists, that Gay Lussac, who never took any pupil whatever into his laboratory, accepted him as his only pupil, and, more than that, joined with him in his continuation of those researches which at that early age he had brought to such perfection. This preface is beautiful in its conception and feeling, and has been printed in all the seven editions of the work which have since been published. If there were time this would perhaps be the place to show the wonderful influence which Humboldt

has exercised upon the science of all countries; how he everywhere endeavoured to attach the talents, to perfect their welfare, to introduce them into good positions, to make them teachers or workers; how he everywhere supported attempts and doctrines down to the very end of his long life; and I might, for example, quote the remarkable influence which he had in establishing through and with Col. Sabine, the magnetic observatories which this country has so splendidly arranged in various parts of the globe, but I see time passes so quickly that I must pass over that subject and continue the account of Liebig's life.

Through the recommendations of Humboldt and Gay Lussac, both of which were addressed directly to the Grand Duke of Hesse Darmstad, Liebig was, at the age of 21 years, by the supreme will and absolute power of the Grand Duke, appointed first Professor of Chemistry in the University of Giessen. A new chair was established for him, and as a laboratory he received a room, as he expresses it, with four walls. Great was the opposition against this new professor; for what was chemistry? Chemistry was no science, nobody knew anything of chemistry, nobody would have it. Moreover the appointment had not been made in the regular way, therefore the whole of the authorities of the University set themselves against it. The consequence was, that the majority of that University persecuted that man for 27 years; and no matter what was his reputation, the amount of his work, or the importance of his position, for 27 years this man could never once be made Rector of the University of Giessen. But where are the opposing influences now? History will not mention their names. Their ultramontane participators tried to decry the great man as an atheist and materialist, and by that means to remove from him the assistance of the State, and to diminish his chance of gaining a living. But he was too strong for all of them. In the year 1826 he was appointed Professor in Ordinary, a promotion by which he became a fixed servant of the State and a fixed member of the University. In that year he married Henrietta Moldenhauer, a most amiable lady, who now survives him.

Now comes the period of work, which lasted to the year 1834. The work itself I will not now enter upon, but we will, in the future lectures, see what was the nature of that work. We will perform before your eyes some of those operations by which that work has become of the utmost importance to mankind at large; and you can then see how, from a small point, there can be a light shed upon the largest problems of science.

In this year 1834, however, Liebig fell ill from overwork and anxiety. A portrait which was taken at that time by the now deceased painter Engel, gives evidence of that, and I remember that the late Professor Zamminer told me that he had seen Liebig about that time taking short walks in the evening air, looking pale and haggard, like a man in a consumption, with little spots of hectic on his cheeks, and that his friends were afraid he would soon die. At that time he retired from Giessen for a time, and went to Baden Baden in the hope of recruiting his health. The patience which he had exercised for many years under the most narrow arrangements then gave way, and he asked for the building of a new lecture room, the arrangement of a proper laboratory, and for an increase of salary. All was refused by the narrow-minded Government of Hesse Darmstadt, through that close-minded man, the then Chancellor, von Linde. Then Liebig wrote to von Linde a letter, in which, after the introduction, he continues thus:—"I should have gained some convenience by these arrangements, but they were not intended for me personally; they would have been of lasting value for the University, and would have secured to the chemical chair an advantage over all others in Germany. For the institutions of a University the largest sums may be expended, for this increases the respect and affection for them; but the suitable employment of these sums must be strictly controlled. The sums are there, but they are used in an intolerably ridiculous manner. I must be certain of what I may have to expect at Giessen. If driven to extremities I shall not return there this winter, whether I obtain leave or not. I shall know how to justify this step, for no one has been maltreated in the University in a more conspicuous manner. One cannot live at Giessen upon a salary of 800 florins. Four years ago, I in conjunction with four colleagues asked for an increase of salary; it has been refused. You (the Chancellor von Linde) have assured me with smiles that the State treasury had no funds; from this I saw that you have never known grief and torturing care for the daily bread. From the moment of that refusal I have endeavoured to acquire an independent position by ceaseless work; my exertions have not been without success, but they have surpassed my strength, and I have become an invalid; and if now, when I do not require the State any longer, I consider that, with a few miserable hundred florins more, my health need not have suffered in former years, because my life would have been more free from care, the hardest thought for me is that my situation was known to you. The means which the laboratory possesses have been too small from the beginning. I had four walls given to me instead of a furnished laboratory. Notwithstanding my requests, no sum for furnishing the same, or for buying apparatus, has been provided. I required instruments and specimens, and have been obliged to spend on these items annually from 300 to 400 florins from my own means; besides the famulus paid by the State I required an assistant, who costs me 320 florins—deduct both expenses from my salary, and there remains not enough to clothe my children. From this original treatment of the laboratory the consequence has arisen that it possesses no property, for I can show that the arrangements, fittings, instruments, specimens which have made the Giessen laboratory —I can say it without blushing—the first in Germany, are my property. I will say nothing more about myself—my account with Giessen is closed. My path is not the one of reptiles, the easiest though the dirtiest. What I have said will suffice to justify with the ministry and the Prince my resolution not to lecture at Giessen during this winter (1834-35). If I am in health, I may not lack the power to establish a kind of university for my branches of science at my own risk. If I am not permitted, and if I receive my *congé*, this will free me from the charge of ingratitude towards the country from the means of which my scientific training has been possible. I have learned to bear much injustice, many a false judgment, but this reproach of ingratitude would be too heavy for me to bear." This letter pictures to you the conditions which prevailed at Darmstadt, but it is still more important, because it shows that such strong language was required to bring down the ministry, and that which no kind of friendly representation had been able to effect, this threat did. In 1835 he had to take compulsory repose. I find in the list of his publications only three small papers dating from this period, of which one only was a research, but in almost every other year there were from 10 to 20 researches and publications.

In 1836 another active period begins. In that year there were nine researches by himself alone, thirteen by himself and Pelouze. In 1837 there were nine researches by himself and five with Wöhler, including the celebrated one on lithic acid, and two with the celebrated French chemist Dumas. In that year the British Association for the Advancement of Science, at their Liverpool meeting, made a request to him to write a report on the then state of knowledge of organic chemistry. It was this report which originated the work which he published in 1840, namely, the work entitled "Organic Chemistry in its Application to Agriculture and Physiology." In 1838 he published a memoir on the state of chemistry in Austria, in which he exhibited its shortcomings in trenchant language, and the effect upon the Austrian Government was such as no one would have expected.

In reply to his essay he received the offer of a chair at Vienna. "Come to us," they said, "reform our chemistry, and we will give you a chair." But the conditions were not sufficient, and the Austrian Government, having received Liebig's refusal to go to Vienna, at their own expense sent a number of young chemists to Giessen, there to study chemistry under Liebig, and to prepare themselves for the important function of becoming teachers of the new chemistry in Austria. In the year 1840 he published the work which I have already mentioned, and he also published a memoir on the state of chemistry in Prussia. You know what was the state of Prussia in 1840; the promises made by the King in the year 1813 regarding a liberal constitution had all been falsified, a narrow-minded bureaucracy governed everything, a minister of education who did not comprehend his time, could not understand that physical science required any promotion, or any State help. He soon went into that movement which has been described as *muckerthum*, a kind of pietism which shows itself by casting up the eyes in a praying attitude, having God more on the tongue than in the heart; by a mock modest morality which would, for example, have caused the Council of this institution to have those beautiful nymphs on our walls painted over with drapery. Under these circumstances no science could progress, and there was not in the whole of Prussia a single establishment, laboratory, or teaching room where a man could learn practical or even theoretical chemistry. It was the great boast of even talented teachers of chemistry, that all the apparatus they required for teaching was a dozen test tubes. This attack on the state of chemistry in Prussia had no effect whatever of a good kind, but, on the contrary, the bureaucracy used its power and influence to prevent the Prussian youth from visiting the University of Giessen, and I have the authority of Kolbe that for a time the visiting this University was actually forbidden to young Prussians.

About this period Liebig purchased from the municipality of Giessen a sand-pit, at a place called Trieb, on a little height east of the town, and there he made experiments on vegetable physiology. This place bears the name of "Liebig's Height" to the present day, and I daresay it will bear it for many years to come. He also published his work on "Chemistry in its Application to Physiology and Pathology," which he dedicated to Berzelius. In 1844, appeared his first "Familiar Letters on Chemistry," in the *Augsburg Gazette*. These letters were afterwards published with many new ones from time to time in several editions, and by this means he contributed greatly to make chemistry popular, while still keeping it in the most scientific form needful. In 1850 he published a pamphlet on spontaneous combustion, on the occasion of the death of the Countess Görlitz, who had by experts and doctors at Darmstadt and Giessen been declared to have perished from spontaneous combustion, but it was afterwards found out that she had not perished in that way, but that she had been murdered by her butler, and afterwards burnt. About this time also Liebig effected a reform in the medical studies and examinations in the University of Giessen, and this reform was so important, and effected by so great a participation of public opinion, that we see there how great was his power, although in the University itself he was kept out of office as far as possible. These reforms amounted to nothing less than this—complete liberty of study. You know that in this country medical students have no liberty of study; they are obliged to attend lectures, to have heard at least two-thirds of the lectures given, and if it is not certified by the beadle, who comes in to every lecture and takes the names of all present, that they have been present at two-thirds of the lectures, they are not allowed to enter for the examination. This state of things also existed in the German Universities previous to this reformation. At that time, however, this was completely done away with, and every student was allowed to obtain his knowledge where and how he pleased. He was not obliged to enter any University whatever, but he was obliged to pass an examination, and to pass that examination publicly, an examination which should so thoroughly test his knowledge, that after he had passed it there could be no doubt whatever about his fitness to follow his profession. Now let me recommend to your attention this most remarkable system of public examination. The remarkable effect it had on the University of Giessen was this, that whereas formerly many students coming unprepared were rejected, since the introduction of public examinations few rejections have taken place, because the students take great care to get up their subjects and to come so fully prepared, that in the presence of their countrymen, in the presence of any person who likes to enter the hall when the examination takes place, they can show that they are fit to follow their profession.

I have already, I see, passed the time allotted to me, and I shall not detain you many more minutes. In the autumn of the year 1852 Liebig left Giessen, having received a call to the University of Munich, where the then King Maximilian was desirous of following his father, Ludwig, on another path of glory. You know that Ludwig had made it his life business to restore art in Germany and raise it to a high footing in Bavaria, and Maximilian now wished to do the same thing for science in general, and he therefore endeavoured to collect from all parts of Germany the best men whom he could attract. One of these was Liebig, the King having made him President of the Academy, with the condition that he should undertake no laboratory teaching; that he should deliver lectures only, and at the same time be the Curator of the Botanical Gardens. In that position he remained up to his death, devoting himself mainly to the public part of his duties, which he performed with grace, honour, and glory, and in the laboratory which had been constructed for his own immediate wants he only performed such analyses, partly himself, and partly by a number of assistants, as were necessary to give him the data for the publication of his several works.

At last, in the year 1873, on April 18th, he died, nearly 70 years of age, and in full possession of his faculties, not having, as other philosophers have had the pain of doing, experienced any diminution of his mental powers.

A few words as to his personal appearance. He was impressive, solemn; his hair was dark; his features strongly cut; his look was piercing. His voice was somewhat low, but highly impressive. His lectures were most attractive. I remember now the intonation and nature of his eloquence, which had very few oratorical efforts at enforcement, except those which consist in repetition, and the repetition would take place at the end of important sentences. The lectures which he gave were rich and instructive; and, in fact, he sacrificed, I may say, on the altar of his lecture-table, such a vast amount of his own money, that I remember Professor Bischoff, the anatomist, now of Munich, saying, in a lamenting voice and tone, "Professor Liebig will die a poor man; he spends everything upon this laboratory and upon these lectures." The audience in the lecture-room was always very attentive. By eleven o'clock every seat was taken every available standing place was filled down to the door-steps, and just in front of the lecture-table there were always a few chairs occupied by distinguished strangers or foreigners. These were the only lecture-rooms which in my life I remember to have seen from the beginning to the end of the session as full as they could be. For an hour and a half everything was attention, everything went on in the most wonderful manner; at the end there was a tremendous ring of applause, and you saw the professor disappear through a little door to his laboratory, there shortly afterwards to resume his teaching, and the continuation of those researches which were carried on by his pupils. In his laboratory teaching he knew how to

attach men to him. He encouraged them to overcome difficulties, and if you look into the nearly 200 volumes of the journal entitled "Annalen," which he has established, you will see the enormous number of works, not only by himself, but by his pupils, which I believe would altogether reach to more than one thousand; his own contributions being upwards of three hundred. He established what may be called the first school of complete chemical analysis, upon a new system, namely, that a person who wants to know chemical analysis must perform it himself upon the articles placed before him, he knowing nothing of them; and it is only by a practical acquaintance with the processes that the student is able to appreciate that which he learns in the lecture-room from the professor. Therefore the one ought to go hand in hand with the other, and that is now the system adopted all over the world. Do not forget that Will, the successor of Liebig at Giessen, and Fresenius, who has been for many years at Wiesbaden, were many years his assistants, and that their works on analytical chemistry are the standard works on that science throughout the world. Of course in their work is continued work which Liebig initiated. It is the same with numbers of researches connected with the names of Strecker, Fehling, Fleitmann, Guckelberger, Hemeberg, Schlossberger, Dôpping, Crasso, Engelhardt, Rochleder, Theyer, Schlosser, Schlieper, Sthamer, Haidlen, Bensch, von Bibra, Bopp, Enderlin, Redtenbacher, Varrentrapp, Playfair, Stenhouse, Brodie, Bromeis, Hoffmann, and many others of equal repute—all these men learnt and studied, and worked with him, as his pupils, some afterwards as his colleagues; most of them were taken by him into friendship, which continued throughout the whole of their lives. Amongst these pupils there were but few Frenchmen. But perhaps that is redeemed by the fact that two of the most celebrated French chemists, namely, Pelouze and Dumas, worked with Liebig conjointly in some of his first researches. Liebig declined many other honourable calls to other Universities, and in 1851 even made an attempt to improve the Giessen institutions by offering to remain if the town and Government would unite in improving conditions. However, nothing was done, and he left. Great surprise was experienced when, after Liebig had left, all the other celebrated professors left the University one after another, and it sunk in an incredibly short space of time to a very low state indeed. The State and University too late perceived their loss, which they did not foresee, because even then they did not appreciate the greatness and the world-wide fame of this man. He was made a member of many learned societies, besides being the president of the Academy, and was particularly connected with this Society, in that it conferred upon him, that which he wrote to me he considered one of the greatest honours of his life, namely, the Albert Medal of the Society of Arts. He wrote a letter to the President of our Society, which I am sorry has not yet been published, and perhaps I may express a hope that after his Royal Highness shall have returned from his important visit to the East, he will allow us an opportunity of participating in the sentiments which this great man has expressed to our President in that letter. A monument is now in progress which will hand down his features to future generations.

SIXTH ORDINARY MEETING.

Wednesday, December 22nd, 1875; Sir Francis C. Knowles, Bart., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Benjamin, Horace, F.R.G.S., Chaldow-house, Fulham, S.W.
Clarke, Alderman Edward, Park-cottage, Macclesfield.
Denny, P., Leven Ship-yard, Dumbarton.
Denny, William, Leven Ship-yard, Dumbarton.
Haddon, John, 3, Bouverie-street, E.C.
Hone, George John, 11, Strand. W.C.
White, James Sewell, 34, Cornwall-gardens, South Kensington, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Barker, William R., 143, Bond-street, W.
Berrow, Isaac, Clarendon-mansions, New Bond-street, W.
Bischof, Gustav, 4, Hart-street, Bloomsbury, W.C.
Dulcken, A. C., care of F. J. Angier, 79, Gracechurch-street, E.C.
Grinling, Charles, 35, York-terrace, Regent's-park, N.W.
Haynes, William, Vinter's-road, Maidstone.
Lumley, Joseph, 45, Upper Grange-road, S.E.
Mander, Samuel Small, 17, Gracechurch-street, E.C.
Seymour, Henry Danby, Athenæum Club, S.W.
Shepheard, Wallwyn Poyer Burnett, M.A., 18, Taviton-street, Gordon-square, W.C.
Sperling, Rochefort A., 22, Warwick-gardens, Kensington, W.
Thompson, Charles, Preswylfa, near Cardiff.
Young, Captain Allen, 1 St. James's-street, S.W.

The paper read was—

A METHOD OF PRODUCING PURE CHARCOAL STEEL DIRECTLY FROM THE ORE.

By Henry Larkin.

There is no subject in the whole circle of Metallurgical Art in which there exist such differences of theory and such uncertainties in practice as exist in connection with the very ancient art of making steel. We are not yet agreed even as to the specific compound we shall indicate by that long familiar word. For thousands of years we have been handling steel, for good and for evil, and familiarly speaking of it as if we knew what we were talking about; and yet, even to this day, it remains a mystery. Iron we know, and gold and silver, and perhaps every other metal and alloy of metals in general use, so that, in selecting them, we can define with very great accuracy the precise material we desire to obtain. The value of a bit of gold or silver may, by careful assaying, be estimated with any degree of accuracy that may be desired. The value of a bar of iron, if it be simply iron, is a perfectly known quantity. But with steel it is not so. The moment we pass from the consideration of iron, or of any other simple metal or metals, to the consideration of steel, we pass from terms of scientific accuracy to mere customary phrases of eloquent empiricism. Fortunately, however, with such speculations we need not now trouble ourselves. To an ordinary user and worker of steel a bit of good steel means a material prepared from iron which he can forge into a tool, and so harden and temper as to produce a good working point, or edge, or surface. Until quite recently the fundamental idea of all steel was tool steel, for piercing, for cutting, and for giving or resisting a blow. Within the last few years, however, a great change has taken place in our ideas on this subject. A new material has been introduced by Mr. Bessemer and by Messrs. Siemens-Martin of extraordinary value for strength and malleability, yet which is neither wrought iron nor tool steel, but intermediate between the two, both in composition and character; being as much stronger than the one, as it is milder and tougher than the other.

This mild form of cast steel, the manufacture of

which has already grown to huge dimensions, promises before long to supersede the use of iron for all the more important engineering purposes; and especially now that Sir Joseph Whitworth has perfected his method of casting under pressure, and thus of producing it as free from honeycomb, and as uniformly sound and reliable as the best wrought iron. But of this giant industry, full of interest for the future as it is, it is not now my business to speak. My present subject is one of far smaller dimensions, although by no means of smaller interest, namely, the good old fashioned tool steel, such as the natives of India knew how to make a thousand years ago, the value of which is not to be measured by mere thousands of tons. Really excellent tool steel may be a comparatively small thing in a commercial point of view, but it stands absolutely alone for value amongst all the implements and utilities of civilised life. We could better part with all the metals ever dug out of the earth than we could part with the steel from which our tools are made. There is not an art, or a comfort, or hardly a mouthful of food that we eat but, in one way or another, is dependent on steel. A good, trustworthy bit of tool steel is simply invaluable. But what shall we say of a bad bit of steel in comparison? There is *no* comparison. The difference is that of opposites; like that of good and evil, beneficence and malfeasance, like that of trustworthiness and of treachery. There is nothing that man can make more trustworthy than steel, and there is nothing more disastrously treacherous. Man has been wisely defined as a Tool-using Animal. With the exception of a few microscopic rivals and forestallers of our privilege, which Mr. Darwin knows of—Man alone knows how to make tools and how to use them. The highest artist is simply the man who can handle the best tools to the best purpose. The perfection of our tools is but another name for the perfection of our material civilisation, and every tool we can lay our hands to is made either of steel or by steel.

Such being the importance of steel, one would have thought that among all the developments and applications of modern science, one of the first and most indispensable would have been, to know how to make good steel with the same certainty and uniformity as we know how to make good sovereigns and shillings. But instead of this being the case, I believe I am stating a mere well-known fact, when I express my belief that there is not a manufacturer in Sheffield who really knows why his steel comes out sometimes good and sometimes bad. The bulk of our tool steel is still made, not by the light of science, with clear understanding of every step that is taken, but by the merest technical routine and rule of thumb.

Some three or four years ago I was ambitious enough to hope that I might do some little to correct this anomaly. It seemed to me that the production of steel must necessarily be an uncertain thing so long as the ordinary routine of doing and undoing—of smelting, and puddling, and converting, and sorting by rule of thumb, was continued. While occupied with these speculations, I was so fortunate as to obtain a few tons of the well-known magnetic iron sand to experiment with; and my thoughts were—Here is a perfectly uniform material, free from any impurity that would be injurious to the steel which might be made from it. If I can succeed in converting this material into steel by the agency of pure carbon and by strictly uniform treatment, I ought to succeed in producing a pure and uniform steel. My notion was, to thoroughly mingle the powdered ore with powdered charcoal in accurately regulated proportions, and then to reduce it in closed retorts at the lowest practicable heat, so as to prevent the reduced metal from cohering together. I saw from the first that if I could only obtain the reduced metal in a pure and powdered condition, I should have no difficulty in mixing together any reasonable bulk of such powder, so as to be uniform throughout; and that I could, by analysis or other experimental test, ascertain accurately what the entire bulk consisted of, and so know perfectly the material I was to work on. The next step I proposed was to prepare the material so obtained for being melted into cast steel of any required quality, by adding to, and intimately mingling with it just so much carbonaceous material as should be found necessary. This uniform mixture would only then need to be uniformly melted and worked; and, so long as the operations of nature are uniform, the result obtained could be no less so. Such was the origin of my method for making pure charcoal steel directly from the ore: which method, after the usual experiences of long months of disaster and disappointment, I have now the great privilege of explaining, in its matured and I modestly trust triumphant condition.

Before, however, proceeding any further with this explanation, it will probably be of some interest, and certainly will be only fair to my less fortunate predecessors, if I give a short sketch of what, almost unknown to me at the time I speak of, others have done or have proposed to do towards the solution of this interesting metallurgical problem. In order to keep my subject within reasonable limits, I will confine my notice strictly to the various attempts which have had for their leading principle the reduction of iron ores at a comparatively low heat in closed retorts. It has long been familiarly known that iron ores could be reduced at a heat very much lower than that needed for the fusion of the metal. In fact cast iron and cast steel are quite modern inventions. Originally all iron and steel was produced at such comparatively low temperatures, and worked only at a welding heat. But the idea of reducing iron ores at a low heat in closed retorts belongs, I believe, entirely to the present century.

So far as the records of the Patent-office inform us, Mr. William Neale Clay seems to have been the pioneer and first actual worker in this enterprise. In the year 1837 he obtained a patent for "Improvements in the manufacture of Iron." In his specification he speaks of the difficulty then experienced in smelting the richer kinds of hematite ores, which could only be done by "mixing them with poorer ores at considerable cost." He therefore proposes a method for "working such rich ores, and producing malleable iron therefrom by a very simple process, and at a comparatively small cost." He says:—"I take any quantity of red Lancashire or Cumberland ore, or other ores of a rich character, and break the larger lumps, by means of a pair of rollers or otherwise, to about the size of walnuts, which I believe to be the best size for working. With one hundred parts by weight of such broken re, I mix twenty parts of clean dry coal ashes,

or cinders, or of coke, charcoal, charred peat, anthracite coal, or other suitable carbonaceous matter, broken so as to pass through a sieve of half-inch mesh. The mixture is put into retorts or vessels, which I prefer to be of a ⌓ shape, about seven feet long, and eighteen inches high, and two feet wide, made of clay, fire-bricks, iron, or other suitable material." There is no special arrangement for heating the retorts, beyond causing the waste heat from a puddling or other furnace to pass through flues carried transversely beneath a row of such retorts, placed side by side, seemingly, from the drawing given, to the fabulous extent of some fifteen or more. It is quite certain that no such extensive arrangement of retorts was ever actually worked on this plan; but it is no less certain that Mr. Clay did really obtain a remarkable degree of success by his very simple, although crude arrangement. His retorts are shown as opening only at one end. Through this opening the mixture of broken ore and carbonaceous materials was shovelled into the retort, which when thus filled was closed by means of a moveable door. After the mixture had been kept at a full red heat for a sufficient number of hours to ensure the reduction of the ore, the door of the retort was removed, and the charge withdrawn into an empty iron barrow run alongside to receive it. It does not appear what precaution was taken to prevent the exposure of the red hot reduced material to the oxygen of the atmosphere. We are only told that when malleable iron is required, "the charge on being withdrawn from the retorts may be immediately conveyed into a puddling or balling furnace." The completion of the reduction was to be discovered "by taking out some of the pieces of ore from the retorts by means of a pair of tongs, and with a file filing the surface of such ore to ascertain whether it had arrived at a metallic state."

No further patented attempt of any note seems to have been made towards the solution of our problem until 1854, nearly seventeen years later. In that year a patent was obtained by M. Chenot, the scope of which was very much wider and more ambitious. He proposes to make what he calls "metallic sponges" from rich iron ores by reducing them in closed furnaces by the agency of pure carbonic oxide. This pure carbonic oxide is to be expressly manufactured for the purpose in the first instance. It is then used for the reduction of the ore, during which operation it takes up another atom of oxygen, and becomes converted into carbonic acid. This carbonic acid is carefully collected as it passes from the reducing chamber; and a sufficient portion of it is reconverted into carbonic oxide by causing it to pass through "a retort containing carbonised matter at an incandescent or red heat." By this means, he says, "I obtain a rich source of pure carbonic oxide; and the use of gas, which has hitherto been impracticable, is made very easy and effectual." If, however, the ore from which the "metallic sponges" are thus made should not be of sufficient purity to produce metal of the quality desired, "the sponge is to be pulverised by any suitable apparatus, and after pulverisation the matter passed to an electric sorting machine." No intelligible working description is given of this "electric sorting machine;" and the only novelty claimed for it is "the use of electro-magnets, employed to sort in a continuous manner," instead of "natural or permanent magnets, which have been used on a small scale to free brass filings from particles of iron." Nevertheless, the idea of applying it to such a purpose is of undoubted value, and M. Chenot is fairly entitled to the credit of having proposed it. Another idea of at least equal value is that, after the "metallic sponge" has been pulverised, and thus freed from extraneous matter, the metallic powder may, if necessary, be intimately mixed with carbonaceous matter and compressed into any desired shape. It is very singular that the value of this idea of mixing the powders was so little appreciated that it is actually added as a kind of second-best expedient. It seems not to have occurred to the writer that when he had thus got his materials into a powdered condition he could mingle them as accurately and as uniformly as if they were so many liquids. His main idea runs entirely on the singular advantages of the spongy condition. He says that if the ore be sufficiently pure "it need not be pulverised, and as the sponge properly prepared is porous, that property is used thoroughly to incorporate with the sponge the carbon necessary to the constitution of steel. To this effect the sponge is plunged into a fatty preparation, whose composition is calculated according to the density or absorptive power of the sponge, which latter absorbs equally throughout, and the excess of fat is driven off by distillation almost carried to carbonisation, and the sponge then contains all the constitutive parts of the quality of steel desired, the hardness of this steel varying according to the density of the fatty preparation employed. This method constitutes an entirely new principle, by means of which I obtain carbonate of iron with exact doses of carbon incorporated throughout its mass without the use of heat." There are many other ideas put forth in this specification which I need not specially refer to. The two points which seem to me to be really interesting, or at least which in any way anticipate my own method, are those which I have mentioned, namely, the "electric sorting machine" and the occasional pulverisation of the "metallic sponge" and its subsequent compression in moulds. There is no detailed description of any furnace or other apparatus by which the ideas are carried into practical effect, and there is very little that gives one the conviction of its having been written from actual working experience. In all cases, "metallic sponge" is M. Chenot's leading thought; and he only proposes to pulverise it when it proves otherwise unmanageable. This metallic sponge he proposes to melt into steel, either in a cupola, stratified with carbonaceous material, or in crucibles, or in the open hearth of a reverberatory furnace.

The next patent bearing directly on our subject is dated only a few weeks after M. Chenot's. This also is by a French gentleman, M. Bellford. The specification describes a very elaborately arranged furnace, in which reducing, refining, and melting are all carried on in a continuous series of operations, without allowing the material to cool down in the process. But the entire arrangement is ingeniously hypothetical and quite impraticable. The one point of interest for us is that "the ore from which the steel or wrought iron is to be produced is first pulverised in a sufficient manner according to its general character,

and next intimately mixed with charcoal or other sufficiently carbonaceous matter."

After this, curiously enough, there is another interval of seventeen years before the records of patents show any renewed activity in our special direction. In 1871, Mr. T. S. Blair, of Pittsburg, Pennsylvania, obtained a patent for "Improvements in the means and apparatus for the reduction of Iron Ores, and for preparing the same for reduction." The specification describes very clearly two ingenious and perfectly distinct arrangements of apparatus for exposing finely pulverised iron ore to currents of heated reducing gas. Nothing is said as to how the spongy iron thus produced is to be utilised; and I am unable to say whether either arrangement has stood the test of actual trial. But the probability is negative, as in 1872 Mr. Blair again comes forward with a patent for "Improvements in the manufacture of Iron and Steel, and apparatus therefor," the apparatus therefor consisting of a third arrangement of reducing furnace, much more elaborate than the two previous arrangements, and altogether different. This last improvement consists essentially of an arrangement of upright cylindrical retorts, about thirty feet high, and three feet internal diameter. The ore is to be fed in with carbonaceous matter at the top, and, when reduced, to discharge itself by its own weight, cold, from the bottom: the reduction being continuous, and the retorts kept always full. This idea of continuous reduction in upright retorts is rather taking in its simplicity, and was already adopted by M. Bellford in his special apparatus; but there are serious objections to it which will be considered presently. In this third arrangement of furnace Mr. Blair proposes to use as his reducing agent, either solid carbonaceous matter, or "gas flames rich in carbon." But, he adds, "when the carbon is supplied in a solid state (as charcoal, coke, &c.), the mixture to be treated will be found a bad conductor of heat, and if the process were conducted in a chamber of large area it would be impossible to convey to the central portion the necessary heat, so as to perform the work with regularity all through the mass. Hitherto this difficulty has not been successfully met. My improved method, which may be called 'initial heating,' removes the difficulty altogether."

If this were true, Mr. Blair's triumph would be great indeed. But this notion of the importance of "initial heating" is based on a very evident fallacy, the fact being that the real pinch of the work lies in the final, not at all in the initial heat given to it. Mr. Blair has devised what appears to be a sufficiently effective arrangement for bringing the upper part of his furnace to a full reducing heat, and he seems to think that having once thus started the operation, he has only to let the material slip down into the body of his furnace with a very moderate supply of extraneous heat, when the process of reduction will continue of itself! I read many months ago, in an American periodical giving an account of the exceeding economy of Mr. Blair's process, a distinct statement to this effect, namely, that the very operation of reduction, when once started, generated sufficient heat to secure its continuance, if only the inevitable loss by conduction and radiation were compensated by some small external supply. If this were in accordance with the facts, I should have to congratulate Mr. Blair on the efficiency of his furnace arrangements; but unfortunately the fact is exactly the reverse. The act of reduction, whether performed at a red heat or at a melting heat, absorbs heat instead of generating it. In fact it is a cooling operation, and not a heating operation at all. It is true the carbon consumed is half burnt into carbonic oxide, and a certain equivalent of heat is thus set free; but simultaneously the oxide of iron has to be wholly *un*burned, and a certain proportion of heat must as inevitably disappear. It is to supply this constant absorption during the whole operation of reduction, and, as it were, to compel the oxygen to leave the iron and put up with the carbon, that the heat of the furnace, so long as the reaction is to continue, needs to be kept up to its full efficiency by an extraneous supply. The notion of this process of reduction of iron when once fairly started, going on pretty much of its own accord, is, alas, but another instance of the "perpetual motion" futility, that brightest hope of the unregenerate human heart, to persuade nothing to bring forth something!

I have no hesitation in saying that any possible improvement in the "initial heating" of our materials, instead of removing the difficulty altogether, would be a matter of little or no importance to the success or the economy of the operation. The initial heat may be a very dull red, without involving much loss of time. The first half of the oxygen is very easily and quickly got quit of. The iron at first seems ready enough to part with it; but it is very different when it comes to its last gasp. Then comes the real tug of war between iron and carbon; and nothing short of full red heat, with clear preponderance of carbon, would ever compel the iron to quit its final hold.

I said there were serious objections to upright retorts for reducing. I do not pretend to imply that these objections cannot be fairly met. But to give my objectors every chance, I will briefly state my experience; for I have tried both methods. In the first place, I have not found the force of gravity to be at all sufficient to be depended on to clear them effectually. If the heat be raised a little too high, portions of the reduced metal are constantly liable to stick to the inside of the retort, and need to be thoroughly cleared off, or they would become more and more firmly adherent, until they formed a very serious obstruction. With a horizontal retort, in which each charge is entirely removed before another is introduced, this presents but little difficulty. But with a perpendicular retort, acting continuously and always kept full, it seems to me the difficulty would be insuperable. And Mr. Blair himself ominously admits that "the heat should be carefully kept at the required degree, which is a fair red tending toward yellow, as a higher heat makes the sponge sticky, and gives rise to trouble."

In the next place, even if the material did not stick very tightly to the retort, but the heat were only so much in excess as to cause the material to cohere together but slightly, and this is a thing which would be sure to happen occasionally, the thoroughfare would be inevitably blocked, and the furnace would cease to be self-acting. Lastly, even if the whole contents of the upright retort were periodically cleared out, as in the case of the horizontal retort, it seems to me, as an eye-witness of the difference, that the punishment the workman would experience in standing over the

mouth of a red hot retort to clean it, compared with that of standing at a moderate distance in front, would be alone sufficient to decide the question of their respective efficiency. Of course, in judging of what I now say, every needful allowance will be made for any possible bias of a rival patentee; but I am unconscious of having said one word from a wish to disparage any just claims on the part of Mr. Blair. I fully admit the great ingenuity of his inventions; but I do not believe in their practical value, and if I am to speak of them at all, I am bound to say so frankly. Mr. Blair has a further patent, two years later, in which he claims "the producing cast steel in the open-hearth process by the treatment of iron sponge with admixture of carbon and agents for accelerating carbonisation," instancing "yellow prussiate of potash." But in this idea he was anticipated twenty years before by M. Chenot, who, in describing his methods of carbonising iron sponge for the production of cast steel, either in crucibles or on the open hearth, says, "the carbon may be found in any powdered carbonaceous matter, or derived from salts of iron, of manganese, or of other metals, from alkalies in the state of cyanides, or from cast iron."

We must now return to the year 1872, in which year our American cousins seem to have been especially alive to the importance of the problem now under consideration. A few weeks after the date of Mr. Blair's principal patent, a patent was obtained by Mr. Joel Wilson, for "Improvements in Furnaces for deoxidising Iron Ores preparatory to their being worked into Wrought Iron." The specification describes a circular arrangement of upright retorts for the continuous reduction of the mixed materials, the main object of the invention being a more efficient and economical method of heating the same. In the same year a patent was obtained by Mr. T. R. Scowden, also of the United States, for "Improvements in the manufacture of Steel, and in apparatus employed for this purpose. This invention relates to "apparatus by means of which articles of iron have their exterior portions or entire substances converted into steel, by treatment with hydrocarbon vapour, and heat;" and consists further in the application of the same arrangement to the conversion of spongy iron into spongy steel.

In 1874 a patent was obtained by Mr. N. W. Wheeler, of the United States, for "Improvements in the art or process of reducing iron and other ores, the production of Steel, and in apparatus for the practice of the same." According to this invention, "ore in form of sand or powder is let fall in a shower down a shaft, having the upper part filled with a column of heating and even oxidising flame, and the lower part filled with a column of reducing gases, so that the particles fall first through the flame, and during such fall become heated to fusion or incandescence; and afterwards entering and falling through the reducing gas, yield up their oxygen to the carbon or hydrogen, and thus fall in a reduced state into a hearth or crucible at the bottom of the shaft."

Two days later a patent was obtained by Mr. Edgar Peckham, of the United States, for quite an assortment of improved reducing furnaces. Of this elaborate specification the only concise account I can give is, that it consists of fifteen pages of printed matter, and is illustrated by twenty-four very carefully prepared drawings. For further particulars I must refer to the document itself, for I can give no sufficiently brief description that would be of any value of the several arrangements proposed.

I have now indicated as concisely and as faithfully as I am able all the various proposals bearing on our subject which have been patented in England. And I believe I have frankly stated all the points in which I found that my own ideas have been anticipated. But I must add, not one of the specifications referred to shows any recognition of the facilities afforded by the powdered condition of the materials for accurately mixing, and for obtaining precision and uniformity of result. And, accordingly, not one of them proposes to begin with for reducing, a uniform mixture of powdered ore and carbon; and to end with for melting, a mixture of uniform metallic powder, with accurate proportions of whatever other powdered material may be necessary to produce the quality of steel required.

The list which I have gathered is the result of several days' very close research at the Patent-office, and I trust that no patent of any real importance has escaped my notice. No one of course is bound to take my judgment on the several proposals as in any way final. I have in each case given both name and date when referring to a patent, and it will be a comparatively easy task for any person desirous of pursuing the matter to recur to the original specifications and judge for himself. For my own poor judgment, I must say they nearly all seem to bear the marks of having been chiefly, and in some cases entirely, worked out on paper, instead of through the disastrous yet wholesome discipline of actual experience. With the single exception of Mr. Clay's patent, taken out nearly forty years ago, I doubt whether one of the arrangements so elaborately described on paper has stood the test of six months' good work actually done. M. Chenot's specification is, for the value of his suggestions, worth all that I have ever read on this subject. But his proposals, valuable as they are as suggestions, are very far from being carried out into working detail; and it is hardly to be wondered at, that a mind which could aim simultaneously at so many good things, should have practically missed them all. I believe the one secret of success in all such unknown enterprises is, to stick pertinaciously to one thing at a time, until you have thoroughly conquered it, and got it fairly in hand. I should be sorry to weary any one with a tedious account of all the difficulties with which I have had to struggle, one by one, in maturing the idea with which I started. That idea I have already indicated. And in that simple idea I venture to hope I have laid the foundations of a new method of producing steel, by which that seemingly inscrutible metalloid will yet be brought under the control of science, and be obtained in all its useful varieties with clear-eyed accuracy and certainty.

I trust we shall once more be able to produce steel of the purest and very highest character, rivalling even the Damascus and Toledo blades of which history speaks with such enthusiasm, but which, to most modern manufacturers, have become an unimaginable and incredible myth. There was a time when a man could speak of his "trusty sword" as an almost sacred thing, which, while

strength remained in his own right hand to wield it, could never fail him; when the proverb, "True as Steel," went home to each man's conscience, indicating to him whatever was most to be depended on in the hour of trial and direst need. The time now is when this high character has almost passed away; when a new proverb, "Treacherous as Steel," would more fitly express the experience of those who have to deal with it. I make bold to hope that we are fortunately destined, sooner or later, to change all that; that we shall all gradually rise to a higher appreciation of the value, not merely of really good steel, but of really good quality in all things; that "True as Steel" will not always continue the unmeaning phrase it now is, but will once more become the expressive symbol of all that is most honourable in our dealings with each other; and that we shall yet practically find, in all that we are engaged in, that business and beneficence may really walk hand in hand together, to the quite infinite advantage of both.

I am very far from boasting that we have already altogether realised this sanguine dream. I know too well how easily the best steel may be spoiled by unskilful manipulation, either in the melting or in its subsequent treatment, to hope that such perfection of results will ever be attained without a corresponding perfection of care and experience in every step of the process. I have no hope of ever being able to dispense with human faithfulness and sagacity; and I cannot confess to even a wish to do so. My utmost thought is to give faithfulness and sagacity a fruitful field to work in; and an intelligible method of working, by which good work shall necessarily lead to an equally good result. And this I do claim to have actually done. The Red Moss Metal Company has been working the process on a small, but regular manufacturing scale in Warrington for some eight or nine months, with all the difficulties of inexperience to contend with; and the tool steel which they have produced, for all varieties of temper and purposes, has been pronounced by those who have used it, with but few exceptions, superior to any other steel obtainable: samples of all which are now lying on the table.

It is true we have made our mistakes and had our disappointments, owing chiefly to comparative inexperience in the melting; but when I say that we do not go in for picked steel, and that the high testimonials we have received are simply testimonials to our average production; and that it costs us no more to produce the best steel than it would cost us to produce the worst; manufacturers of steel will fully understand the importance of such a statement, however little they may as yet be able to credit it.

I said that I began my experiments with a few tons of pure magnetic iron sand. There are many large deposits of this singular ore in various parts of the world. One of these deposits, many miles in extent, exists on the coast of Taranaki, in the northern island of New Zealand; and a few years ago there was a great talk of the wonderful iron and steel that could be made from it. But all these sands, which are essentially disintegrated magnetic oxide of iron, although specially suited to the process under consideration, are very troublesome to work in a smelting furnace, on account of their liability to choke it. For this reason there has been hitherto little or no market for it, and there has been no encouragement to anyone to bring a continuous supply. In consequence, we have not found it prudent to depend on any mere iron sand as the basis of our manufacture. Any rich and pure ore is almost equally available; although there is an advantage in the magnetic oxides which will appear as we proceed. The ore which we are using comes from Marbella, on the south coast of Spain. It is a magnetic oxide, rich, pure, and easily disintegrated, and it can be obtained through the Marbella Ore Company regularly, punctually, and in any quantity required.

The large and small lumps of this ore are first passed through the jaws of a Blake's crusher, set as closely together at the bottom as practicable, and the crushed material is sifted as it falls. The coarser portion is then passed through a disintegrator. In this way the whole bulk of the ore is very cheaply and readily reduced to the condition of the iron sand already described. But of course the gangue of the ore is crushed equally with the ore itself; and the next step is to separate the actual ore from all such extraneous matter, and get as nearly as possible a pure oxide of iron. This is very effectually done by means of a self-acting magnetic separating machine, specially devised for the purpose, and capable of dealing with large quantities of material. In this machine the particles of magnetic oxide are picked up by magnetic attraction, and carried into their proper receptacle while the refuse is safely deposited in another. Having thus got as pure and rich a material as possible in a powdered condition, the next operation is to thoroughly mix with it a sufficient quantity of powdered carbonaceous matter to combine with the oxygen of the ore, and thus effect its reduction. The carbonaceous matter used consists of powdered charcoal and powdered resin, or other suitable bituminous substance, the two being reckoned together somewhat in excess of the oxygen to be removed. This mixture of powdered ore and carbonaceous powders is slightly warmed, and compressed into bricks in an ordinary brick press, and will then be ready for the reducing furnace.

The reducing furnace consists of a series of ⌓ shaped gas retorts, with doors to open at each end. These retorts are heated by a fire acting somewhat upon the principle of a Siemens' gas-producer, and are thoroughly supported throughout their entire length by an intricate arrangement of brickwork, which also serves to prevent a too ready escape of hot air into the flue. The burning gases from the fire are also made to completely envelope the retorts by being carried over and under in a zigzag way, thus still further delaying their passage and arresting the heat with which they are charged. Air-holes are opened at regular intervals in order to complete the combustion of the gases as they circulate around the retorts, thus securing the greatest heat where it is actually wanted and also securing complete combustion of the fuel used. I need hardly add that the consumption of the smoke is perfect. There are other points of importance in connection with the furnace, but as they would not help to a clear idea of the method as a whole they may be omitted.

Let us now imagine one of these retorts at an average working heat, empty, and ready to be charged. The door being removed from the feed-

ing end of the retort, a small stack of pressed bricks, consisting of ore and carbonaceous matter, and of bulk to fill the section of the retort, is closely packed on a rectangular plate, and pushed into the further end by means of an iron rod. The iron plate is then withdrawn, leaving the small stack of bricks securely placed. A second and third feed immediately follow, filling the retort, which is at once closed. After having been exposed to a pretty full red heat for nearly twenty-four hours, gas will have ceased to be given out, the carbonaceous matter will have become practically consumed, and the oxide of iron will have become converted into red-hot iron powder.

The next problem is how to convey this red-hot powder from the retort without exposure to the action of the atmospheric air, and to keep it so till it is cold. We will now imagine a charge ready for such removal.

Ordinary coal gas is first, by means of pipes provided for the purpose, turned on into the inside of the discharging end of the retort, in order to produce a full outward pressure of gas while the discharging door is removed, the door being at the under side of a projecting end-piece of the retort. This door being thus removed, an iron receiver is brought up closely under the projecting end-piece, and securely supported there. By a similar arrangement of pipes, gas is now let also into the inside of the feeding end of the retort, when the door of that end is quickly removed, and a temporary door with a wide slot halfway down the middle of it, is put in its place. The slot is for the introduction and working of the discharging tools, by which the red hot powder is quickly pushed forward into the receiver placed at the discharging end. As soon as the retort is empty, the gas at both ends is turned off, and the iron receiver containing the metallic powder is removed and kept carefully closed until its contents are cold. When the metallic powder is sufficiently cooled down, and no injury can arise from its exposure, it is turned out of the receiver, and again passed through the disintegrator and the magnetic machine for a final purification.

Thus by a few simple and almost self-acting operations, requiring little more than faithful attention and accuracy in weighing and mixing, we are able to produce the pure metallic powder, the value of which I have already sufficiently urged. For the production of tool steel, which is the subject immediately before us, we mix with the metallic powder (besides some small percentage of flux) whatever additional amount of carbon may be needed, chiefly in the form of resin. This resin enables us easily to compress the finished powder into solid cakes, in the same way as the bricks of ore and charcoal were compressed in the first instance. The cakes of finished material are then stacked up, ready to be melted in crucibles in the usual way, with the addition of manganese or any other alloy that may be found advantageous.

If I were now asked for a definition of steel, which should be quite up to the latest development of science and art, instead of venturing upon some high speculative abstraction, I am afraid I should be tempted to modestly reply: — A metalloid obtained from an accurately adjusted mixture of pure iron powder and carbon, perfectly fused with the addition of manganese, either in crucibles or in an open hearth furnace.

DISCUSSION.

Sir Antonio Brady said he had had the privilege of seeing some of these operations for converting ore into steel direct, both in America and in this country, and the greatest advantage they possessed was that the metal was reduced at a low temperature, and did not mix with the impurities. It then became extremely infusible, and when it was put into the Siemens-Martin furnace, the metalloid was in a pure state, and the impurities were melted off with the slag, instead of being mixed with it as in the case of a blast furnace. There was no doubt therefore that chemically speaking this process was infinitely superior to that in common use. The only question was as to the amount of carbon needful to be introduced. Mr. Blair, at Pittsburg, was converting ores on a commercial scale very successfully, but he used ores from the Iron Mountain, which contained 60 or 70 per cent. of pure iron, so that they were much more economical than the impure ores of Europe, especially the clay ironstones of England. A firm at Burslem had lately put up some test works to try this process, but unfortunately they tried to improve upon it by making the retorts in one piece, the consequence of which was that, expansion not being allowed for, they broke down, and the proprietors had not yet got the apparatus into work again; he believed they would do so in a short time, and they would then have a sponge which could be reduced in a Siemens-Martin furnace. This process would have been utterly useless without such an apparatus for fusing the metal, for pure iron was almost infusible. Mr. Larkin had shown some very ingenious contrivances, but it appeared to him the process was only useful for magnetic ores, whereas Blair's could be applied to any ore sufficiently rich to pay for reduction. Messrs. Ireland were doing this by means of peat, and thus avoided the general impurities of sulphur and phosphorus, which were so prejudicial. He did not quite agree with Mr. Larkin that the horizontal retorts were an improvement, because he feared the iron would become oxidised in the very act of discharging. He believed Chenot failed entirely through cooling the sponge and not taking it direct into the reverberatory furnace, for it lost nearly 30 per cent. by oxidisation. Mr. Blair's retort was vertical, heated by gas on the outside, and the carbonic oxide given off in the retort took flame, and thus the gases were used to reduce the ore. The great advantage of his plan seemed to be that in passing down by gravity, the mass at the top was sufficient to keep the atmospheric air from having any influence on it while hot. In time there was a very great saving, for it only required four hours to reduce the ore instead of twenty-four. In other respects the two processes were very similar. The specimens of steel on the table were very fine, the whole thing was very ingenious, and he hoped they were on the eve of great improvements in the manufacture of both iron and steel.

Mr. Riley thought Mr. Larkin had hardly done justice to previous inventors, having simply got his details from the Patent-office; but as he had seen some of the processes at work on a large scale, he might venture to state the results. David Mushet was the first who made steel direct from the ore, and in 1855 or 1856 the Ebbw Vale Company put up one of Renton's furnaces, consisting of a series of upright chambers, about nine inches square, built of fire-brick, in which were placed the ore and charcoal mixed, while the products of combustion from the reverbatory furnace below passed up through them. They worked it for some time, and produced some excellent iron, using the Ebbw iron, not a magnetic oxide; but the process was discontinued after a time. M. Chenot's process was practically tried at Sheffield by Messrs. Moss and Gamble, in 1864 or 1865, and at the time he thought it would be a failure from the proportions of the furnace. Speaking from memory, he believed the retorts were about two feet square and

six or eight feet long, and the fire was to go up through a space on each side. As might have been expected from the non-conducting character of the material, the ore was fused on the side of the fire-clay partition before the heat got through; but still some excellent steel was produced. M. Chenot's plan was the same as Mr. Larkin's, except that he used vertical retorts; the sponge was crushed and melted in crucibles. One of the great causes of failure seemed to be the difficulty of getting the heat to pass through; and there was also some uncertainty in the product. The great disadvantage in making steel direct from the ore was that in melting it in the crucible it occupied so much bulk, that you only got eight or ten pounds out of a pot instead of about sixty. From experiments he had made many years ago he had no doubt that very excellent steel could be produced direct from the ore, but up to within the past six or eight months his opinion was in favour of reducing the ores, and making the steel from them, but his ideas on this point had been very rudely shaken lately. He had seen some samples of Siemens-Martin metal made in Sweden which was now used largely in this country, and practical opinions were that it was everything that could be desired for a soft material. It was almost chemically pure iron, indeed the purest he had ever examined, and he had had some 25 years' experience; purer than the finest drawn iron wire, containing only .05 per cent of carbon and a mere trace of phosphorus. If iron could be produced of such a quality he did not see how any process like this could compete with it. There were a great many objections to the sponge, in the first place it oxidised very rapidly, it was very apt to absorb sulphur, and was very difficult to melt. With regard to tool steel it was very difficult to tell what its excellence consisted in; he had found two very large manufacturers, one using Mushet's steel and saying they could not get anything like it, while the other did not care about it. He questioned whether it was necessary to have the steel pure, for he had turned up a cast steel wheel with a tool made from steel containing two per cent of silicon. The steel made at Sheffield had not been so good lately as it was formerly, and he was lately informed that at the Crewe work they were actually using up the old slide bars of locomotives made in the early days of locomotives. For such purposes price was not an object; if you could get good quality it mattered little whether the steel for a tool cost 6d. or 6s. a pound. Still, he thought it an open question whether this new process was the best for the purpose. Swedish pig iron was a perfectly pure carbide of iron, and it could be supplied at a little over £5 a ton, and this, he thought, would compete with any direct ore process. Mr. Larkin had not alluded to one process by which carbon and iron were oxidised by means of rich iron ores, a process which he believed was actually in use on the Continent. Again, he believed the rotatory puddler would give, as nearly as possible, practically pure iron, no matter what the pig contained in the first place. There was also the process of Dr. Siemens, by which he, with appropriate machinery, reduced the iron ore, and melted it with the other materials by means of powdered coal. There you had the advantage of a flux, which would take up all the impurities.

Dr. Siemens, F.R.S., said the old Sheffield method of making cast steel might be called a method by error. They took the ore and smelted it in a blast furnace, turning out a product which consisted of iron mixed with slag, and a great deal of carbon, all the carbon that could be gathered from the ingredients put into the furnace. All that foreign matter had then to be removed, and so it was puddled. The result was iron mixed with slag, but without any trace of carbon, or at any rate in no definite combination therewith. This was not what was wanted, which was iron combined with carbon, or steel, and so it was again subjected to a very different process, termed cementation, whereby it was kept heated for a fortnight in a furnace, packed with charcoal. This gave a metal which was certainly steel, but it was mixed with slag and full of blisters, so that it was not yet fit to be used. After some years they adopted the method of fusing it into pots, and so produced cast steel such as was used in Sheffield to the present day. Any means of producing this material by a short process must be of great importance to the country, since steel was becoming more essential every day. Several methods of producing steel direct from the ore had been mentioned, but others had been omitted. He himself introduced the system of reduction by a rotator in 1868, and might state the results he obtained. The cheapest and most direct method of reducing iron ore was in a rotatory furnace; the iron ore and the carbonaceous material were introduced at one end of a large rotating cylinder, and brought out in the condition of spongy iron continuously at the other end; nothing could be simpler or cheaper, but still he saw reason to abandon it. First, because the spongy iron thus obtained absorbed in the very process a good deal of sulphur, and this could not be remedied unless you could prevent its contact with the sulphurous acid produced in the combustion of the coal. Then, again, it was not easily dissolved in the bath of metal, even if that were sufficient, because it floated on the top, and rapidly oxidised under the influence of the flame of the furnace. Moreover, unless you used such materials as could not practically be employed on a large scale, the spongy iron became enclosed in the gangue of the ore, and would not melt in the metallic bath, the gangue forming a screen which prevented intimate contact between the fluid and the solid sponge. He, therefore, modified the process without abandoning the principle of the rotatory furnace, and now raised the heat to the point of melting, not the ore, but the gangue contained in it, and thus effected the reduction. The result was a metallic ball enveloped in scoria, which did not absorb sulphur, and which could be hammered out into bars, or transferred to the open furnace and melted down into steel. He believed that would be found the cheapest and most direct method. He alluded chiefly to the production of mild steel in large quantities, with regard to tool steel he was not sure if the presence of a little foreign matter, such as silicon and sulphur, should be entirely avoided. The famous hard steel of India contained a considerable proportion of these elements, and generally compounds of iron were harder than the pure metal.

Mr. Mattieu Williams said he differed from Dr. Siemens and Mr. Riley with regard to the necessity of tool steel being absolutely pure. He considered for such purposes they required simply pure iron and carbon. The reason why complicated methods such as had been described were employed was that we had such impure materials to deal with. The Hindoos, Chinese, and other people, who he believed made steel before they made iron, because it was a much simpler process, selected small quantities of fine ores, and by means of nearly pure carbon, converted it into iron, combined accidentally with more or less carbon from the charcoal they used as fuel. We used coal containing pyrites and other impurities, and very bad iron ores, even those of Cleveland, some of which were actually deposited on fossil fishes, so that it was no wonder they contained phosphorus. Thus bad iron was made first, which had to be purified in a puddling furnace, and the carbon had to be added afterwards. There were two distinct branches of manufacture, that of iron and mild steel on a large scale for rails, girders, and the like, and of perfect steel for tools. He believed the tool referred to by Mr. Riley was the one which he had exhibited at the Chemical Society, and that illustrated a fallacy very commonly fallen into on this subject. That was a tool to be used in a lathe for turning iron or steel, and for that particular purpose hardness was the first essential; the angle at the edge of the tool was nearly a right angle, as it was in all tools of that character, and hardness was the

great requisite, which no doubt was increased by silicon, but at the same time it rendered it brittle. The real test of tool steel was that it should be suitable for a razor or for a carpenter's plane or wood-chisel, where you had an acute angle. He had seen some splendid steel made from Swedish iron, and remembered very well a cutler at Tronjhem trying one of his carving knives against one of English manufacture by chopping the edge of one against the edge of the other, when the Swedish knife cut into the edge of the other one without losing its own edge. If the English knife had been a hard one it would have broken, but being soft it was notched. That hardness was not the only requisite was shown by the method of tempering. In the case of a razor it went down, not to a straw colour, as in the case of a file or turning tool, but nearly to a blue, showing that hardness was not the first essential. One peculiarity in Mr. Larkin's process seemed to have been missed, even by himself; it was not, as he termed it, a direct process of making steel, but an indirect one, and that was a great merit. First, he produced pure iron, and then converted it into steel by a process akin to cementation.

Mr. Hale thought Mr. Larkin had been rather severe on his predecessors, and wished to know what was the cost of producing steel by this process as compared with the old method.

Mr. Riley said Mushet's steel was never hardened, but was thrown down and allowed to cool. Some of his steel contained $1\frac{1}{2}$ per cent. of silicon, and it made some of the best "jumpers" ever seen in South Wales. It also made good knives and razors. He still thought it an open question whether pure iron and carbon made the best steel for tools.

The Chairman said Mr. Larkin seemed to assume, though he did not say so, that earthy matter combined with ore was a great difficulty, and that a certain process was necessary for the purpose of getting rid of it. He, however, was able to state, as the result of many and costly experiments, that nothing was more easy than to take up that earthy matter, and thus was let in a large class of ores which would be inadmissible if this process were necessary; and it was of great importance that we should be able to utilise our own native productions. He had no difficulty in adjusting the carbon or the fluxes, and obtained a perfectly clear transparent glass, and a steel of the most remarkable density, which had the peculiarity of tempering at a low blue, and therefore as, to use the trade term, it did not take up all the water, you could raise it to any required degree of hardness. It would produce a turning tool at violet, and if raised to a straw colour would almost break when dropped on the ground. Its density was about $\frac{1}{8}$ more than ordinary. These peculiar properties probably arose from some molecular constitution, which was not obtained when the metal went through several distinct processes. Another experiment he had tried was this:—At one end of a long retort he put some hematite, and at the other some extremely well dried peat; it was submitted to the usual process, raising it to a cherry-red heat, until all the steam had passed off from the peat; the retort was then closed, and left for about an hour and twenty minutes, and he had then obtained, not a metallic sponge, but an absolutely cemented mass, which could be run down into steel with the greatest facility. He was confident that the method of reduction by means of carburetted hydrogen gas admitted of the greatest nicety both in reduction and cementation, and if it could be carried out would be very advantageous. You got not a sponge but a cemented mass, which could be drawn from the retort with no danger of re-oxidation, and could then be reduced to powder and mixed so as to produce as close an average quality as you pleased, and you then had only to add the fluxes and melt it. But the great difference in all these direct processes was the melting in pots, which came very expensive. Some time ago he found it necessary to manufacture some cams for large tilt hammers, and he did so by running the steel made directly from the ore into moulds, merely skimming off the scoria and running the metal directly into the mould; so made, he found they lasted for years, notwithstanding the heavy and sudden shocks to which they were subjected. He concluded, by moving a hearty vote of thanks to Mr. Larkin for his valuable paper.

The motion having been carried,

Mr. Larkin, in reply, said he had by no means attained the degree of perfection in his process, which he believed it was capable of, but he had great pleasure in describing its present position. He did not suppose it would supersede everything, but he claimed for it especially the means of securing accuracy of operation in the production of steel. He could not at present go into the question of comparative cost, and certainly could not compete in that particular with some of the larger processes which had been described. However, all the differences of opinion which had been expressed with regard to the qualities of good tool steel seemed to show the value of his method in enabling makers by careful attention to details to ascertain exactly what was being produced. He could take pure iron and mix it with any other powder which he found convenient, but practically at present he only used carbon and a small portion of manganese. Whether other additions might not be found to improve the quality of the product he was not prepared to say, but in any case it must be an advantage to have pure iron as the basis of operations. He quite agreed with the remarks of Mr. Williams, but still thought he was justified in terming his a direct process, especially after Dr. Siemens' graphic description of the old roundabout method. A remark had been made that it was only suitable to magnetic ores, but this was not the case, though it was especially applicable to them, because you could then get rid of the gangue before commencing operations. He had produced as good steel from rich hematite ore, the only difference being that he could only use the magnetic separating machine after the reduction had been completed. The greatest practical difficulty was that of discharging the retorts, but it had been entirely overcome by the arrangement he had described. The time occupied depended on the bulk operated on. He had, no doubt, omitted mentioning some previous inventors, but he had made no pretensions to give a complete history of the process, for which, indeed, he did not feel competent; still he felt bound to give what information he possessed, and after going to the Patent-office had given the account of each process, so far as possible, in the inventor's own words.

JUVENILE LECTURES.

Two lectures, suited for a juvenile audience, will be given on Tuesday, January 4, and Tuesday, Jan. 11, by Dr. W. B. Carpenter, C.B., F.R.S., on "The Wonders of the Microscope." The lectures will commence at 7 p.m., and will be illustrated by the oxy-hydric and electric lights. As the number of seats is limited, tickets have only been issued to the extent of the accommodation available, and the issue has now ceased, enough applications having been received to fill the room. Members are reminded that in no case can any person be admitted without a ticket. To this rule no exception can be made.

MEETINGS FOR THE ENSUING WEEK.

Tues....Anthropological Institute, 4, St. Martin's-place, W.C. 1. Mr. John Evans, "Note on a proposed International Code of Symbols for use on Archæological Maps." 2. Miss A. W. Buckland, "On Divination by the Rod and by the Arrow."

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Experimental Electricity." (Juvenile lectures).

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FRIDAY, DECEMBER 31, 1875.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The competition for the four free scholarships given by the Society will take place in London in February next. The competition will be restricted to nominees of members of the Society, each member having the privilege of nominating two candidates, one of each sex. Forms of nomination, and all information as to the terms and conditions of the competition, may be had by applying to the Secretary.

EXAMINATIONS IN DOMESTIC ECONOMY.

These Examinations are particularly intended for women, but there is no reason against men taking certificates in them. The subjects are—

Clothing and its Materials.
Health.
Housekeeping and Thrift.
Cookery.

The Examinations will, in 1876, be held simultaneously with the Commercial Examinations, commencing on the 25th of April.

Programmes may he had gratis, on application to the Secretary,

CANTOR LECTURES.

The second Lecture of the first Course of Cantor Lectures for the present Session, "On the Discoveries and Philosophy of Liebig, with especial reference to their influence upon the advancement of Arts, Manufactures, and Commerce," by J. L. W. Thudichum, M.D., was delivered on Monday, November 29th, 1875, as follows:—

Lecture II.

Analysis of Researches and Discoveries continued.—Advancement of General and Organic Chemistry by Elementary Analysis.—Lectures and Laboratory Teaching.

If in the contemplation of human occupations we inquire after their general purport or their ultimate object, we seem to come to a conclusion which compels us to believe that in comparison with the general powers and laws governing the universe they are perfectly trivial. Mill has defined the general purport of human occupation as the carrying of things from one place to another. If we consider that there was a time when there were on this globe no beings which we call organised, and that it is perfectly certain that there must be a time again when there shall be on this globe no beings that we term organised, we involuntarily come to the conclusion to which many ancient philosophers came, that everything was idle, that there is no object in existence, and that it would have been much better if man had not been born at all. But when we again consider that it is possible to enjoy life, it seems necessary that we should arm ourselves with faith as to the improvability of human affairs, which will be mainly that of the Epicurean school, namely, that we should endeavour by the exercise of all our powers to make this existence, such as it is, as happy and as agreeable as we can. Now the sources of happiness of the human mind are many and various. They are physical and they are metaphysical, so called, and to the metaphysical belongs that peculiar innate craving, the desire for knowledge. The want, therefore, that all ages have after they have satisfied their physical wants, is to endeavour to obtain a kind of food for their minds, which is generally defined as an idea of the laws which govern the world, and for which the ancient term as meaning the love of knowledge was philosophy. In modern times we find that those men have been the greatest philosophers who have apprehended both these objects of the human intelligence, namely, who have at once sought the material well-being of man, and at the same time have increased that knowledge which in itself is not useful in the sense in which we generally use the term, but affords only pleasure to the mind.

One of these men was Oersted, the great Danish philosopher, the discoverer of the principle of electro-magnetism, upon which are based those wonderful instruments, the telegraphs. In one of his philosophical discourses Oersted says the picture of the world, which even the highest philosophers have framed for themselves, has frequently suffered by want of appreciation of natural things. He then continues:—

"That an idea of the world is a fundamental part of every philosophy I do not need to prove. But that this philosophy must be partly empty, partly and in many parts erroneous, if it does not receive the essential portion of the truths which are taught to us by natural science is not less certain."

Although the philosophers of the present time are not unacquainted with the results of natural science, yet they so far neglect them that natural science has hardly any influence upon their teaching.

In the last lecture I showed you the contrast between the philosophers of Germany at the end of the last century and the beginning of the present, and the philosopher whom we have come together to remember and consider. I now come to the interchange of ideas which took place between a more modern philosopher and Liebig himself, and this modern philosopher is Mill. In one of the prefaces which Liebig prefixed to his Animal Chemistry, he uses of Mill's work on philosophy these remarkable words:—"The author cannot disguise how great has been the use which, for his purposes, he has found in the study of the System of Logic of John Stuart Mill; nay, he believes that he has no other merit in what he has previously said, but that he has carried out some of the principles of inquiry into natural things which this eminent philosopher has previously enunciated, and that he has applied some other principles to special events in nature." If we now go to Mill's works, we shall find that in his Inductive Logic he tells in one of his chapters on the explanation of natural laws how the researches of Liebig on respiration, on contagion, and others must be considered as admirable examples of the severity of the deductive method. And it will strike you at once that there must be an essential and great difference between the philosophy of

the beginning of this century and that of John Stuart Mill, which gives a distinct colour to the mode of thinking of the present day. In order that we may more fully appreciate the points of contact and the differences, I will now proceed with a short analysis of the early labours of Liebig, and I shall do so in this manner. Whenever I come to a cardinal discovery or research I shall make a short halt, enlarge upon it as far as will allow of illustration and demonstration; in that way I hope we shall get over the ground agreeably and profitably, and without too much occupation of our time.

In the year 1823 was published the first paper of Liebig; it was in French, under the title of "On a Green Colour," and in the same year, that on the "Fulminates of Silver and Mercury." An Englishman named Howard, remarkable for several other discoveries, first made this peculiar compound, and it was called for many years the "fulminating compound of Howard." So it was originally named in Liebig's paper. You know that a considerable use is now made of fulminating compounds, for it has been discovered not only that they could be used as they had formerly been in the form of percussion caps, but that by their peculiar action they determine a peculiarly violent explosive function of gunpowder, of nitro-glycerine, of gun-cotton, or of various other explosives, which thereby either became for the first time useful as explosives or had their usefulness very largely increased. We see then that the research made in the year 1823 on these fulminating compounds, which then had no use whatever in trade, commerce, or manufactures, has now a bearing in its consequences and is of immense usefulness. The quantities of fulminates which are used in the world at large are very considerable, and you see here another illustration that in scientific research it is not at all requisite that there should be a direct practical object; but that on the contrary it is frequently very much better to work on in the field with which the inquirer is acquainted, no matter how remote it may appear from any practical application, and to exhaust a subject for the time, so that at a subsequent time there should be nothing to be added thereto, and then the application will appear at a certain time by a convergence of circumstances, or if you like to call it so, by accident.

In the year 1824 we find Liebig engaging in those questions which then agitated the minds of chemists. They knew that there were two varieties of carbonate of lime, of which the one is called arragonite, and the other chalk spar. The analyses of these compounds, such as they were at that time, were sufficient to prove that though they had different appearances and different forms of crystals, yet they had one and the same chemical composition. However, it was held by chemists at that time that identical chemical composition involved of necessity identical physical properties, and various explanations were offered of these chalk crystals. One of them was the theory that carbonate of lime was present in the one, say the chalk spar, and that in the other, the arragonite, there might be present calcium metal, which was less oxidised, and an acid which was more oxidised. These explanations were all rejected, and as is frequently the case, the best analyses were doubted, and in the general fight for supremacy, the one or the other chemist had the best of it, according as he could best persuade his followers. Already in 1824 we find Liebig investigating this question, and he found that he could produce artificially these carbonates of the earths, including those of baryta and of strontia, and he shows that if carbonate of lime be precipitated from a boiling solution it takes the form of arragonite, and if precipitated slowly from a cold solution it assumes the form of chalk spar. Here then is a principle which might lead to the explanation, viz., that absence or presence of heat, or of more or less heat, might have a determining influence in producing various forms. But the solution was not admitted, because, as I have said, nobody believed that these bodies were dentical in composition.

The acid which Liebig found to be combined with the fulminate of silver and mercury, and called fulminic acid, was ascertained by him and Gay Lussac, with whom conjointly he made this research, to have a certain composition. The results were published in vol. 25 of the "Annales de Chimie," under the title of "Analyse du Fulminate d'Argent." A few years later Wöhler published a research on and analysis of an acid consisting of nitrogen, carbon, and oxygen, which was called cyanic acid because it was obtained from a body called cyanogen, and he observed that this very acid had the same composition as the fulminic acid of Gay Lussac and Liebig. Here again the incredulity of the chemical world was so great that some rejected the analysis of Liebig, and some that of Wöhler and Berzelius, would know nothing of the proposition that there could be bodies having the same chemical composition and yet being different in chemical properties and in physical appearance. Wöhler's research on cyanic acid appeared in 1825, and it was on his paper as a theme that Liebig wrote.

In that year also he decomposed the fulminate of silver by sulphuretted hydrogen.

In 1826 he investigated various questions connected with mineral waters, others connected with cyanates, worked on bromine and on some double salts, one of which had a very important bearing upon a subsequent event in his life. He found in pan-deposits of the salt works at Salzhausen a peculiar double salt of potassium and calcium carbonate; and that double salt he afterwards employed when he formed his first artificial manure for the purpose of making, as he believed advantageously, potassium salt insoluble in water. Therefore this is important, as evidently having given him at that time a certain method upon which he worked for several years, until he subsequently recognised his error, as we shall see in a future lecture. He also analysed some double salts of cobalt and others, and with that the year 1826 closes. Let me add that during the whole of this time he was engaged, without publishing, in perfecting and elaborating methods which we shall have presently to speak of.

In 1827 we find him again appearing in French with a "Lettre sur quelques Combinaisons Particulières," and also with a memoir upon the bitter substance produced by the action of nitric acid upon indigo, silk, and aloes, which was afterwards known under the name of carbazotique acid, and is now called picric acid, owing to its very bitter taste. This substance has become a dyeing material for silks and various other tissues. It is made in large quantities, and it is very curious that the impure acid is preferred by dyers to the pure, from which many chemists draw the inference that the natural dyeing ingredient is not the picric acid itself, but that it ought really to be white, or colourless, and that that which dyes is a yellow matter, which hitherto chemists have not succeeded in removing from the crystallised acid.

He continues in the year 1827 to study indigo; and he also works on the subject of nitrification, and makes some remarks on bromine and bromide of potassium.

In 1828 he studies again the bitter substance in aloes, and the before-mentioned carbazotic acid. Aloes form the most important drug in the pharmacopœia. It is, perhaps, the most ancient of medicines, and has been the most benefit to mankind through the longest period of time. It was known to the Romans, it was brought from India, and was sold in small pills which were called *coccii*, and this word having been generally used on the drawers of English druggists, people now ask for purgative pills under the name of "pill coachy." There is nothing surprising that a man of the education of Liebig, who had great facilities, being in his father's business, which was that of a wholesale druggist, should also study this most important of drugs, but as many things are hidden from us for a long time until they are found out by accident, so at this time crystallised aloetine

was not discovered, and it was only a few years ago that the active ingredient in aloes was isolated and discovered.

We find him again in 1828 investigating the composition of this carbazotic or picric acid, and he published several other papers, particularly those marked 21 on the list, in which he found that from this acid nitric acid may be reproduced, so that it was necessary to assume that carbazotic acid was a compound of an organic body into which the nitric acid had entered as an ingredient, though not discoverable by ordinary re-agents for nitric acid.

In 1829 we find him engaged on the compounds of chlorine and upon some salts. He works on the platinum black of Edmund Davy, and on the peculiarities of platinum sponge inflaming hydrogen. He gives a new mode of preparing the cyanic acid of Wöhler, and also makes the discovery of hippuric acid, and gives a correct analysis of it. In 1830 he had already discovered organic analysis, and now begins that wonderful series of researches which has enriched chemistry with the largest amount of data which were ever given to tho science. Tho year opened with a research on the composition of malic acid, that which gives to apples and various other fruits their sour taste. He also gives a mode of producing nickel and cobalt free from arsenic; and if you consider that nickel, which at that time had not been used at all for any trade, but now is used very largely for the purpose of producing that most useful, desirable, and at the same time cheap material called nickel silver, a manufacture which the Messrs. Elkington have pushed to the highest perfection, if you consider that this is one of the most useful metals which you possess now, you will see that this paper of Liebig's was one of very great importance; for it is within my own knowledge that much of the nickel employed at Messrs. Elkington's works 15 years ago came from Nassau, where I have myself seen the nickel produced by Liebig's method.

In this year commenced the publication of the analyses of organic compounds which were so important; and here I may ask you to consider what was the state of knowledge relating to the composition of organic substances at the end of the last century. The idea of organic as distinct from inorganic did not exist; substances were called vegetable and animal, but that there was any connection between vegetable and animal, or any similarity in the action, did not enter into the mind of any one. Their constitution, from the ingredients which entered into them, and which formed their bodies, was not yet known. The mode which was applied to their investigation was generally one which we know now to be destructive of the very purpose for which it was instituted. When a chemist wanted to know what an organic matter consisted of, he put it into a retort, applied heat, and then watched what took place. First there came over water, then there came an oil; next there came an alkali which he knew well enough in the shape of ammonia; but then there came gases which escaped, and he did not collect them, and lastly their remained carbon in the retort, and by continuing to incinerate this carbon there generally remained a residue of ash which might arrest his attention or not. In most cases this ash was considered an accidental ingredient, and although for example Boyle, a celebrated English philosopher, when incinerating blood he found a red ash, was highly puzzled to know what it was, and could not at all explain it, and thought it was some remnant of the red colour of the blood which he had analysed, though he could not understand how it should remain red after having gone through the heat. It did not occur to him that that was oxide of iron, because the idea was never entertained at that time that any mineral matter might be an essential ingredient in animal tissue. In a similar manner when phosphorus was found in organic liquids which were in process of distillation by Brandt and Kunckel, it was not exactly known from what that phosphorus came. It was only accidentally discovered that it was derived from the mineral constituents of those animal liquids, for it was supposed that this phosphorus was somehow introduced into the organic compound in the process it passed through, but it was supposed that the vegetable organism had actually the power of producing some of the mineral ingredients found in it. For this reason, that most useful of the ingredients of the ash of plants, potash, was supposed to be a product of the plant, and was therefore called vegetable alkali. It was obtained by taking the ashes of trees and plants growing along the sea shore, lixiviating their ash, or extracting it with water, evaporating that again, and fusing the resulting salt in a pot, hence called potash. The salt was frequently called lixivium, and the ash was called lixiviate, and in the Edinburgh Pharmacopœia that which is now called potassium was not many years ago termed lixivia.

Now let us be present at one of those remarkable events, where an enormous error is found out, and a new truth is established, the discovery of potash in the mineral kingdom. I quote from "Klaproth's Chemical Essays," published in London in a translation in 1801. On page 362 there is a section devoted to the analysis of leucite, a crystallised mineral found in volcanic stone, as for instance on Mount Vesuvius:—

"I was surprised in an unsuspected manner by discovering in leucite another constituent part, consisting of a substance, tho existence of which certainly no one person would have conjectured within the limits of the mineral kingdom, and, least of all, in the natural mixture of a solid fossil, which, in a mineralogical sense, is simple ore unmixed. This constituent part of leucite, which now appears in the character of an oxydognostic or mineral substance, is no other than potash, which hitherto has been thought exclusively to belong to the vegetable kingdom, and has on that account been termed vegetable alkali. This discovery, which I think of great importance, cannot fail to occasion considerable changes in the systems of natural history till now established, and will seem to illustrate various phenomena in the mineral as well as the vegetable kingdom."

Now, gentlemen, in the year 1800, it was supposed that potash could only be obtained from plants; then for the first time it was discovered that this mineral called leucite contained 22 per cent. of potash. Years afterwards in the centre of Germany there were found various salt springs, and it was proposed that they should be utilised for making salt, but there was this objection, that they contained too much potash, till at last it occurred to somebody to dig down in those places where those salt springs originated, when there were found layers of potassium salt from 16 to 115 metres in thickness, and now in the centre of Germany, near Anhalt, and at Kalucz, in Galicia, there are established perhaps 60 or 70 factories of the largest size, where annually millions of hundredweights of potassium salt are produced, to be used for the various purposes of human intelligence, for making manure, for the production of glass, for the manufacture of soap, and for a hundred other uses it would be difficult to enumerate. And here again you see the vast importance of science in establishing certain truths and removing certain errors. From the small discoveries in the laboratory there arise gigantic industries.

The theory that the substances of organised nature were composed of elements, came to the foreground in the time of Lavoisier. He began by burning some of these substances in oxygen gas, and was astonished to find that they contained carbon, hydrogen, oxygen, and nitrogen. Gay Lussac and Thénard improved upon this mode by employing an agent which did not give off oxygen itself, namely cupric oxide. This analytical agent was also employed by Berzelius, who first used the horizontal tube which you see before you. This he filled with cupric oxide, and a given

quantity of the material to be analysed mixed with it; the tube was gradually heated from one end to the other, and thereby was engendered a slow combustion of the substance, the composition of which was to be ascertained. But it was necessary, in early days, to collect the products by a laborious mode, and it was here that the genius of Liebig intervened, and by the invention of a most remarkable apparatus, made this part of the process simple and easy. This little glass apparatus is the celebrated "potash bulbs" of Liebig. It is intended to collect the carbonic acid produced in the tube in the course of organic analysis, and it is thus constructed on the following grounds. In the first instance its weight has to be ascertained by a very accurate balance, and therefore it must not be greater than that which can be accurately ascertained by the best chemical balance, that is, it must not weigh above 50 grammes. Further it must make provision for the gases to penetrate the solution of caustic potash so thoroughly that they ultimately shall be quite free from carbonic acid, and that no carbonic acid shall escape. Therefore the gas engendered in the tubes here comes in contact first with the solution in this large globe, then passes through three bulbs, rises again, and passes through the last bulb, or globe. These two upper bulbs are really in the nature of safety vessels, and are intended to prevent any of the potash being lost no matter in which direction the current may move. At the beginning of the combustion the gas will always move in one direction, but at the conclusion of the combustion, when there is no more new gas evolved, the carbonic acid gas contained in this bulb is absorbed, and the potash rises. Now if the bulb was not sufficiently capacious to contain the whole of the caustic potash placed in those three lower bulbs it would infallibly enter the combustion tube, and thereby the whole of the analysis would be destroyed, the tube would burst, and the weight of the bulbs would be vitiated. In this arrangement a potash solution is used instead of soda, because it does not froth. In this way there has been found a method of removing those numerous difficulties in the way of organic analyses which previously existed. In the early portraits of Professor Liebig, particularly the one by Engel, you will find these potash bulbs depicted in the corner of the picture.

Now what is the advantage of our being able to ascertain the composition of bodies? It is this, that we thereby establish their individuality beyond the reach of doubt, and we can always test their identity and purity. When, therefore, a few years ago the Medical Council came to the conclusion to leave out of the pharmacopœia the formulæ representing the chemical composition of bodies as ascertained by organic analysis, they made a step backwards. This was happily altered by the eloquent appeal of Professor Apjohn of Dublin, and you now find that the medicines which are best known have their chemical formulæ attached to them, and these we know by means of organic analysis. Before you, on the table, is a furnace such as was employed by Liebig in analysis, and it has some historical interest. The analyses were then performed by means of charcoal, but in modern times we perform the operation by means of gas, and there you see a model furnace by which the process is performed by that means. In one case we have made an analysis of carbon and hydrogen. This is the carbon, and here we have collected the product of combustion in the shape of water in this apparatus which was connected immediately with the tube. The gas evolved is compelled to pass through a small quantity of concentrated sulphuric acid, which absorbs the whole of the water, and whatever gases were left had to pass into the bulbs where the carbonic acid is collected. Whilst, therefore, we have performed the determination of the hydrogen contained in the organic matter in the shape of water; we have on the other hand determined the carbon contained in the organic matter in the shape of the carbonic acid.

In this apparatus again we have made another analysis, namely, we have determined the quantity of nitrogen contained in organic bodies in the shape of gas. However desirable it may be for us to be able to determine the carbon as carbon, and the hydrogen as gas, it is impracticable to do so. We, therefore, determine the hydrogen as water, the carbon as carbonic acid, but the nitrogen we can determine in two forms, either as gas or combined with hydrogen in the form termed ammonia. Both these methods in their perfection came out of the laboratory at Giessen, although in the first instance the nitrogen analysis was discovered by Thénard, but it was elaborated and brought to its present simple form at the Giessen laboratory, more particularly that nitrogen analyses which employs the form of ammonia as the terminal form. That was elaborated by two of Liebig's assistants, Professor Will, of Giessen, and Varrentrapp, who has been dead for some years. This determination of nitrogen as ammonia is not effected by means of oxide of copper, but by means of an alkaline powder, consisting of burnt lime, which has been slaked with a solution of caustic soda; this compound has the power of so burning up the organic matter that the hydrogen is partly set free, and combines with the liberated nitrogen and goes away in the form of ammonia. The ammonia is then collected in hydrochloric acid, and is ultimately determined in combination with platinic chloride. The simplification which has lately been applied to the mode of obtaining the nitrogen in the form of gas made the results so direct, and the product so pure, that in my laboratory during the last 20 years, hundreds of analyses have been performed by this method in preference to the other, which determines the nitrogen as ammonia.

Now I should give you, if time allowed, a sketch of the enormous influence which this determination of the exact composition of organic matters has had on the increase of science at large. Organic chemistry has made rapid advances in all countries; the number of papers you see published is perfectly astonishing; research is everywhere instituted because quantitative accuracy is now possible, and the man who has got any result whatsoever is able to clench it with perfection for ever, and to leave no question of ultimate composition in uncertainty. What is the operation, for example, of such analyses on trade and commerce? It is enormous. You have only to see the development of artificial colouring matters as examples of the progress which manufactures have made by means of chemistry. That chemistry could never have existed without quantitative organic analysis, for it was only by that means the constitution of the bodies produced could be determined. For instance, in the case of benzole, its individuality and purity were first determined. Then the benzole was changed by introducing the nitrate nucleus into it, and this nitrate nucleus was again transformed by other additions; these yielded aniline, and then compounds and metamorphic products of aniline were discovered by the aid and guidance of organic analysis, and from this arose an application of a very practical kind. When you read Mr. Perkin's account of how he came to discover the aniline colour, you will find that he says:—"Having considered the composition of aniline as verified by elementary analysis, I thought I would set about to make quinine artificially." He wanted to make a medicine, and he set about it, but he did not succeed, and got a brown matter which was no use to him, so he set about it in another manner, which he describes, and he got a little brown matter, which, when he dissolved it in alcohol, to his great joy, was of a very beautiful colour. You see there how by means of organic analysis wonderful results are obtained. Nobody could have guessed that when a man set about to make a medicine he should produce these aniline dyes, and now you see the results of these theoretical researches in the laboratory are of such vast magnitude that manufactures are established which employ an immense amount of capital, thousands of hands, and a large quantity of machinery. Other colouring

matters have been discovered, including artificial alizarine. The aromatic ingredient of vanilla has been discovered, and is also now produced by artificial means.

I might go on for a whole evening speaking of the remarkable results of these synthetical researches, all of which without exception are based upon the foundation of organic analysis.

I have before me the work of Liebig, in which he laid down the description of organic analysis. This is an extract from the dictionary of chemistry which he published jointly with Berzelius and others, and it was printed for the first time in 1837. Many editions have appeared, and now chemists know how to perform organic analysis so well that you might say it is almost a portion of their natural consciousness, and it seems almost impossible to imagine that there could have been a time when men could not have been in possession of so simple, so manifestly perfect, and so useful a method of investigation.

The researches of Liebig have thrown light not only on this subject but on others as well. Wherever we look into his operating faculties we see an enormous dexterity, and the shortening of work thereby attained is very wonderful. In front of you is an apparatus generally known as Liebig's drying apparatus. When organic matters have to be dried without being exposed to the air, so that the loss they experience can be measured, they are put in that little machine there, and the apparatus is then weighed. It is then placed in that copper vessel, the water is made boiling hot, and while it is so boiling hot a current of air or of any other gas is passed through it by means of an aspirator; if the substance loses anything in weight, that loss will generally be found to be water. You can catch the water on the one side by means of this apparatus, or you may let it go away. In any case the result is useful, because you can immediately weigh the tube and put a portion of its contents into the combustion tube, and the weight by which this apparatus has been diminished gives you the exact weight of that which you have put into the combustion tube.

The most beautiful analysis which Liebig invented is that of air. The composition of the air was made known at the end of the last century, and then it was shown to consist of oxygen and nitrogen in certain proportions, the oxygen being about one-fifth and the nitrogen about four-fifths of the volume, and nearly the same proportions by weight. But these proportions were not exactly ascertained, because it was necessary to remove the oxygen by means of a complicated process of deflagration, by mixing it with hydrogen, which occasioned certain imperfections. These were entirely removed by the method which Liebig invented. He took a quantity of air, enclosed it in one of these tubes, and then brought in contact with it a solution of pyro-gallic acid in caustic potash. This pyrogallate of potash has a very great avidity for oxygen, and in a short time absorbs the whole of the oxygen contained in the tube. In that tube we have a quantity of air, and my assistant has introduced a quantity of pyrogallate of potash, and you see how gradually the absorption takes place. The gas becomes diminished, and the liquid rises in the tube accordingly, and out of the original five parts there remain only four at the conclusion of the experiment. The whole of the oxygen is absorbed without leaving any residue whatever, and you have one of the most accurate methods of ascertaining the composition of the air. Applying this generally to the most varying circumstances, it is found that the air, for instance, on Mont Blanc, and in the deepest mine, and wherever else it has been investigated, in any part of the globe, has the same composition. There is nowhere any difference whatever. The very same regularity is observed in the composition of sea water, wherever you analyse it, except in the immediate neighbourhood of mouths of rivers, it contains the same amount of salt, and this regularity of composition is one of the great safeguards for the existence and preservation of animal and vegetable life.

Of course there are impurities in the air. This room, for instance, now contains a quantity of carbonic acid, and in other places there is found a quantity of ammonia, and that increases during the winter time when no vegetation is going on; and decreases in the summer time. These small additions of gases not being oxygen or nitrogen are so imperceptible that it requires very large volumes merely to show their presence, and still larger ones in order to determine their quantity. Therefore, in an analysis like this, the presence of these slight impurities is actually beyond the limits of accuracy which are imposed upon us by our methods of research. We cannot regulate the pressure or the temperature as we should like, so that there should be no difference between the pressure inside and out. There are these slight irregularities which we always have to allow for, but they are still greater than those produced by the admixture of carbonic acid and ammonia. And here again you find a wonderful provision of nature, that the diffusion of gases is so great that they cannot, for any length of time, collect in enclosed places, except they are specially made impervious to gases. In open nature, in rooms, in caverns, houses, valleys, on mountains, the gases get diffused so quickly that you may stand before a burning limekiln and you will hardly perceive it; in fact, in order to perceive the presence of gas, which goes away in volumes, you must actually go close to the fire and hang your head over it.

In enumerating the researches which Liebig has made, I have already told you he discovered the feature called isomerism. A body which has the same composition, the same number of elements as another, but differs in other chemical and physical properties, is isomeric to it. Take, for example, a pack of cards; no matter how you shuffle them, you have always the same number, only you have them in a different arrangement, but you do not alter the whole constitution of the pack. So with organic bodies, you can make the atoms change their places just as you can cause the cards to change their places, and the ultimate compound will contain the same number of atoms, and this similarity in quantity and dissimilarity in arrangement is called isomerism. You may take the celebrated illustration of the twenty school girls, frequently given by mathematical tutors. It is supposed that one of the school girls is in love with a young man, and tries always to walk in a certain place in the procession of the school girls when they go out for a walk. The mistress is supposed to perceive this, and at every walk she endeavours to put this girl in a different place, and of course the other school girls also; and a great many learned essays have been published, which treat of the problem of these school girls, which admits of such an enormous number of changes that I am afraid to give you the exponent which shows that number. But the very same number of compounds of a chemical kind is possible where there are say, 20 different atoms. You can place them in just as many different ways as the 20 school girls, and therefore, you can see that in any compound of a large number of atoms, a vast variety of isomeric arrangements are possible. These ideas have been enlarged, and then you have polymerism, and metamerism. Metamerism is the resemblance where bodies have the same proportion in their constituents, though not the same number of atoms; and the number of atoms is a *not* simple multiple of those contained in the body which contains the smallest number. Again, where bodies yield the same elements apparently to organic analysis, yet are so constituted that the body containing the larger number of atoms is, as regards these atoms, a simple multiple of the body containing the smaller number of atoms, this relation is called polymerism. Take, for example, two packs of cards and put them together. They represent one chemical compound, and that compound of two packs of cards is a polymero of the compound, which only consists of one pack. If you analyse it you

find apparently the same proportion between the reds and the blacks as you find in the simple pack, but when you count the numbers of the red and black contained in each, you find the actual difference.

These discoveries are the direct results of organic analysis, and of the method of determining atomic weight, which was the result of organic analysis.

Liebig further investigated alcohol, ether, and other bodies, particularly chloroform and chloral. He made researches on ethereal and benzol compounds, and thereby developed the theory of organic radicals. At this time also he entered into many polemics against the French chemist Dumas, against Laurent and Gerhardt, and we must always admire the acumen he showed in controversy. He also spoke strongly against Berzelius, who, having left the basis of experiment, indulged his greatness by criticising all round. Every new discovery, no matter what it was, he endeavoured to put down, because he did not see its actual importance and value; and therefore all young chemists had to fight him hard. But he had this honourable feeling, that when he saw he was losing, he repeated the experiments himself, and then came forward and said it was all right.

At that time he made a joint research with Wöhler on lithic acid, which I mentioned in the last lecture; and about the same time with that research occurred what you may call the transition from the ancient physiology to the new. But that transition was so important and striking, that I must devote a special lecture to it.

MISCELLANEOUS.

REGISTRATION OF TRADE MARKS.

The Rules for the Registration of Trade Marks, which the Lord Chancellor was authorised, by the Act of last session, to draw up, were published yesterday (Thursday, the 30th), two days before their coming into effect. They include an elaborate classification, containing 50 classes of goods. A trade mark may be registered under any one or more of the classes, the fees being £1 on application and £1 on registration of a single mark, 10s. for application and 10s. for registration of every additional mark registered in the same class, 2s. for application and 2s. for registration of a mark under any additional class. In case of any doubt as to the class to which a particular description of goods belongs, the decision rests with the registrar. The fees are not to be paid in cash, but by post-office order or cheque. A person wishing to register will be required to send in a statement with the following particulars:—

(*a*.) The name and address and calling of the applicant.

(*b*.) The description or reference to a description of the trade mark to be registered.

(*c*.) The class or classes of goods (being some one or more of the classes specially mentioned), and the particular description or descriptions of goods in such class or classes, with respect to which he desires the trade mark to be registered.

(*d*.) In the case of a trade mark used before the passing of this Act, a description of the goods in respect of which it has been used and the length of time during which it has been so used.

"The statement is to be upon foolscap paper of a size of thirteen inches by eight inches, and shall have on the left-hand part thereof a margin of not less than one inch and a half.

"Subject to any other directions that may be given by the registrar, a description of a trade mark shall be given in writing, and shall be accompanied, when practicable, by a drawing or other representation in duplicate, not less than three inches square, on foolscap paper of the size aforesaid, or by pasting or otherwise fastening on such paper a specimen of the trade mark.

"Where a drawing or other representation or specimen cannot be given in manner aforesaid, a specimen or copy of the trade mark may be sent either of full size or on a reduced scale, and in such form as may be thought most convenient.

"The registrar may, if dissatisfied with the representation of a trade mark, require a fresh representation either before he proceeds with the application or before he registers the trade mark.

"The registrar may also, in exceptional cases, deposit in the Patent Museum a specimen or copy of a trade mark which cannot conveniently be placed on his register, and may refer thereto in his register in such manner as he thinks advisable."

The declaration must be on foolscap paper of the above-mentioned size, and "must verify the statement," and declare that, to the best of the applicant's knowledge and belief he is lawfully entitled to use the trade mark.

As soon as may be after the receipt of an application, the registrar shall require the applicant to insert an advertisement of the application in the official paper, during such time, and in such form, as the registrar may think desirable, and distinguishing whether the mark has or has not been used before August 13th, 1875. The official paper for the purposes of these rules shall be some paper published under the direction of the Commissioners of Patents, or such other paper as such Commissioners, or any one of them, may from time to time direct. For the purposes of such advertisement the applicant may be required to furnish the printer of the official paper with a wood-block or electrotype of the trade mark.

Notice of opposition is to be sent in duplicate, one copy being transmitted by the registrar to the applicant. Within three months of receipt of such notice a counter statement is to be sent in by the applicant, or his application will be considered withdrawn. The objector will then be required, within fonrteen days, to give security, or his objection lapses. The fee for notice of opposition is £2.

On the expiration of three months from the date of the first appearance of the advertisement in the official paper, the registrar may, if he is satisfied that the applicant is entitled to registration, register the trade mark on payment of the prescribed fee of £1.

Where each of several persons claims to be registered as proprietor of the same or a nearly identical trade mark, in respect of the same goods or goods belonging to the same class, the registrar is to use his discretion as to registering all or any of such trade marks, either unconditionally or on the condition of the introduction of such variations (if any) or otherwise as he thinks fit, or the registrar may, if in any case he thinks it expedient, submit or require the claimants to submit their rights to the court.

Identical trade marks will not be registered in the same class, or "with respect to the same or similar goods as belonging to another class." The date of application will be deemed the date of registry. Notice of registration will be sent to the applicant. The person to whom any registered trade mark has been assigned or transmitted may apply to be registered as proprietor thereof on tho production of suitable evidence, defined by the rules. The fee for registering such subsequent proprietor is £2.

The protection is to hold good for 14 years, and can be renewed for a fee of £2, if paid before the expiration of the 14 years, or £3 if paid within three months of the end of such period. A lapsed mark can also be restored on the payment of an "additional fee" of £2. A trade mark like one removed is not to be registered for five years.

The court may, on the application of "any person aggrieved," remove any trade mark from the register on the ground, after the expiration of five years from the

date of the registry thereof, that the registered proprietor is not engaged in any business concerned in the goods with respect to which a trade mark is registered.

Alterations and rectifications of the register may be made by leave of the court, the fee being 10s. Such alterations are subject to opposition. An alteration of address will be inserted in the register for a charge of 5s.

The court for the purpose of the Act is declared to be the Chancery Division of the High Court of Justice. Application to the court may be made by motion, or by application in chambers, or in such other manner as the court may direct.

The remainder of the rules apply to the Cutlers' Company, "Declaration and Evidence," &c.

It may be added that the offices of the Registry are at 47, Quality-court, Chancery-lane, and that Mr. H. Reader Lack, chief of the Statistical Department of the Board of Trade, has been appointed to undertake, for the present, the duties of registrar. Mr. Lack's name will be familiar to the members, as he is one of the treasurers of this Society.

SIR H. COLE AT LIVERPOOL.

Speaking at the recent distribution of prizes at the Liverpool Institute, Sir Henry Cole dwelt at some length upon various subjects with which the Society of Arts has been connected. The whole speech is too long for quotation, but the following extracts may be worth republication:—

Of the alteration in the Society's examination scheme, Sir Henry said:—"During the last session, Parliament (and Lord Sandon had a great deal to do with the business) determined that every child in public elementary schools who was taught music and singing could earn a shilling. What did that mean? Why, it meant that if these two millions of children were all taught singing, they would draw a sum of £100,000 from public taxation. Were they going to be laggard on this question, which the Government was trying to get everybody to take up? It was out of the question. They were already in alliance with the Society of Arts, and the Society of Arts gave them prizes. The Society of Arts recently re-arranged its curriculum of the subjects for which it gave prizes, and it had introduced the subject of health, the subject of cookery, and also other branches of domestic economy. Now, he was told that some ladies were coming up to receive prizes in drawing; perhaps there might be one or two who were coming up to receive prizes in general education; but he feared none of them would come up for prizes in science, and therefore he ventured to suggest to the directors that they should pay some attention to this new programme of the Society of Arts, which was pre-eminently intended for the benefit of ladies—clothing and its materials, health, housekeeping, and thrift and care. These subjects were also matters of elementary education; and in any school where a child had passed the thing called the fifth standard—if it could be certified as knowing something about clothing, the making-up of dresses, shirts, and things of the kind, and cookery—that school got four shillings a year out of the pockets of the ratepayers." At the conclusion of his remarks the speaker said:—"I now approach a subject on which bitter differences of opinion prevail, but I hope I shall not give offence in stating my own views—I mean the use of Sunday. I will not enter on the religious differences involved in Sundays and Sabbaths, or the customs which history has made known to us. I will only attempt truthfully to relate what comes under my own personal experience, especially in London and our great towns, of the ways in which my countrymen pass Sunday—dividing them into the few rich, the numerous middle-classes, and the overpowering millions of poor classes. I hate this imperfect nomenclature of classes, and use it only as expressions commonly understood. A rich man with £10,000 a year may be a poor man and have no money at his bankers, and a poor labouring man, with his 20s. a week, may be a rich man with money in the savings bank. The rich, relieved of their weekly work, go to church (often in their carriages) in the morning, and send their wives and daughters in the afternoon or evening. They frequent their clubs, read the *Saturday Review* or *Economist*, admire and examine the pictures they possess in their gilded homes. They go to the Zoological Gardens. The middle-classes also go to church or chapel, have a good dinner on Sundays with a cosy nap afterwards, take a walk if it be fine, and spend the rest of the day in looking at the pictures in the illustrated newspapers. Both classes give their servants a holiday to go to church or chapel if they are so minded, or to walk with a cousin. I regret to say that all I can see and learn proves to me that the millions of the poor classes do not go to church or chapel. They spend the forenoon in their only one room if they live in towns, and generally in bed. They read a penny newspaper, which, as a parish missionary told me, is "Church, chapel, and Bible to them," and they pass the evening in the public house. Do not let us deceive ourselves. The millions of this country have ceased to be attracted by our Protestant churches and chapels, and the law can't compel them to attend. Our forefathers before the Reformation induced the people to come to churches, and abbeys, and cathedrals, where the poor found music and pictures on the walls and in the windows. The Roman Catholic Church now makes its way with the people by the same attractions, and all creeds have done so, whether regulated by Moses among Israelites or Sesostris among the Egyptians, or by the priests of Pallas in Athens, or, in subsequent years, by Leo X. in Rome. Human nature craves for beautiful work of God or man. The fine arts are the handmaidens of religion and gentle culture. But during the last three centuries in our kingdom we have neglected, if not despised, this craving. Fine arts are now beginning to be recognised again as humanising. If you wish to vanquish drunkenness and the devil, make God's day of rest elevating and refining to the working man; don't leave him to find his recreation in bed first and the public house afterwards; attract him to church or chapel by the earnest and persuasive eloquence of the preacher, restrained within reasonable limits; help him to solve the mysteries of his daily life by the simple light of his Bible, rather than puzzle and weary him with dogmas spoken during long hours; give him music in which he may take his part; show him pictures of beauty on the walls of churches and chapels; but as we cannot live in church or chapel all Sunday, give him his park to walk in with music in the air; give him that cricket ground which the martyr Latimer advocated; open all museums of science and art after the hours of Divine service; let the working man get his refreshment there in company with his wife and children, rather than leave him to booze away from them in the public house and gin palace. The museum will certainly lead him to wisdom and gentleness, whilst the latter will lead him to perdition and brutality. I rejoice greatly in telling you that your neighbour, the Duke of Westminster, with true Christian benevolence and his socially political foresight, opened his palace in London in the months of last August and September, not only on week-days but on Sundays, to the working man, as an experiment, and it proved most successful. His Grace writes thus to me:—"Visitors numbered in the two months 10,560, and the applications were so numerous that the clerk's time was entirely taken up with this work, that we had to say that 'no more could be entertained or tickets issued.' I had no idea that there would have existed so great a desire to see these things, and am heartily glad of it. It shows that if the opportunity could only be given, that thousands would gladly avail themselves of visiting to their benefit such collections on, with many of them, the only available days—namely, on Sundays, and thereby

improving their taste, and assisting towards the instruction required. Another year we may make better provision beforehand. Among other applications (refused) was one for admissions for the Thames bargees!" As a general rule, Sundays are the only working man's available day for recreation. The average number to Grosvenor-house on week-days was 143, whilst on Sundays it was 510. I trust other enlightened owners of pictures will follow the Duke of Westminster's lead. In London we are foolish and illogical on this Sunday question. I may go and see pictures in Hampton-court Palace, and in Greenwich Hospital, and visit the Natural History Museum in Kew Gardens on Sundays, and hundreds of thousands do so likewise to their great benefit, morally and religiously. It is sheer tyranny to prevent me from going to galleries if I wish it, and I protest against such tyranny. I force no one to go to museums who dislikes it; but why keep me out of the National Gallery, and the British Museum? and why forbid me seeing Raphael's Bible Cartoons in the South Kensington Museum if I wish to go?

ADULT EDUCATION BY PUBLIC MUSEUMS.

Number of visitors for the month of November, 1875. When they are counted by sight the words "by sight" are used, when by turnstile the word "machine":—

	Amounts voted in 1875.	Number of Visitors in November	How counted.
	£		
1. British Museum[1]	17,471	...	(by sight).
2. National Gallery	6,346	25,504	,,
3. Kew Gardens and Museum[2]	4,273	6,271	,,
4. South Kensington Museum	39,019	...	(by machine).
5. Bethnal-green	7,325	...	,,
6. National Portrait Gallery	1,956	...[3]	,,
7. Geological Museum, Jermyn street	9,070	...	,,
8. Patent Office Museum	...	19,975	,,
9. Edinburgh National Gallery	2,100	...[4]	,,
10. Edinburgh Museum of Antiquities	...	...[4]	,,
11. Edinburgh Museum of Science and Art	10,509	29,378	,,
12. Edinburgh Botanic Gardens	1,750	2,311	,,
13. Dublin Museum of National History	1,717	...	,,
14. Glasnevin Botanical Gardens and Museum	2,224	3,597	,,
15. National Gallery of Ireland	2,339	...	,,
16. Museum of Royal Irish Academy, Dublin	200	2,916	,,
17. Zoological Gardens, Dublin	500		,,
18. Tower of London	1,500	22,767	(by sight).
19. Royal Naval College, including Greenwich Painted Hall	...	13,776	,,
20. Royal Naval Museum, Greenwich	1,190	1,980	,,
21. East India Museum[5]	5,883	2,335	(by machine),
22. Hampton Court Palace[6]	3,465	...	,,

[1] Return refused.
[2] Open on Sundays.
[3] Return refused.
[4] Open on Sundays. Closed during month of November.
[5] Paid for by Indian Government. Admission daily by payment of 1d., except Thursday and Friday, 6d.
[6] Open on Sundays.

A Guide to Philadelphia, with official documents concerning the Exhibition generally, and an appendix containing particulars as to the contents of the British Section, to be compiled from information, which exhibitors are invited to furnish without delay to the publishers, is announced for early issue by Messrs. J. M. Johnson and Sons, of Castle-street, Holborn.

In 1872, the United States produced 2,854,558 tons of pig iron; in 1873, the corresponding production was 2,869,278 tons, and last year it was 2,689,413 tons.

PRESERVATION OF MEAT.

Some works have lately been completed at Sydney, by Mr. T. Mort, for the purpose of preserving and packing meat for transportation to Europe. On the occasion of their being opened, a large number of guests partook of a luncheon, consisting entirely of provisions prepared by Mr. Mort's process, and all of which had been preserved for considerable periods.

The *Sydney Morning Herald* gives a description of the works, from which the following account is taken:—The preserving process is effected in two large apartments, each about 75 feet square and 9 feet 6 inches high, called respectively the cooling-room and the freezing-room, the latter being underneath the former. These apartments are entered only through trap-doors from above, and are surrounded with non-conducting substances. These two apartments each will hold, when closely packed, something like two or three thousand tons of meat. The cooling-room will be used for the storage of meat intended for home consumption, which will not be actually frozen, but merely reduced to so low a temperature that it will keep sweet for any time, until it is wanted. The freezing-room below, however, is intended for the reception of meat designed for exportation, which it is hoped and expected will solve the great problem of how to supply the English market with whole carcasses of Australian beef, mutton, and pork. The temperature of this room will always be kept considerably below freezing point, as low even as zero, and the meat here is frozen perfectly hard. This meat it is intended to ship to Europe and elsewhere the holds of the vessels being prepared after a principle similar to that of the refrigerating machines intended for household use, so that the meat will remain in its frozen state until it reaches the English markets, where it will be offered for sale in the carcass, just the same as meat fresh from the shambles. It is calculated that about one penny per pound will include all charges attendant upon this mode of preserving meat, including even the cost of transit to England.

The machinery used for effecting the freezing process, which is the result of the numerous experiments alluded to, is the invention of Mr. Nicolle, and is an improvement upon the apparatus invented by the same gentleman, which has for some time past been used at the Sydney Ice Works. There the principal agent used was ammonia in its gaseous state, which necessitated the use of a very high pressure, and therefore was subject to considerable inconvenience and risk of loss by leakage. Here, the ammonia is used in a state of solution, under a pressure of from 50lbs. to 70lbs. to the square inch, while at the same time the power of the machine is very much increased. The machinery, which appears complex, is really simple, so much so, that it only requires the aid of two persons to work it—one to fire the engine, and the other to watch and regulate the apparatus. The same ammonia, after having been used to produce the cold, is reabsorbed, and made to do duty again, so that there is absolutely no waste beyond an absolute minimum from leakage, and a constant circulation of liquid is continually going on. At present the meat-preserving process is not fairly at work, but the machinery is used in the production of ice. The machinery by which the ice is produced is this:—A series of suitable vats are filled with ice-moulds, arranged side by side, and into these a proper quantity of fresh water, filtered on the premises, is poured. All being then covered up, the cooling liquid is run into the vats in such a manner as to circulate all round the moulds, the contents of which, in a few hours, are frozen into blocks of ice, which are then turned out of the mould, and conveyed down to the freezing-room, there to be stored until required for use. A machine of an entirely novel character for the manufacture of ice has just been invented and brought into operation. This apparatus consists of a large drum, the periphery

of which is made of copper. Nearly the whole of the lower half of this drum is immersed in a trough of water. The interior of the drum contains the cooling liquid, and the drum then being made to revolve, the ice forms on the upper surface, whence it is scraped off in the form of snow. It is then packed in the moulds and submitted to pressure until it becomes a solid mass.

The abattoirs at North Lithgow Valley are very extensive, and the arrangements may be thus briefly described:—The external arrangements for cattle are three large paddocks, each one capable of holding several hundred head, and one large triangular stock-yard. Communicating with the stock-yard are four forcing yards, each with three subdivisions, and connected with the four slaughter-houses. The external arrangements for sheep are one large paddock, two forcing-yards, each of which communicate with three slaughter-houses. The internal arrangements for dealing with cattle are as follows: — Over the four slaughter-houses previously mentioned are placed planks, from which the beasts are pithed. They are then opened, and cleaned; the entrails, with the head and shanks, are left on the floor. The beast is then, by means of a traveller worked by machinery, lifted and placed on a carriage, which brings it to the skinning-floor where the hide is taken off and the carcass dressed ready for market. The carriage which brought it to the skinning-floor again lifts and carries it back in the bags provided for cooling, after which another traveller, worked also by machinery, takes it from the carriage and lowers it into the cold room, until required for market, when the traveller again lifts it. The beast is then quartered, weighed, placed in vans, specially prepared, and conveyed to Sydney. The sheep are brought from the forcing-yards into a passage-way, communicating with the three slaughter-houses on each side, where they are slaughtered. After opening, they are lifted on swivel hangers. Underneath these are placed buckets, the entrails drop into them ready to be taken to the cleaning-tables; the skins are laid on a horizontal bar, from which they are collected, placed in a box-truck, and brought on a tramway to the railway-truck. The carcasses, after being dressed, are placed in carriages brought to the hoist, lifted, placed on a trolly and conveyed either to the hanging space on the upper floor, or lowered by machinery into the cold-room. The entrails, &c., are all brought from the slaughter-house in buckets on trollies to the cleaning-room, where special preparation is made for dealing with every part—troughs for washing the paunches, blocks for taking out the cheeks and palates on, tables for cutting out the fat. A hoist placed about the centre of the room lifts every portion to be put into the digesters, on to a stage where, by means of shoots, the digesters are filled. The tallow from these is blown by the superheated steam into a receiving tank. Connected to this is a steam donkey pump, which delivers the tallow into a clarifier overhead. Thence, after clarifying through a coil cooler into casks below, the blood is collected from all the slaughter-houses and is delivered either for treatment in the digester, or to a trolly leading to the piggery. The water for all purposes is pumped from the creek by a force-pump connected to the engine, and delivered into two tanks placed in the roof; pipes from these convey it into all the slaughter-houses and other parts of the building. A tank placed in the cleaning-room receives all again; and a steam donkey pump, by means of pipes, delivers it to the drinking troughs provided for the pigs. The arrangements made for pigs are—one large shed, divided into six compartments as sleeping places; three small yards each containing a drinking trough, three feeding troughs, and a large paddock, in which they are allowed to roam by day. The food is all conveyed to the pigs by a trolly running on a tramway drawn by a pony. A large fan has been placed in the roof with a delivery-pipe running the whole length of the building, having outlet-valves in every compartment in which the carcasses are hung, for the purpose of driving out the heated air and producing currents, preventing the blow-fly from entering the room. An engine has been specially fixed for driving this at the rate of 2,000 revolutions per minute. In addition to the two revolving digesters for treating the entrails, &c., already referred to, one large digester, fixed in a vertical position, has been erected for the purpose of boiling down sheep if required, its size being sufficient to boil 250 at a time.

GERMAN CLASSIFICATION OF TRADES.

With reference to the classification adopted for the new Trade Mark Registration Rules, it may be interesting to see the classification of trades drawn up by the Central Statistical Department at Berlin, and applied to the registration of trade marks in Germany.

Group 1.—Gardening and horticulture.

Group 2.—Fishery.

Group 3.—Mining, smelting, and manufacture of salt. Class I.—Metals (except iron and steel). Section 1. Winning ores (except iron ores). Section 2. Smelting ores of silver, lead, copper, tin, and zinc. Section 3. Smelting ores of nickel, cobalt, antimony, bismuth, and arsenic. Class II.—Iron and steel. Section 1. Winning of iron ores. Section 2. Blast furnaces, manufacture of steel, rolling and puddling iron and steel. Class III.—Salt. Section 1. Salt mines. Section 2. Brine springs. Class IV.—Mineral fuel. Section 1. Coal pits, and coke-ovens. Section 2. Lignite mines, and manufacture of artificial or shaped blocks of fuel. Section 3. Working peat beds, and pressing and drying peat.

Group 4.—Stones and earths. Class I.—Stone and slate. Section 1. Working quarries of marble, stone, and slate, machinery for shaping marble, stone, and slate. Section 2. Manufacture of articles of marble, stone, and slate. Class II.—Quartz and sand. Class III.—Lime, cement, and trass. Class IV.—Gypsum and heavy spar. Class V.—Loam and clay, and articles of the same. Section 1. Loam and clay-pits, brickfields. Section 2. Pottery, manufacture of fine and fireproof pottery, stoneware, &c. Section 3. Potters'-clay pits, and washing potters'-clay, manufacture of crockery ware and porcelain. Class VI. —Glass. Section 1. Grinding quartz, glass furnaces, and manufacture of glass in general. Section 2. Glass-blowing. Section 3. Plate-glass and mirrors.

Group 5. — Working metals. Class I.—Precious metals. Section 1. Beating gold and silver. Section 2. Goldsmiths' and silversmiths' work. Section 3. Drawing gold and silver wire and imitation gold and silver wares. Section 4. Coining. Class II.—Other metals and alloys except iron and steel. Section 1. Leaden shot and bullets. Section 2. Small articles in lead and tin, and metal toys. Section 3. Cast and stamped zinc articles. Section 4. Coppersmith work. Section 5. Manufacture of metallic alloys of all kinds. Class III.—Iron and steel. Section 1. Cast and enamelled iron. Section 2. Sheet iron and tin-plate. Section 3. Articles of sheet iron and tin plate. Section 4. Bolts, nails, screws, nuts, chains, wire ropes, &c. Section 5. Horse shoes. Section 6. Locks and fireproof safes. Section 7. Scythes, knives, side-arms, hardware, and steel pens. Section 8. Needles. Section 9. Pins and wirework, including wire gauze.

Group 6.—Machines, tools, and apparatus. Class I.—Machines, tools, and apparatus. Class II.—Modes of transport, exclusive of locomotives. Section 1. Carriages. Section 2. Shipbuilding. Class III.—Fire-arms. Class IV.—Mathematical, physical, and chemical instruments, and apparatus. Section 1. Instruments and apparatus in general. Section 2. Telegraphic apparatus. Section 3. Anatomical and microscopical preparations. Class V.—Instruments for measuring time. Class VI. —Musical instruments. Class VII.—Surgical instruments. Class VIII.—Lighting apparatus, lamps,

Group 7.—Chemical products. Class I.—Chemical products made on a large scale. Class II.—Chemical, pharmaceutical, and photographic preparations. Class III.—Medicines and drugs. Class IV.—Dyes and colouring matters (except coal tar colours), including animal charcoal and filters. Class V.—Coal tar products and derivatives. Class VI.—Explosive substances. Class VII.—Lucifer matches. Class VIII.—Refuse products and artificial manures. Section 1. Sewage and disinfection. Section 2. Artificial manures, bonedust. Section 3. Slaughterhouses.

Group 8.—Heating and lighting. Class I.—Heating. Section 1. Firewood. Section 2. Preparation of coal. Section 3. Wood-tar. Class II.—Lighting.—Section 1. Tallow, candles, soap. Section 2. Stearine and wax candles. Section 3. Mineral oils, air-gas, &c., paraffin candles, petroleum. Section 4. Gas-works. Class III.—Oils and fats.—Section 1. Train oil, grease for leather, and cart grease. Section 2. Oil mills. Section 3. Essential oils and perfumery. Class IV.—Resins and varnishes.

Group 9.—Textile fabrics. Class I.—Fibres and fabrics of silk. Section 1. Drying and preparing silk. Section 2. Winding silk. Section 3. Spinning silk and remaking waste silk. Section 4. Weaving silk, including velvets and ribbons. Section 5. Dyeing and printing silk. Class II.—Fibres and fabrics of wool and other animal hair. Section 1. Preparation of wool. Section 2. Spinning and weaving wool and vicuna wool. Section 3. Spinning carded wool. Section 4. Mungo and shoddy. Section 5. Weaving woollen yarn, including worsted braid. Section 6. Dyeing, printing, and dressing woollen fabrics. Class III.—Fibres and fabrics of flax, hemp, tow, oakum, jute, &c. Section 1. Retting flax. Section 2. Heckling and spinning flax. Section 3. Weaving linen including tape. Section 4. Weaving jute. Section 5. Bleaching, dyeing, and dressing fibres and fabrics of flax, hemp, tow, jute, &c. Class IV.—Fibres and fabrics of cotton. Section 1. Wadding, spinning cotton and thread. Section 2. Woven cotton goods including tape. Section 3. Bleaching, dyeing, and printing calico. Class V.—Bleaching, dyeing, and dressing fabrics, not included in the foregoing classes. Class VI.—Fibres and fabrics of other materials than those included in classes 1—4. Class VII.—Lace, net, crochet-work, knitted and embroidered fabrics. Section 1. Hosiery. Section 2. Knitted fabrics, crochet work, and embroidery in various colours. Section 3. Finishing stockings and knitted fabrics. Section 4. Lace and embroidered linen. Section 5. Washing, bleaching, and dressing lace and embroidered linen. Section 6. Fringe. Class VIII.—Nets, sails, ropes, &c.

Group 10.—Paper and leather. Class I.—Paper and pasteboard. Section 1. Manufacture of paper and pasteboard, oiled paper, and sand-paper. Section 2. Carton-pierre and papier-mâche. Section 3. Coloured and fancy papers. Section 4. Paper-hangings and endless paper. Class II.—Leather and its substitutes. Section 1. Bark mills and manufacture of tanning extracts. Section 2. Tanning, parchment making, dyeing and varnishing leather. Section 3. Oil-cloth and leather-cloth. Section 4. Driving belts. Class III.—India-rubber and gutta percha. Class IV.—Bookbinding, fancy boxes, and cardboard ornamental boxes. Class V.—Harness, saddlery, and upholstery.

Group 11.—Wood-working and carving. Class I.—Sawing and preserving timber. Class II.—Polished woodwork. Section 1. Splints for lucifer matches and toothpicks. Section 2. Rough wooden ware. Section 3. Parquetry, flooring, and joinery. Class III.—Barrels and coopers' work in general. Class IV.—Matting, &c., of split wood, straw, bast, and rushes (except wicker-work). Class IVa.—Wicker-work. Class V.—Turnery and carved works. Class VI.—Cork and articles in cork. Class VII.—Combs, brushes, hair pencils, and quills. Class VIII.—Walking-sticks, umbrellas, and parasols. Class IX.—Ornamental and artistic carvings.

Group 12.—Food. Class I.—Vegetable food. Section 1. Mills and rice-hulling mills. Section 2. Baking and confectionery. Section 3. Vermicelli and maccaroni. Section 4. Starch. Section 5. Beetroot sugar. Section 6. Cocoa and chocolate. Section 7. Substitutes for coffee. Section 8. Compressed vegetables, preserves, &c. Class II.—Animal food. Section 1. Salted and pickled fish. Section 2. Meat. Section 3. Condensed milk, butter, and cheese. Class III.—Beverages. Section 1. Waterworks and water supply. Section 2. Ice and ice-houses. Section 3. Artificial mineral waters. Section 4. Malting. Section 5. Brewing. Section 6. Brandy, liqueurs, and yeast. Section 7. Wines. Section 8. Vinegar. Class IV.—Tobacco.

Group 13.—Clothing and washing. Class I.—Washing, clothing, head coverings, and millinery. Section 1. Plain sewing. Section 2. Tailors' work. Section 3. Millinery, artificial flowers, and feathers. Section 4. Hats and caps, and felt articles. Section 5. Furs and skins. Section 6. Braces, cravats and gloves (except knitted gloves). Section 7. Stays and petticoats. Class II.—Foot coverings (boots and shoes). Class III.—Preservation of the hair and beard. Class IV.—Washing. Section 1. Baths. Section 2. Washhouses and drying rooms, washing and ironing.

Group 14.—Building. Class I.—Contractors. Class II.—Architects, civil engineers, land surveyors, and mine surveyors. Class III.—Bricklayers. Class IV.—Carpenters. Class V.—Glaziers. Class VI.—Painters, whitewashers, and floor-waxers. Class VII.—Stucco. Class VIII.—Tilers and slaters. Class IX.—Paviours and layers of asphalte. Class X.—Boiler setters. Class XI.—Chimney sweeps. Class XII.—Well sinkers.

Group 15.—The Polygraphic arts. Class I. Cutting punches, type-founding, and wood engraving. Class II.—Typography, lithography, zincography, printing from plates of copper and steel, and ruling paper. Class III.—Playing cards, embroidery patterns, picture sheets, and oleographs. Class IV.—Photographs.

Group 16.—Art industry.

Group 17.—Trade. Class I.—Merchandise. wholesale and retail. Section 1. Dealers in animals. Section 2. Dealers in agricultural produce. Section 3. Dealers in building materials and fuel. Section 4. Metal dealers. Section 5. Dealers in colonial produce, food and beverages. Section 6. Wine merchants. Section 7. Tobacco and cigar dealers. Section 8. Cotton, woollen, and leather dealers. Section 9. Dealers in dry goods. Section 10. Dealers in hardware and fancy articles. Section 11. Dealers in miscellaneous articles not previously specified. Section 12. Dealers in old clothes. Class II.—Money dealers, bill discounters and banks (except saving banks). Class III.—Carriers and commission agents. Class IV.—Booksellers, picture dealers, and music sellers. Section 1. Booksellers, picture dealers, and music sellers. Section 2. News agents. Section 3. Lending libraries. Class V.—Commercial agencies. Class VI.—Trades auxiliary to commerce (*Hülfsgewerbe des Handels*). Class VII.—Auctioneers, money lenders, and labour agencies. Section 1. Auctions and auctioneers. Section 2. Pawnbrokers. Section 3. Lending establishments (except lending libraries). Section 4. Establishments for storing goods (Pantechnicon), wardrobe-warehouses. Section 5. Labour agencies and register offices. Section 6. Advertisement agents.

Group 18.—Traffic. Class I.—Traffic on roads and streets. Section 1. Passenger traffic on roads (except tramways). Section 2. Goods traffic. Class II.—Transport by ships, boats, and floating rafts.

Group 19.—Lodging and boarding. Class I.—Lodging, including hotels and furnished apartments. Class II.—Boarding, including public-houses, wine-shops, refreshment and dining-rooms.

The establishment, at Lille, of a School of Mines is in contemplation.

THE CULTIVATION OF USEFUL PLANTS IN INDIA.

Two reports have recently been received from Calcutta, both dated in June last, one treats of the progress and general utility of the Botanical Gardens at Calcutta, and the other gives us some details and statistics of the capabilities of the cinchona plantations in British Sikhim. From the first report—that on the Botantical Gardens—we learn a good deal of what has actually been done in the diffusion of really useful plants, and from Dr. King's remarks we may also learn what more might be done, if tho Government were ready to grant a small outlay for the collection in and proper transit from the native countries, of valuable plants which have been introduced and proved to be suitable for cultivation in Indian soil. Thus the mahogany tree (*Swietenia mahagoni*), for instance, the wood of which is always in most extensive demand, realising good prices, has been proved to grow well in Bengal, so that its diffusion in India is not difficult, and is really a matter of great importance. Of this valuable timber tree, however, we are told no seeds, except a few from Indian grown trees, were received during the year. So important does Dr. King consider the cultivation of this tree in India that he expresses an opinion that a collector should be sent from India to Honduras or Jamaica, or engaged in those countries for the express purpose of collecting the seeds and transmitting them to India.

On the subject of caoutchouc or india-rubber plants, Dr. King thinks that the *Hevea brasiliensis*, or Para-rubber tree, which has been introduced into India, and which furnishes the best commercial caoutchouc, will not thrive in that part of India. He says, "It appears to suffer here equally from the damp cold of December and January, and from the high temperature of the hot weather and rains. Plants have been tried at a low elevation in the cinchona plantation under a slightly more equable climate, but with similar results. *Hevea* is a thoroughly tropical plant, it lives naturally in a climate remarkable for uniformity of temperature and for regular supply of moisture." The Andamans and Ceylon, as well as Malabar and the southern part of Burmah, are suggested as being likely to prove more suitable for the cultivation of the *Hevea* than any part of the Bengal Presidency. On the other hand the caoutchouc plant of Madagascar (*Vahea madagascariensis*) promises to thrive, and there are many plants of this kind in India; considering, however, that this plant is a climber, and that rubber furnished by it is of inferior commercial value, together with the fact of its having to contend with the indigenous rubber plant of India (*Ficus elastiea*), it is not probable that it will ever be grown for commercial purposes.

On the subject of the acclimatisation of ipecacuanha in India, a plant the well-being of which in its new home ranks next in importance to cinchona itself, it may be well simply to reproduce Dr. King's own words. He says, "with the view of discovering the most favourable situations for the cultivation of ipecacuanha, a number of sets of plants were put out during the early part of the year at different spots at low elevations in the cinchona rererve in Sikhim. Experience having shown that this plant requires essentially tropical conditions, warm, well-sheltered places, with good virgin soil were chosen. Some of the plants thus put out were protected by the natural shade of the forest, others by a sloping thatch of grass. Until the arrival of the cold weather all went well, but the unusually low temperature that prevailed during that season was fatal to the majority of the plants, and I am driven reluctantly to the conclusion that it is doubtful whether ipecacuanha can be successfully cultivated as an out-door crop in Sikhim. This is also the opinion of Mr. Gammie, the residing manager of the cinchona plantation. Further trials will, however, be made before finally recommending the abandonment of the experiment in Sikhim. The provinces already mentioned as likely to be suitable for *Hevea* cultivation will also, in my opinion, probably answer for ipecacuanha, and with the sanction of Government I propose to send supplies to these provinces. The plants sent last year to the Botanical Gardens in Ceylon are reported by tho director, Dr. Thwaites, to be promising fairly. The propagation of the plant by root cuttings is now thoroughly understood, and there are in the hot-beds at Rungbee more than 100,000 young plants, while two years ago there were rather less than 7,000. The plant is therefore fairly introduced into the country, and a suitable locality for growing it profitably as a crop will doubtless soon be discovered."

In the matter of the paper supply, which continues to occupy a large share of the attention both of commercial and scientific men, it is stated that two acres of ground in the Calcutta garden have been planted with the seedling plants of the Baobab (*Adansonia digitata*), with the object of proving whether the tree can be profitably cultivated in India as a paper material, quantities of the bark having been imported into England from Africa, and used in the manufacture of paper with great success. Notwithstanding the fact of the bark possessing all the requirements for making a good and strong paper, it would appear that its comparative slow growth will always prevent it from becoming a recognised article of trade with paper-makers. As in many other tropical countries where fevers are prevalent, the blue gum tree (*Eucalyptus globulus*) has been planted in India, and repeated experience has shown, that although growing with great rapidity and vigour on the Neilgherry and Khasia-hills, at elevations of from 5,000 to 8,000 feet above the sea, it can hardly be got to live even for a year or two in the hot plains. Dr. King endorses the opinion of many other scientific men that there is no satisfactory evidence of any beneficial effects coming from the planting of eucalyptus trees in malarious districts.

Turning to the special report on the cinchona plantations in British Sikhim, it is satisfactory to find that the plants are not only luxuriant in growth, but have also been increased in number to a very large extent. The number of red bark trees (*Cinchona succirubra*) planted out during the year was 310,000, bringing the total number in the permanent plantations up to 2,390,000. Of the yellow bark plants (*Cinchona calisaya*), 60,000 have been added during the year, making a total of 354,000 young trees. These figures represent the number of plants actually in the open plantations, and are exclusive of the stock in the nursery beds, so that in round numbers, these plantations contain three millions of plants of *Cinchona succirubra*, half a million of other sorts, and a nursery stock of about half a million plants.

From experiments made in removing bark under the mossing process, from which so much was at one time expected, it appears that the operation is not in all cases satisfactory, or rather that the results did not promise well. The soft newly forming bark proves highly attractive to ants, which abound in Sikhim, and it was removed by them as fast as it was formed, and in many cases no new bark whatever was formed over the wounds.

The quantity of dry bark obtained from the plantation during the year amounted to 39,405 lbs., 15,160 lbs. of which was placed in the hands of the Government quinologist, who, it is satisfactory to know, has settled on a cheap and efficient method of extracting the total febrifugal alkaloids. The quinologist's preparation consists of an amorphous powder of a pale buff colour, and entirely free from resin; it is readily soluble in water slightly acidulated with sulphuric acid. This febrifugal powder has been used by the Indian medical department, and has also been given to coolies suffering from fever, both in the plantation in Sikhim and in the Botanical Garden, Calcutta. In all cases it has proved to be an efficient febrifuge.

OPIUM IN CHINA.

The users of the various descriptions of opium are described by Consul Medhurst, who states that roughly speaking there may be said to be three tracts, the inhabitants of which are marked by as many peculiarities of taste. Along the coast as far north as the Yangtsze, with the apparent exception of the districts about Ningpo, Bengal opium is almost exclusively made use of. The general taste is for Patna, but Benares is the favourite in Formosa and in some parts of Fuhkien. Ranging west and north of this line, and including part of Kwangtung and Kwangsi, Kiangsi, Anhwaé, and the North-Eastern Provinces, and Shingking, is a second belt in which Malwa is consumed, to the almost entire exclusion of Bengal, the latter, apparently, being only smoked by those who elsewhere have become accustomed to its use. To the west and north of this belt, again, native opium is mainly used, the foreign drug being considered a luxury, and only purchased by the opulent or by connoisseurs in the article.

The three classes of opium are considered by the Chinese as having peculiar characteristics. Bengal opium, which is prepared with great care, though having strong narcotic properties, is free from many of the objections which the Chinese aver attaches to the others. Malwa is of a stronger flavour, more coarse and biting to the taste; it is said to have a tendency to induce an unhealthy condition of the skin, and is altogether more pungent and stimulating. It produces heartburn in those unaccustomed to its use, and is irritating to the nervous system. Native opium, again, possesses all these bad qualities of the Malwa drug, with others of its own. It is said to be coarser and more fiery than the Indian, its flavour is inferior, and it produces disagreeable and troublesome eruptions of the skin, and it is moreover constantly adulterated to a great extent with seaweed, oil, &c. To remedy these defects it is said that the smoker is compelled to have occasional recourse to the foreign drug.

The difference between the foreign and native sorts is so marked that the Chinese say that no man can exchange the use of even the inferior foreign drug for that of the best quality native product. The smoker of Patna will not, unless compelled by absolute necessity, take to Malwa. So long as any of his favourite drug is to be had he will purchase it, however high the price. The smoker of Malwa does not, however, feel the same difficulty in exchanging for Patna. It is probable that the worst inconvenience he will feel from the change will be the absence of the pungent flavour to which he has been accustomed. Climate and bodily condition seem also to have had a good deal of effect in the formation of local tastes. It will be noticed that in the more relaxing districts of the south, Bengal opium is mainly in favour, while, in the colder districts of the north, inhabited by a ruder and more robust race, the more pungent Malwa is the favourite. This preference seems to be most marked where the Tartar element in the population is most developed. To use the nomenclature of the Chinese, Patna is "mild," Malwa "fiery." It may likewise be remarked, though possibly the coincidence is only accidental, that the districts using Patna are also those where the people have been longest in the habit of smoking the drug. This probably points to a growing refinement in the taste of the smokers.

The true reason, then, of this preference is apparently to be found in the fact that the Bengal drug is more carefully prepared, and undergoes more perfect manipulation; while that of Bombay, being left to private enterprise entirely, is sent forward in a comparatively crude condition, and complaints of admixture with inferior qualities are frequent. Mr. Medhurst considers it doubtful what would be the ultimate effects of any considerable curtailment in the supply of Bengal opium. Its immediate effect would be to enhance the price very considerably, as old smokers would be bound to obtain it at any cost. This enhancement of price would inevitably result in the wholesale adulteration of that imported with the inferior qualities of native. This adulteration is already carried on in the north of China to a considerable extent. Indeed it is probable that a considerable proportion of the opium imported at Newchang is made use of to improve the flavour of the Manchurian drug. At present it may be affirmed that no native opium is grown in districts consuming the Bengal drug. The inferiority of the native to Patna and Benares is too great to admit of its cultivation when the usual sorts are procurable. As the outer limits of the Malwa-consuming districts on the other hand, it is found that the cultivation of the native drug increases from year to year. Any serious interference with the supply of the Bengal drug would, therefore, in all probability have the effect of introducing the cultivation of Chinese opium into the coast provinces, where, hitherto, the cultivation of the poppy has been confined within the narrowest limits. An analogous result, in many respects, might follow upon the prohibition of the import of green teas in the United States. It is probable that before the national taste would become reconciled to using black, some other substitute for the beverage would come into use. The almost certain effect of reducing the production of Bengal opium would be to seriously diminish the export of Indian opium of all descriptions, and to stimulate in a proportionate degree the production of the Chinese drug.

CHARPENTIER'S SYSTEM OF UNDERGROUND IRRIGATION.

The following is taken from a pamphlet published by M. Charpentier, descriptive of his system:—

Drought has a disastrous influence on vegetation, whereas heat and moisture, combined in suitable proportion, promote vegetation. Watering in the open air upon heated ground is always defective and insufficient; it hardens the soil, rarely reaches the fibrils of the roots, and three-quarters of it is lost by evaporation. The question for the cultivator is this—how to give to the roots of plants the moisture they require, how to supply it so that they may absorb it with the least possible waste, and at the same time drive away noxious insects and animals, especially the mole, and the mole cricket, for whose destruction considerable rewards are offered. I think I can resolve this important problem, the solution of which will cause a real revolution in agriculture; for with such a process nothing is impossible, and heat, whose excess is sometimes formidable, will become a real benefactor to the cultivator. The system which I have invented can be applied in four ways:—

1. The distribution of water in the interior, and at a greater or less depth of soil, forming what I term subterraneous irrigation, by means of communicating pipes fed by a main communicating with a reservoir at a higher level. This reservoir is fed, as is required, by a hand-pump.

2. The exterior watering by means of tubes or pipes joined to lower pipes which rise just above the point from whence the branches of trees spring, so as to apply water to them in small but continued quantity, either by spreading it on the leaves like rain, or letting it fall in little drops on even the trunk of the tree.

3. Draining land in winter and in spring during cold rains, or replacing moist air by the introduction into the pipes dry air, or nitrogenous gas, proceeding from dung or other manure. For this purpose a suction ventilator, or a blowing ventilator, can be applied when wanted for circulating this air, or gas, in the pipes. Consequently this gas can be diffused over the plants and over the roots of trees and shrubs.

4. The conveyance and distribution of liquid manures by the same pipes either to the foot of the plants or

to the roots of the vegetables. To the roots of grass in meadows, to trees and shrubs, and also where branches of trees meet, there liquid manure can be let fall in small or fine drops. These ideas, and their general application to all branches of practical agriculture, will be easily understood by examining the detailed description of the process, as follows. Taking a hectare ($2\frac{1}{2}$ acres) of land, 100 metres each way, and supposing a spring, a river, a stream, or any water course is near the land supplying 60 litres (13 gals.) a minute, that is daily, 86,400 litres (19,200 gals.). This supply, taking it at one-sixth, is 10 litres a minute, or daily, 14,400, and in two days 28,800, say $2\frac{3}{4}$ litres the square metre. If 6 litres are required for ordinary watering, I calculate that a fifth of this quantity will be more than is necessary on my system. Having obtained the necessary water for this hectare, we form a tank and a column of water containing 9 to 10,000 litres (about 2,000 gals.). Where there are several sources of supply at our disposal a vessel may be constructed of the same dimensions as above-mentioned. This vessel should be placed on a truck with large and broad wheels so as to be taken to the spring. It can be filled by help of a hand pump or by the Archimedean screw.

From the tank or vessel, the main of which is always furnished with a valve with a grating in front, the water necessary for supplying the irrigating pipes placed one or two metres distance from each other is caused to run into a conducting pipe. This main pipe, say 20 centimetres (8 inches) in diameter, will be set on trestles or on a bank of turf; this bank will be raised 50 centimetres (about 20 inches) above the soil. In this thin pipe there must be as many vertical pipes as irrigating rows placed from 20 to 25 centimetres deep underground for meadows, and 40 to 50 for market gardens, and 55 to 60 for arable land.

For placing the irrigating tubes, open trenches of 30 to 40 centimetres wide should be drawn with a plough, which breaks the earth and renders it pervious. These rows should have a fall of two to three millimetres per metre, so that the pressure and the current of water may, when needed, be capable of cleansing the irrigating pipe when stopped up. Parallel to the principal pipe, and at the distance of 100 metres, a ditch should be made 1 metre 33 centimetres deep, to receive the orifice of the last irrigating tubes. This orifice can be made to open and shut by means of a cock or wooden bung fastened by iron wire. The object of this bung is to retain the water and to cause it to rise and thus escape by the openings which the joints of the tubes admit of. It will be desirable to cover with an entire collar the first eighty of these joints, and as at the other extremity the water from the fall of the ditch may come down too abundantly, the last irrigating pipes are also covered with a whole collar. Instead of large pipes for the principal conduits, flag stones hollowed out in the form of portable gutters placed on trestles may be employed, from whence all the irrigating pipes would start. From these the distribution of the water takes place. This system of irrigation not only supplies water to the roots of plants, to the branches of trees and shrubs, but also carries with it, dissolved or suspended in the water, other elements of fertilisation, and above all takes them below the surface without expense. The soil will thus be fertilised in a few years, as there is no evaporation, on the contrary, gases will be formed which will supply the nitrogen and revivify it, as well as destroy noxious animals and their eggs. This irrigation is further extended by means of small leaden pipes from the reservoir to plantations, gardens, and parks, to fruit and ornamental trees, &c., which drought might otherwise destroy. The same results may be obtained for vine and wall fruits; the plan is equally suitable to orange trees in boxes or pots, and even for flowers in pots on balconies. This mode of watering is still more efficacious where branches fork; the water can be spread drop by drop to the entire plant, night and day if necessary. These successive drops are absorbed to the extent of three-fourths by the bark of the tree, and transmitted to the sap. The pipes are made of cast iron, tin plate, wrought iron, zinc, and in all kinds of metals; of Roman cement, terra cotta, gutter tiles, bitumenised wood, and other materials. The above description shows my system can be established where the supply of water is less than that which is necessary for ordinary watering. A litre for each metre is more than enough for two days, besides watering is not necessary during all the year; it should especially be used during the four hot months; or, if a large source of supply is not obtainable, a cistern may be made to contain 9,000 tons of rain water, which will be sufficient for irrigating 10 hectares for 60 days. It is not difficult with farm buildings, and stone troughs round the house and its courts well levelled to store 9,000 or 10,000 tons in the autumn, winter, and spring. This would be enough for a kitchen, fruit, and flower garden, with meadow land amounting altogether to ten hectares (25 acres).

As to the depth at which my pipes are placed. In meadows I place them at 20 to 25 centimetres (8 to 10 in.) beneath the surface, to avoid breakage of the irrigating pipes by animals which are feeding in the fields. In fields where animals do not graze, the pipes need not be put more than 15 to 18 centimetres (6 to 8 in.) deep, which assists vegetation greatly, especially if irrigation be carried on with manured water weekly. In three-fourths of the permeable soils, sandy or flinty, in lands easy to work, the rows of pipes will be placed two metres (80 in.) from each other, which will be 50 rows per hectare ($2\frac{1}{2}$ acres).

In this case the passage of the water, which rises by capillary attraction, will only have 95 to 99 centimetres (about a yard) to run before it meets the water brought by the neighbouring pipe, the second liquid column being distributed in the same way and in the same proportions.

After three or four days watering the whole of the soil will be impregnated in a suitable degree. In market gardens, where much labour is necessary, the irrigating pipes will be placed 40 to 50 centimetres deep, the irrigating rows at one metre according to the want of the market gardener. In every case I assert that I can realise three or four harvests. These exceptional harvests will be obtained at an immense saving of expense, since we dispense with a costly staff and night and day work.

In gardens as well as in meadows, irrigating tubes may be placed at the depth of 20 centimetres. For orchards and fruit trees, it will be desirable to adopt the same depth both for watering and manuring.

For exterior watering, for gardens and trees, no watering pots are used; I carry on my irrigation by means of series of taps. I take the pipe which has been placed underground for irrigation and I fix to it a small zinc, leaden, or india-rubber pipe; I direct this against the tree at the bottom of the stem, and place there a pipe terminated by the rose of a watering pot or in the form of a gas jet, so as to let the water fall drop by drop on the trunk of the tree, in the line of fruit trees, espaliers, vines, orange tubs, and flower pots. For the two latter, I besides employ a drain pierced with small holes, which I place 10 centimetres underground, in the tubs or flower pots. I introduce water by a tap into the drains, fill them and turn the taps. By this means I obtain a continued freshness. Oranges will blossom at will. Empty spaces are thus ornamented and a luxuriant vegetation produced. My orange trees blossom twice, and my flowers in pots no longer die from drought. The foliage of large shady trees thus managed may be preserved and their leaves kept constantly green. For shrubs and fruit trees it is still much more advantageous. A kind of permanent circulation of the sap is thus artificially secured, thanks to the influence of a certain temperature. Besides early ripening, the fruits not having been arrested in their development are well

grown, without too much wood, without blemish, and are thoroughly ripe.

No doubt arboriculture will give France a much larger revenue than is generally supposed. French plums alone represent a value of several millions; it is the same with apples, pears, peaches, and grapes. If you ask confectioners they will tell you there is never enough fruit, especially cherries, pears, peaches, and apricots. With my system of irrigation, 25 to 200, and even 1,000, fruits may be left to ripen; they will all be good. I will not dwell on the advantages to market gardens; consult the first market gardener you meet, even if ignorant, and he would comprehend all this. Watering pots are completely got rid of, and besides less land is necessary, so there will be less digging, and the manure will be more concentrated and more efficacious.

The Advantage of Underground Irrigation in regard to its Cost.

As I have already shown, my system can be applied in four different ways.

1. Underground irrigation with liquid manure applied fortnightly, suitable for market garden cultivation, for meadows and arable land, will produce vegetables and fodder for farm yard animals and others on a large scale, which will have the effect of cheapening meat.

2. Placing pipes against walls and at the foot of rows of trees for the purpose of introducing a good liquid manure principally to poor, light, and sandy land will give the opportunity of using water saturated with rock salt, clay, and pulverised marl dissolved by means of an instrument which I place in my reservoir, a detailed account of which I propose giving in my work on the new agriculture.

3. The same system affords a complete, simple, and inexpensive method for gardens and parks, lawns, orange boxes, flower pots, fountains, &c. The arrangement admits of the use of rose jets for producing at will an artificial rain in the midst of trees, &c., as also for the drainage of damp lands.

4. The employment of this method of underground irrigation admits of the introduction and regulated diffusion of gases useful for cultivation.

These objects vary considerably as to their cost; but it is certain that the expense once incurred diminishes by two-thirds the daily cost. I have for a long time had in my mind the idea of underground irrigation, but it is owing to the dryness of last summer that I at last succeeded in drawing up a simple, correct, practical, and comparatively inexpensive plan.

I had signed an agreement by which I had engaged to deliver green vegetables to purveyors of such things; it consisted of 14,310 francs worth of cauliflowers, long peppers, garlic, gherkins, tomatoes, French beans, carrots, and radishes. Heat burnt the young plants and stunted vegetation, and nothing prospered. The water began to fail, the waterings were insufficient. I endeavoured to double the quantity of water for irrigating the trenches; I dug in two places, and there found two springs, which gave me a sufficient quantity; I thus watered by my trenches. Finding that I used a great deal of water, and wasted a considerable quantity, I placed irrigating pipes amongst my vegetables, and the waterings were carried on solely by this new plan. In September and some part of August I was greatly surprised. The bean pods were doubled in size, tomatoes were enormous, and carrots very fine. I was thus enabled to carry out my agreement, and had diminished the cost of watering by 66 per cent. I carried on the same operations for part of my tobacco plantations, and produced the best tobacco in the Gironde. These facts speak for themselves, and a clever and intelligent gardener, M. Dagorno, sen., 26, Rue de la Voie-Neuve, Charonne, seeing their importance, congratulated me on such a satisfactory result. He expressed his opinion that my system would inevitably revolutionise market gardening cultivation. Many of his colleagues are of the same opinion, as well as many celebrated gentlemen whom I shall name later on. M. Imaz, the head of an important banking establishment, has asked me to introduce my system in his grounds, as he has no doubt of its simplicity, durability, and efficaciousness. Growers of early vegetables on hearing this plan were much impressed with the idea, especially when I showed them that during the winter they could distribute underground water warmed from 60° to 80.° C., and that this water on running underground would be at the proper heat for warming the manure, which would reduce its cost to one-half especially after days of frost. This method is as practicable and simple as the others, for the same underground conduits are used. The idea of putting the dung, which cost from 4,000 to 5,000 francs, below the soil instead of above, thus utilising gases and liquid portions, was especially satisfactory. As regards expense. Take for example one hectare; having settled this I can multiply it by 10 or 100. For one hectare of land of second quality I will not enter into general expenses, each proprietor having already his fountain, springs, wells, pump, &c. A tank must be constructed which will cost from 100 to 400 francs, according to the number of hectares to be irrigated. Supposing the hectare forms a long square, the first thing is to fix a main placed at an elevation of 50 centimetres (20 in.) above the surface of the land and gutters, their fixing will cost altogether 1 franc 50 centimes per metre say for an extent of—

	Francs.
80 metres at 1·50 fr.	120
100 vertical pipes 30 frs. per 100....	30
Expense of placing in ground......	10
Irrigating tubes, 2 metres apart, 120 metres in length, 40 rows of 375 tubes per row, in all, 15,000 drains with fixing will cost 35 frs. per 1,000	525
Shafts and unforeseen expenses	115
Total hectare	800

Or £12 16s. per acre.

The pipes will convey water, liquid, and air, which it will be easy to give at night, by means of plugs fixed for retaining or letting out water. This hectare of land may also be dried during winter by means of these same pipes, even better than by ordinary drainage. The air will also circulate in the bowels of the earth, and deposit the nitrogenous matters contained in it. It can be easily understood that irrigating pipes which are open at both ends (if necessary) with shafts, will enormously facilitate the drying of the ground. Drainage pipes have only one object, often badly attained, namely, that of drying the soil. I say that drainage is misunderstood, because the pipes are generally placed at much too great a depth, which, in dry years, takes away the necessary moisture from the ground. For years of drought pipes of 70 centimetres (2 ft. 4 in.) at most will be needed, open at each end, and with shafts.

The Calendar of Operations with Underground Irrigation.

I sow and plant in May. My land has been dried during the winter by my pipes, which serve as drains. The air circulates for eight months in these pipes, and with the shafts and two openings the air will in summer go through the irrigating pipes and supply the small roots with that air which is necessary to them. They will benefit during nine months from the nitrogen contained in the air. During March and April, I send into the bowels of the earth river mud, clay and marl, the two latter pulverised. I irrigate with liquid manure. I thus fatten the interior of the land, if I may so express myself. I am careful to drain off the water so used; the natural filter of the earth has preserved the fertilising parts, water which is in excess has been carried away drop by drop, and the desired effects have been produced.

In July we are ready to re-commence. A dampness, nevertheless, remains in the earth for a fortnight at least, and from May to June it is necessary to give at most one or two irrigations. The plants have not suffered from cold rains in consequence of the action of the air; the air circulating in the irrigating tubes, the plants will have pushed forward without turning yellow; they will on the contrary, be a dark green, and will be able to withstand a white frost. Vegetation will, perhaps, be a little interrupted, whilst if this system be not employed, it will soon be in a state of decay, dying, or scarcely vegetating. In this case, the flower opens, but the fruit falls off, or is developed in such a state that it becomes stunted. We can, it is true, mulch the vegetables in June, and thus prepare them for greater heat. I estimate the mulching at 50 francs per hectare. June passes well; July is noted for its heat without rain, but we cannot temper the heat with liquid manure.

Difference in Produce of every kind.

Ordinary tobacco yields 5 centimes per plant. With my irrigated land, I can obtain 15 to 20 centimes per plant, my leaves are broader, taller, and thicker, and each plant will yield 9 or 10 leaves. In this case I should realise 4,500 (£160) or at least 3,500 francs per hectare. This is the result of my harvest this year, and I only put it in operation in September. They calculate on getting 15,000 cauliflowers the hectare; small ones are worth 10 centimes; well grown ones from 25 to 30 centimes. Thus a hectare produced 1,500 to 4,500 francs. The same result with ordinary cabbages in summer. In beetroot three were produced in the place of one.

Carrots for fodder, from 20 to 25 the metre, yielded 1,500 francs the metre; well-grown nearly 4,500 francs. The hectare of red carrots at 45 per metre, the 45 weighing 30 lbs., will give 8,000 to 10,000 francs at 7 francs the 100 kilogrammes. Gherkins yielded 200 to 250; the 250 are worth 1 franc; 2 metres should be planted in each ditch; this also produces 5,000 francs the hectare.

Besides these products, we must not forget potatoes, maize, sugar, sorghum, green beans, producing four-fold; the expense of watering is lessened, and cultivation improved. Meadows aërated in winter, manured in spring, and irrigated for four months, will yield three or four harvests per annum. Before concluding I must say a few words on manuring and watering fruit trees, espaliers and vines, in the open air; it is easy to understand the good effects in both cases.

Irrigation in Pleasure Grounds.

The system is applicable to pleasure grounds, and the proprietor will not grudge the expense of pipes of lead, bitumen, or india-rubber, which, by means of a tap, furnish him with ornamental fountains. With 10,000 litres of water daily, costing 5,000 francs to 10,000 francs, hand labour may be decreased 1,000 francs a year. The rich proprietor will comprehend all the advantages of my system from an artistic point of view. I shall easily be able to show him how I can combine the ornamental with the economical. Water, freshness, a luxuriant verdure from April to October; this is what I promise to those who adopt my system. And the offer which I make them is to carry out on their estates my system of underground manuring and exterior irrigation. As to the properties for produce, we have seen in the first part of this work to what an enormous extent their production may be increased.

The number of miles run by engines last year upon the Central Pacific Railroad was 5,214,441, as compared with 5,010,931 in 1873. The additional distance run last year was thus 203,509 miles, or 4·06 per cent. The total cost per mile run last year was 35·24 per cent. In this total repairs figured for 8·14 cents.; enginemen and firemen for 7·00 cents.; and fuel for 17·88 cents.

CORRESPONDENCE.

TRADE MARKS.

SIR,—As the question of "Trade Marks" is now engrossing public attention, I beg you will allow me to offer a few remarks on the subject, which I could not find an opportunity of making at the last meeting.

I consider the great fault of the new Act is to extend the denominations of trade marks far beyond their natural and requisite limits. The chief object of a trade mark is to distinguish certain articles which by their nature cannot bear any other recognisable sign, or which dealers object to sell with the manufacturer's name for fear of disclosing the source of their supply. Whenever a manufacturer is allowed (as in our trade for instance) to display his name and address in full on his wares, they are sufficiently protected from imitations by common law to require no further legislation. If he chooses to use a trade mark in addition, it is a matter of fancy or of advertisement, but is of no practical utility either to himself or to the consumer. I conclude, therefore, that it would considerably lessen the difficulties of classification and protection, if trade marks could be confined to articles which do not or cannot bear the manufacturer's name, without encumbering the working machinery with an immense quantity of wares which can well dispense with such a device.—I am, &c.,

EUGENE RIMMEL.

96, Strand, London, 20th December, 1875.

HEALTH, COMFORT, AND CLEANLINESS IN THE HOUSE.

SIR,—In connection with "Health, Comfort, and Cleanliness in the House," the quantity and quality of the water supply seem so pre-eminently important, that one cannot but feel surprised at the very small space devoted to this branch of the subject in the paper read before the Society by Mr. Blashill, on the 15th inst.

The great majority of the inhabitants of London are, of course, dependent for their supply on the water companies, and as a rule, have little to complain of on the score of quantity; but no opportunity should be lost of publicly denouncing the quality of the stuff supplied to our houses under the name of "water."

If any one will take the trouble to fill a bottle with water from the main of either of the companies which draw their supply from the Thames, and after stopping the bottle securely so that no impurities can be contracted from the atmosphere, will allow it to stand for a few weeks, he will find at the expiration of that time a filthy deposit of animal and vegetable matter, sufficient to give the water the appearance of having been taken from a stagnant ditch. And yet this water is supposed to have undergone some nominal process of filtration at the company's works, before delivery to the consumer, in order to comply with the provisions of the Act of Parliament.

The condition of house cisterns, in which water so contaminated is stored, becomes in a short time perfectly frightful, unless constant attention is paid to cleansing them; and on this point, instead of omitting all mention of it from his paper, Mr. Blashill would have done well to have laid considerable stress, for there can be no doubt that to the accumulation of filth in cisterns must be attributed much of the typhoid or enteric fever, and other diseases to which the medical officers of the Privy Council are continually directing attention.

Of course the natural remedy for this state of things would be to obtain our supply of water from a purer source, but inasmuch as the carrying out of any one of the schemes proposed for this purpose will involve millions of outlay and years of waiting, we of the present generation must endeavour to make the best of what we

have. To do this, strict attention to the state of the cistern, added to domestic filtration of all water used for drinking or cooking, seem absolutely necessary, and any paper professing to treat of "Health, Comfort, and Cleanliness in the House," must be considered very incomplete, if it fails in giving prominence to these two points.—I am, &c.,

R. G. Blunt.

Battersea, S.W., 22nd December, 1875.

Sir,—In reply to the question of the secret of the gentleman who had lived so many years in a house without ever having a load of rubbish removed therefrom, it is briefly this:—1. He keeps the ashes and cinders constantly thrown upon the back of the fire, whether in sitting-rooms or kitchen, by which one-third of the fuel is economised or saved. 2. Where swine are not kept, the refuse of all vegetables is thrown on the kitchen fire every day, at the back of which cremation is very quick. 3. Where all refuse is constantly burnt, fever, &c., are rarely found. 4. No rubbish is allowed to be put into the ash-bin. The clean ashes are carefully distributed over the lawn in the winter months; in the summer they are as carefully dug or raked in amongst the shrubs and trees, to their great benefit. 5. Those who have neither garden or lawn may, by burning all refuse, reduce their rubbish to a minimum.—I am, &c.,

W. Botly.

NOTES ON BOOKS.

The Octopus, or the "Devil Fish" of Fiction and of Fact. By Henry Lee, F.L.S., F.G.S., F.Z.S., &c. London: Chapman and Hall. 1875.

Mr. Henry Lee, the naturalist of the Brighton Aquarium, is known to have bestowed special attention on the curious creatures known as octopods, and he now presents the results of his labours and studies in the form of a monograph. The octopus had fallen almost entirely out of notice, except when a "devil fish" was shown as a curiosity in some maritime port, until Victor Hugo drew his extraordinary sketch of it, and the establishment of aquaria furnished the opportunity of studying the habits of the strange creature without great difficulty. This Mr. Lee has done with great assiduity, and the results are given in his work. He proves the truth of many extraordinary particulars respecting this animal, and in some cases clears away important errors. Mr. Lee has carefully considered all the stories known about the octopus, from the time of Alexander the Great to the present, and has examined with attention all the preparations in museums within his reach, and, while he has certainly dispelled some fables, he has increased the true story by the authority of research and impartiality. Mr. Lee does not endorse De Montford's story of the "Kraken," which enfolded within its arms and threatened to carry to the bottom of the ocean a three-masted vessel, but he tells us that in the British Museum is the short arm of a cephalopod which he measured and found to be nine feet long and ten inches in diameter; this is one of the short arms of a calamary, and the total length of the creature is estimated by Mr. Lee at about 48 feet. The work contains a great deal of information about the sepia, the squid, and the paper nautilus, as well as notes respecting the value of the whole family from a gastronomic point of view, and their economical value.

Primer of the Phonic Method of Teaching Reading and Writing.—By G. C. Mast. London: C. Bean. 1875.

The system of the writer comprises a number of signs to be added to letters, with the view of explaining their proper pronunciation. The book contains, besides a description of the "method," a number of copies for writing and extracts for dictation.

GENERAL NOTES.

The Educational use of the British Museum.—At the late conference of the head masters of public schools, the following important resolution was passed:—That it be an instruction to the committee to communicate with the authorities of the British Museum and ask them to take into consideration the possibility of placing their vast treasures more readily at the disposal of the country for educational purposes. It was also resolved that the Conference meet in the year 1876, on the Thursday and Friday immediately preceding Christmas-day, at Marlborough College; and Dr. Blore, Dr. Butler, and Dr. Percival were elected to fill the places of the three retiring members of the committee, so that the committee for the year 1876 consists of the head masters of the following schools:—Sherborne (Rev. H. D. Harper, Chairman), Canterbury (Rev. Dr. Blore), City of London (Rev. Dr. Abbott), Clifton (Rev. Dr. Percival), Harrow (Rev. Dr. Butler), Marlborough (Rev. Dr. Farrar), Rugby (Rev. Dr. Jex-Blake), Tonbridge (Rev. Dr. Welldon), Wellington (Rev. E. C. Wickham). It is to be hoped that the trustees of the British Museum will give a respectful attention to the wishes expressed by this influential committee.

NOTICES.

JUVENILE LECTURES.

Two lectures, suited for a juvenile audience, will be given on Tuesday, January 4, and Tuesday, Jan. 11, by Dr. W. B. Carpenter, C.B., F.R.S., on "The Wonders of the Microscope." The lectures will commence at 7 p.m., and will be illustrated by the oxy-hydric and electric lights. As the number of seats is limited, tickets have only been issued to the extent of the accommodation available, and the issue has now ceased, enough applications having been received to fill the room. Members are reminded that in no case can any person be admitted without a ticket. To this rule no exception can be made.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...British Architects, 9, Conduit-street, W., 8 p.m.
Institute of Actuaries, Quadrangle, King's College, W.C., 7 p.m.
Medical, 11, Chandos-street, W., 8 p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Morley, "The Study of English Literature."

Tues. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 7 p.m. Dr. Carpenter, C.B., F.R.S., "The Wonders of the Microscope." (Juvenile lecture.)
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Experimental Electricity." (Juvenile lecture).
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m. Annual Meeting.
Biblical Archæology, 9, Conduit-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Prof. Huxley, "*Ceratodus* and *Chimæra* and the classification of Fishes." 2. Prof. W. H. Fowler, "Description of a Skull of a Species of *Xiphodon*, Cuvier." 3. Dr. Julius Von Haast, "A new Ziphioid Whale."

Wed. ...Geological, Burlington House, W., 8 p.m.
Entomological, 11, Chandos-street, W., 7 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m.
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m. Annual Meeting.

Thurs ...Royal, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Seeley, "The Anti-Napoleonic Revolution of Europe."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Experimental Electricity." (Juvenile lecture.)

Fri.......Geologists' Association, University College, W.C., 8 p.m.

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Prof. Tyndall, "Experimental Electricity." (Juvenile lecture.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,207. Vol. XXIV.

FRIDAY, JANUARY 7, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The competition for the four free scholarships given by the Society will take place in London in February next. Every member of the Society has the privilege of nominating two candidates, one of each sex. Forms of nomination, and all information as to the terms and conditions of the competition, may be had by applying to the Secretary.

EXAMINATIONS IN FINE ARTS APPLIED TO INDUSTRIES.

These examinations are intended to apply to subjects which are not at present to be included in the general Art Examinations of the Science and Art Department, and especially to test a literary knowledge of the decorative arts. Candidates must have taked a second-grade certificate (Art) of the Science and Art Department.

The examination will be held in 1876, on Tuesday evening, the 25th of April.

Programmes may be had *gratis* on application to the Secretary.

CANTOR LECTURES.

The third Lecture of the first Course of Cantor Lectures for the present Session, "On the Discoveries and Philosophy of Liebig, with especial reference to their influence upon the advancement of Arts, Manufactures, and Commerce," by J. L. W. Thudichum, M.D., was delivered on Monday, December 6th, 1875, as follows:—

Lecture III.

Distillation and Reduction of Metallic Oxides—The Physiology of Plants, and the Natural Laws of Husbandry.

There remain, gentlemen, from the former lecture, a few points of importance which I wish to dispose of before entering upon the principal subject of the evening. We have described, and seen in action, various kinds of apparatus relating to organic analysis, to analysis of the air, and others. We have to-day to consider an apparatus, which has been largely used in manufactures, namely, the so-called Liebig's cooler. It stands now before you, and is in action. You perceive that a vessel, in which a liquid is boiling, is connected with a tube in which the vapours evolved by the boiling liquid are being condensed; and on the other side you perceive a vessel which is destined to receive the contents of the other vessel. You see, moreover, that the tube in which the liquid condenses is surrounded by a second tube, and the space between the inner and outer tube is filled with cold water. Now there is nothing, of course, new in the principle of condensing hot vapours by cold water; but what is new is the logical arrangement by which that process of condensation is conducted, and this consists in the application of the law that cold water is heavier than hot, and, therefore, in a mixture of cold and hot waters, will remain at the bottom, whereas the hot water will rise to the top. That is exactly what takes place in Liebig's cooler, namely, the cold water, entering at the lowest point, gradually rises and displaces any water which may have become hot by the process of condensation. The advantages, therefore, are that all the water which runs through the apparatus at a measured rate is fully used for the purpose for which it is intended to be used; further, that the hottest part of the vapours comes in contact, not with the coldest part of the apparatus, but with the hottest part, and that, as the cooling of the vapours increases, so the coolness of the water increases. Hence, there is introduced an element of security which prevents the apparatus from being broken; and, moreover, the apparatus being straight, and, as you see, of glass, admits of perfect cleaning. In former times, and, indeed, almost up to the time in which this apparatus was invented, most condensing apparatus were made of metal tubing. They were, as far as I know, never straight, but always shaped in the form of a worm. Hence, the cooler in trade was generally called a worm. Of course the cleaning of such an apparatus for chemical purposes was next to impossible, and, therefore, in laboratories you hardly see worms employed, except, perhaps, for the distillation of water and of common spirits. This, then, is the arrangement of Liebig's cooler, which is used in all laboratories throughout the world in the form which you there see, and is known by his name.

The application of another principle is going on on the right hand side. It is the application of a body which, though Liebig did not discover it, he was the first to produce on a manufacturing scale, namely, cyanide of potassium. In his studies of that remarkable substance he found that it had a powerful influence upon metallic oxides, and when brought together with them, and in a state of fusion, had the power to reduce these oxides, and transform them into metal, or, what is the same, the cyanogen in the cyanide was burnt at the expense of the oxygen in the oxide. The process, therefore, in a manner, is the reverse of that which you saw in the last lecture. You then saw that organic substances were being burnt by oxide of copper, with a view to the determination of the carbon and hydrogen contained in those substances. Here you see, on the other hand, oxides being reduced by organic matter, or what I will call organic matter, namely, cyanogen, for the purpose of obtaining the metal in a pure state. This application of cyanide of potassium, in conjunction with carbonate, is now commonly used for the production of a variety of metals, and particularly of silver. We are here engaged in fusing a little cyanide of potassium, and we have thrown in some red oxide of lead, and if we wait a little time we shall see the metallic lead collected in the bottom of the glass. If we had any better arrangements for heating, the operation would be instantaneous, but it is very difficult, with a mere gas lamp, and without reverberating protection, so to heat the vessel that the fusion shall be one of ease and quickness. However, I can show you the result. We have here prepared a metallic regulus, or king, of lead, as it was called by the ancients, by the very same process which you see going on. Mr. Kingzett has so beautifully regulated the action that

you can see the fused cyanate and carbonate on the top, and the metallic lead at the bottom.

The cultivation of the surface of the earth for the purpose of producing food or other articles of use and enjoyment for himself or his domestic animals, is one of the oldest occupations of man. It might therefore he supposed that human experience with regard to this branch of human action was greater than with regard to any other; it might be supposed that mere experience had collected the body and volume of a science, and had arrived at the recognition of principles capable of guiding the action of the complete and free understanding. But this is not the case. The agriculture of the past has not only reared and fed nations, it has also ruined and exterminated them, and has left entire countries in such a state that neither the nomad nor the hunter could make a living in them. By its ultimate effects it has convulsed empires, mixed nations, and produced most of the conditions of the thousand years of intellectual darkness which we term the Middle Ages.

The writings of the ancients on agriculture partake, with few exceptions, of the nature of prescription; and if I may judge from my own reading of some of these authors, I should say that, *e.g.*, the book "De Re Rustica," commonly attributed to Cato, was mainly based upon the recipe-book of his grandmother. However, even the best amongst these writers had no influence on the practice of mankind during the Dark Ages, simply because their books were hidden away, or destroyed by the ignorant fervour of the terrible belief which destroyed nearly all the intellectual achievements of antiquity. And even after the revival of learning, literature had no effect on agriculture, because the agriculturists were not learned in any way. Tillage remained a routine. When it failed definitely the tiller was dispossessed, and either died or became a slave, or went to a new country. There were neither teachers nor schools to appreciate, evolve, record, or teach principles. To this neglect the earth replied by famine and plagues; by these man came into the bonds of superstition; and while millions of idlers in monasteries and convents devoured the substance of entire kingdoms, mankind shook the chains of its ignorance, and found them too strong for breaking. Liberty came by a liberator unheeded and unbidden: unaided by priestcraft, which had been battling against the evils in vain; the causes of the evils and their remedies were discovered by science.

The first physiological observation of plant life excited wonder, but remained without consequences for centuries. Van Helmont's experiment upon the willow twig, which grew to be a little tree while being nourished with what appeared to Van Helmont to be pure water, rather mystified than instructed. It was the vital force, he said, which transformed water into the constituents of a tree; and the same force he believed had produced from water the large amount of ash which he obtained from his willow tree on combustion. That a plant takes its carbon from the air, its ash from the soil, in the case of the willow tree from the pure water which contains the mineral matter in solution, escaped even his suspicion.

We have seen in the second lecture, from the testimony of Klaproth, that when he discovered potash in a mineral, no one person then living would have thought such an occurrence likely. Yet even in 1819 the Academy of Amsterdam offered a prize for the best answer of the question, whether or not potash was produced during the combustion of plants. The question was correctly answered by J. F. John, who received the prize. The discovery of oxygen had led to a correct appreciation of the process of respiration in animals, and when the question was extended to plant life, an inverse action was found, already towards the end of the last century. The researches of Saussure on vegetation had led him to the result, only partially correct, that the constituents of plants are taken from the earth in the same form in which they appear in the plant on chemical analysis. The German translator of Saussure, Voigt, adopted most of what was erroneous in Saussure's treatise, and controverted that which was mainly true. He assumed that potash and lime in the ashes of plants are produced by the process of combustion, nay he believed that the so-called nitrogen was mainly instrumental in producing the lime and the alkalies. These doctrines passed into the theory of practical agriculture, and were then interwoven with the dogma of the "organic mould," and this combination formed the basis of all practical teaching in agriculture during the first forty years of the present century. The greatest continental writer on agriculture, A. Thaer, and the greatest number of educated persons who began to pay attention to husbandry as a pursuit worthy of the application of the highest intellect (mark the merit of the man, and of his followers) looked upon animal and vegetable mould (humus) as the almost exclusive source of the food of plants. The most perfect humus they acknowledged was decayed dung, but the conditions of the action of the best dung were so little understood, that Thaer still believed that the earths, which are constituents of plants, are formed within these organic bodies themselves. And at that time it was difficult to believe otherwise, as the Royal Academy of Berlin had given its prize to an essay by Schrader, in which it was maintained that plants produced the incombustible matter themselves during their growth as products of their vitality. That inorganic or mineral substances applied to the land could serve by increasing vegetable growth was well known, *e.g.*, from the example of gypsum in increasing the growth of clover (for the advancement of which Johann Christian Schubert was knighted by the Emperor Joseph II. with the title of "Knight of the Holy Roman Empire of the Clover-field"), and others, but these facts were explained by the assumption that inorganic matters act either upon the roots as a spice would act upon the tongue, by stimulating, as it was termed, vital action, or upon the soil only, in which they decompose the mould and make it more ready to be taken up by the plants. These views influenced those of the principal chemists of that time, Berzelius, Mitcherlich, Saussure, Sprengel, and Mulder. Sausurre, the most scientific inquirer in the field of vegetable physiology, recognised that the plants which grew without aid from man took their carbon from the atmosphere, but for the plants on tilled soil, he still believed "mould" to be an essential source of nutriment. In a similar manner, Saussure maintained that the inorganic ingredients of plants were taken from the soil and possessed the character of nutriment, a proposition to which Sir Humphrey Davy gave great precision. Sprengel, in his works on soil and manure, maintained (1839) that the barrenness of certain soils was the result of the absence of certain inorganic substances. But these propositions lacked proof of convincing power, and, about 1839, the University of Göttingen offered a prize for the best essay on the question whether inorganic matters would occur in plants if they are not offered to them in the soil, and whether these inorganic matters are really essential to the constitution and development of plants.

Under these circumstances appeared, in 1840, Liebig's work, "Organic Chemistry in its application to Agriculture and Physiology." I remember well the curiosity with which it was scrutinised by the gentlemen farmers, and how they could, as the saying is, make neither head nor tail of it. Their inability to appreciate or controvert arose from their complete want of knowledge of elementary matters and even terms concerning the matters at issue. But in scientific circles the work met with immediate appreciation, and it is well described in the words of Stohmann: "The careful study of this work excites astonishment at the geniality and boldness with which frequently, by a kind of prophetic eye, facts are recognised and conclusions drawn, the correctness of which could be doubted at that time but is now above all cavil." The book was revolutionary, for it broke with the past and the established doctrine of the humus

or mould as completely as the chemistry of Lavoisier had broken with the phlogistic hypothesis: for it taught that the first sources of the nutriment of plants are furnished exclusively by inorganic nature; the carbon of the plants is derived from the carbonic acid of air, water, and soil; their hydrogen from the water; their nitrogen from the ammonia which is present in air, rain, and soil; their sulphur is derived from the sulphuric acid in soil and minerals; their oxygen from air and water; their phosphorus is derived from the phosphoric acid contained in minerals and soil; the earth and alkalies found in plants are essential constituents and are derived from the soil; they have special functions in plant growth and in different organs at different periods of growth.

Liebig proceeded analytically against the hypothesis of the nourishing mould. He showed that humic acid, the principal constituent of humus, entirely loses its solubility in water when it becomes dry, or frozen with the water in which it may be dissolved; it cannot be maintained soluble by the alkalies present in the soil, because they are insufficient in quantity to dissolve as much humic acid as would suffice to produce the carbon in any one period of vegetation; further, he argued, from the known solubility of the humates, particularly humate of calcium (as previously from its known combining proportion), that all the water which fell upon a given surface was insufficient to dissolve as much humate as was required to supply the plants with their necessary carbon. He further argued that fields with excess of humus did not produce more than fields in which this element was deficient, and that the conveyance of humus alone to fields of known productive power did not increase their fertility. The carbon of vegetables, he concluded, does and can only come from the atmosphere, which contains of this gas more than the vegetables require. The phenomenon which had been, when first discovered, supposed to be one of respiration only, namely, the absorption of carbonic acid, and exhalation of oxygen equal in volume to the carbonic acid absorbed (which Saussure had shown to be the sole source of nutrition of the wild or uncultivated plants, though he believed that the cultivated plants could not live upon the atmosphere only as regards carbon, and required other sources), Liebig showed to be a universal law of plant-growth. He pointed out the antagonism between animal and vegetable life, the former constantly producing, the latter destroying, by assimilating carbonic acid; the former vitiating the atmosphere for themselves, but making it nutritive for plants, the latter purifying the air, and ultimately offering in their own substance material for the construction and maintenance of the animal body, notably a large amount of carbon, so essential for the production of animal heat. He fully established, as it has been termed, the theory of the circulation of carbon in nature.

Very singular was the bearing of some botanists of profession, who, given entirely to the organographic, or systematic, or morphological (in Goethe's sense) study of botany, cared as little about, and knew as little of chemical physiology as many of the animal physiologists of our day. Thus Schleiden, otherwise a meritorious writer, who twenty-five years ago received more attention in Germany, notably on account of his endeavours to develop Goethe's idea of an arch-plant, and its metamorphoses into all the present genera and species (an idea very different indeed from that which we owe to Darwin), said, in a critical pamphlet hurled against Liebig, that the only new thing in the book was the view that the plant absorbed the carbonic acid of the air by means of its leaves, a view which he declared to be completely untenable. The view, as we have seen, was more than forty years old, but was no more appreciated by this botanist than by the great majority of his calling, or by science at large, least of all by agriculturists. They sowed and harvested, but like the birds of heaven, they inquired not whence the carbon of their bread and butter originally came. Now-a-days, nobody doubts its source. Ingenhouss and Saussure had found that plants reverse their respiratory action during night and darkness, and exhale carbonic acid while inhaling oxygen. This Liebig explains as a chemical action in which the plant behaves like a dead body. The reduction of water and carbonic acid require the action of sunlight and heat upon the leaf; failing these powers, the substances in the plant-tissue follow their own chemical attraction; the resins absorb oxygen, the tannic acids also; from neutral hydrocarbons arise acids; sunlight reverses this action again, and a plant which, like the *Cacalia ficoides*, is acid in the morning like rhubarb, is tasteless about midday, and bitter in the evening. The carbonic acid which plants exhale at night, he explains as being unused stores, carried with water from the soil, and emitted by simple diffusion in the absence of chemical action. Some hold this view to be open to objection, and admit a more complicated theory, by Sachs, but to me the whole of the facts known on the subject seem satisfactorily and uniformly explained by the theory of Liebig.

The actual use of humus in plant growth was well shown by Saussure and recognised by Liebig, though it is sometimes wrongly imputed to him that he had ignored or denied it. He admitted that it was by means of its oxidation a continuous source of carbonic acid for the roots to take from, and he also perceived that it had the effect of making or maintaining the soil porous, so that it could be easily penetrated by air and rain, and by the growing roots. He also admitted that the mould furnished nitrogen for the use of the plants; and in later editions of his work showed that it performed most complicated functions in plant life, functions, however, which merely mineral soils, destitute of mould, sometimes mere sand, perform with almost equal precision.

Regarding the hydrogen of vegetable matters which do not contain nitrogen, Liebig maintained that it was derived from the water. Thus sugar, starch, and cellulose can be considered as carbonic acid in which half the oxygen has been replaced by hydrogen. The oxygen substituted, and that separated from the water, were both expelled by the action of the sun under the guidance of the forces united in the plant. The intermediate stages in this action are represented by the organic acids, which, becoming gradually de-oxidised in the order from oxalic, through malic, tartaric, citric, aconitic, malein, fumaric, are capable of yielding radicals, which by simple triplication furnish the hydrocarbons of the sugar class. From sugar to fat is a simple process, which is, however, more easily performed in the animal.

Entirely original, and not based upon the experiments or doctrine of any predecessor, was Liebig's teaching regarding the nitrogen formed in the gluten, albumen, fibrine, the organic bases contained in plants. He reminded that plants can be developed in calcined earth if this be mixed with some peat ash and watered with rain water. The burnt earth and ash containing no nitrogen, this element must come from the rain water. The rain water can contain nitrogen only in three forms, as nitrogen gas the same as in the atmosphere, as ammonia, or as nitric acid. Saussure had shown that the nitrogen of the air was not assimilated by plants, and this has been confirmed by all later experience. Consequently, said Liebig, there remain only the ammonia and nitric acid of the rain water as sources of the nitrogen in plants. He proved the presence of nitrate of ammonia in 17 out of 77 rain-falls, of which he analysed samples. Other chemists subsequently, by more delicate tests discovered in the progress of analytical chemistry, showed that all rain water, without exception, contains ammonia and nitric acid, and that the rain which accompanies electric discharges is particularly rich in these substances. Thus a thunderstorm was shown to do in the open air what Cavendish had discovered the electric spark to do in a closed space. The experiment of the philosopher, nearly a century after its performance, threw light upon the

problem presented by organic nature. How great is the action of electricity in this respect can be seen from the fact that a single hectare receives per annum from 13 to 44 kilogrammes of ammonia, and from 7 to 61 kilogrammes of nitric acid, the larger quantities near inhabited, the smaller in desolate places.

What Berzelius had maintained in 1837, that the nitrogenous matters of plants were derived from the humus, was yet maintained by Saussure in 1842, two years after the publication of Liebig's work. He would not deny, he said, the usefulness of ammonia as an ingredient of marl, clay, manure, but it did not combine with plants in the isolated state; its action was that of a solvent of the humus, and of the organic matter contained in the soil and air. From this it can be seen how untrue was the statement of Schleiden, that "Saussure had first developed with acumen that ammonia salts are the source of nitrogen in plants, a view which has been further extended by Liebig." This kind of robbery of most of his own discoveries, Liebig resented with a lofty demeanour and genuine contempt.

If organic matter, decaying animal and vegetable tissues, manure and mould of all kinds, are capable of yielding nitrogen to the plants, it is only because by putrefaction and oxidation this nitrogen, originally contained in the form of complicated bodies, has been reduced to ammonia. The ultimate form of the nitrogen produced by natural decay is always ammonia. In the tropics this is oxidised into nitric acid, if not previously assimilated by plants. Thus is established the theory of the circulation of nitrogen in organic nature.

The action of mould on ammonia is similar to that of charcoal; it condenses this gas, and retains it, so that water does not easily extract it. Clay acts in a similar manner, but less intensely; iron soils do the same. Gypsum also attracts ammonia, but in a different manner; its sulphuric acid combines with the ammonia, its lime with the carbonic acid of the air or soil. Thus gypsum and clay are limited, mould and charcoal unlimited condensers of ammonia. And this function the mould of fertile and barren soils performs so perfectly, that it contains about a thousand times the quantity of nitrogen which the richest vegetation or crop could withdraw from it in any one season.

Thus Liebig showed that "carbonic acid, ammonia, and water, contain in their elements all the conditions for the formation during organic life of all animal and vegetable matters. Carbonic acid, ammonia, and water, are the last products of the chemical process of their putrefaction and decay. All the countless products of vital power which are so infinitely different in their properties, regain after death the original forms, for which they have been produced. Death, the complete dissolution of a perished generation, is the source of life for a new one."

The origin of the sulphur which is found as a regular constituent of the principal tissues and juices of the animal body, which themselves are derived from the constituents of vegetables, gluten and albumen, Liebig placed in the sulphuric acid of minerals and manures. To this he also ascribed the origin of the materials which go to build up the stimulant and acrid sulphurised principles of mustard, horseradish, leak, onions, and others.

Sulphuric acid in nature is presented to the plants in the form of sulphates, *i.e.*, combined with earth and alkalies, lime, magnesia, potash, soda, and ammonia, never in the free state. These salts enter the plants by the roots; the sulphuric acid is then deprived of its oxygen, and supplied with some hydrogen and nitrogen, and consequently undergoes a process analagous to that by which carbonic acid is assimilated and transformed. The acid character of the new product ceasing, the bases become liberated, or in part combined with the new product. Thus the sulphuric acid entering the plant, serves at least two purposes, it supplies sulphur, and carries as it were the bases in combination with it, which then serve other purposes in the vegetable organism.

The phosphorus found in plants, Liebig derived from the phosphoric acid of the minerals of the soil. He believed all phosphorus to be present as phosphoric acid only, in the form of phosphates, of earth and alkalies. He admitted a ratio and mutual dependence between the formation of the albuminous substances and the phosphates. But the true connection escaped his observation, and his idea of the form in which phosphorus was present in the soft tissues of plants and animals, and their juices, was only partially true. The condition in which phosphoric acid, without being reduced or deprived of any of its oxygen, enters into combination with organic alcohols, and aids to form the peculiar ingredients of brain and nerve matter, and of all centres of growth and life, propagating or growing cells, blood-corpuscles, &c., was discovered subsequent to the last edition of his work. He appreciated the discovery highly, but had no opportunity of introducing it into the body of his physiological theory.

Regarding the inorganic, or, rather, mineral, *i.e.*, incombustible ingredients of plants, Saussure had already maintained their regularity, or constancy of occurrence, and had pointed out that the small quantity in which they occur was no sign of their uselessness. Liebig enlarged this teaching by many adornments derived from analysis. He showed that the apparent irregularities in the proportions of the bases to each other were all subject to a law, namely, that of substitution by equivalent quantities, so that in whatever proportion metals, calcium, magnesium, potassium, and sodium appeared, the oxygen combined with them was always the same quantity as a sum. He further assigned to the bases a distinct use, which none of his predecessors had done, by showing that they were combined with the various vegetable acids which are met with in all plants, and from the fact of his finding carbonates in the ash of all plants (except those containing much silica), he concluded that all plants contain salts of vegetable acids. He showed that not all the organs of plants can be nourished indifferently by means of any one mineral base, but that leaves, *e.g.*, required much potash at one time, less at another: that in seeds a substitution of potash is not feasible; that some plants can dispense with potash altogether and do with soda, or chloride of sodium, such as the *Salsolas* (or, inversely, the *Salsola kali*), or as was shown by Herapath, the sea-kale, *crambe maritima*. He explained the use of sodium chloride in plant growth by its ability to carry sulphate of lime into the plant, effect a double decomposition within the plant, and allow its chlorine, joined to the calcium of the gypsum, to be excreted by the roots. The excretion of salts not required by the plants by way of the roots he, following Daubeny and Macaire-Prinsep, subjected to consideration and application.

By means of this new theory a great number of new facts were discovered, and a great number of facts known for a longer or shorter time explained. Grasses require silica and potash, and, in absence of either, no good crop of grass is obtained. Volcanic rocks, such as basalts and porphyries, by disintegration form soils in which, on account of the silica and potash present, grass grows particularly well. Gypsum may increase a crop of hay, but after some time the effect will be the reverse; potash having been removed more quickly than it can be re-supplied by disintegration of the soil, the growth of grass becomes stunted. Its growth can be again engendered by bringing wood ashes on the meadow. When jungle or primeval forest is burnt the ash forms the material upon which grain crops can be grown for some time in succession without interruption and without manure.

How assiduously the new light was followed by Liebig and his school, and then by all chemists of the world, is best seen by the list of analyses of the ashes of plants from most genera appended to the first volume of the sixth edition of his work. The most remote, as they appeared, causes of the failure and decay of old crops were shown to be mere want of mineral nutriment; thus Bunsen proved that the sickness which destroyed so

many groves of lemon-trees in Sicily was mere starvation from the absence of mineral food. Grouven proved the same with regard to so-called sick clover (see L. vol ii. 445 and 446).

Such observations of themselves pointed the lessons which Liebig afterwards shaped for the use of agriculturists. To my mind, these lessons follow as a matter of necessity from the established natural laws. But the agricultural mind was not prepared for their reception. They were opposed for twenty years by so-called practical men of no mean order; when they could no longer be opposed they were termed evident truisms.

After a chapter on the formation of arable land or soil —in which there are many most remarkable developments on the properties of silicic acid, the action of the atmospherilia, &c.—Liebig proceeds to discuss the action of the soil with regard to the ashes of vegetables. The soil, when percolated by rain water, retains potash, silica, ammonia, and phosphoric acid so firmly that none appears in the effluent water; if the rain water contained these substances the soil retains them, and the water goes away free from them. Silicate of potash, phosphates of lime and magnesia, in suitable solutions offered to the soil, are completely retained. Common salt, on the other hand, runs away in the solution; chloride of potassium is decomposed, the potassium is retained, the chlorine goes away combined with calcium. It is thus clear that the salts necessary for the development of plants are retained by the soil, while those which are indifferent in this respect are allowed a free passage.

The observations of Liebig on the cultivation of the soil, on rotation of crops, and on fallowing, are full of interest and information, yielding the keys to secrets which have coerced man's action to his disadvantage for ages. The prominent theses were the following:—

A soil can be termed fertile only when it contains all the materials requisite for the nutrition of plants in the required quantity and in the proper form.

With every crop a portion of these ingredients is removed. A part of this portion is again added from the inexhaustible store of the atmosphere; another part, however, is lost for ever if not replaced by man.

The fertility of the soil remains unchanged if all the ingredients of a crop are given back to the land. Such a restitution is effected by manure.

The manure produced in the course of husbandry is not sufficient to permanently maintain the fertility of a farm; it lacks the constituents which are annually exported in the shape of grain, hay, milk, and live stock.

The action of animal excrements can be replaced by matters which contain their constituents.

It must be considered as the vital principle of agriculture that the soil has to receive back that which has been taken from it in the crops; the form in which this restitution is made, be it excrement, ashes, bones, guano, or mineral salts, is indifferent. By these sentences the revolutionary teaching became at once productive, and the antagonists of the great teachers, if they did not cease in their opposition, yet all with one thought and will applied themselves to secure for themselves the practical benefits of the lessons which they denounced. They throve upon it, and have all made fortunes. A vast industry arose in all countries, practising a prescription of Liebig's concerning the transformation of bones and other phosphates into a soluble condition by means of sulphuric acid. The materials pass by thousands of tons, and are known in trade as super-phosphates.

On the other hand, the enterprise in which he engaged about 1845 to supply artificial manures for specific crops failed. This was mainly caused by the introduction since 1846 of guano, which gave immediate results, and thus beat the artificial manures, the effects of which were slow. Liebig did not then know the powers of the soil to retain the plant food, so that water cannot carry it away, and had with the utmost skill so embedded his soluble potash salts in a glassy fused mass that they should come into action slowly and gradually. He had, indeed, with the aid of great labour and misapplied skill, defeated his own most cherished objects. With a lofty freedom of mind he speaks of this false start as a "deplorable, a sad error."

His antagonists now availed themselves of his error as well to discredit his teaching, and there arose what may be termed the "nitrogen period and controversy" in agricultural discussions. As the nitrogen had the practical effects in its favour, the "mineral theory" as they termed it, must, they said, be untrue. We have already seen how when it could no longer be resisted it became "an evident truism."

These circumstances involved Liebig in a long and frequently fervent controversy, in Germany with Wolff and Stöckhardt, chemists, who held prominent places as agricultural teachers; in England with Lawes and Gilbert, equally eminent in practical pursuits and manufactures of manures. Into the merits of these controversies, which attained their climax about 1855 and 1856, I cannot enter, although I have been in a manner challenged to do so. I am mindful of the fable concerning the wager of the cuckoo and the nightingale for the championship of song. The cuckoo proposed the ass for judge, and after the performance the judge decided for the cuckoo, because his melody was choral and kept time. I might by a similar just judgment have acquired a character like that of the judge in this fable, and to avoid this I leave it to the world to make out for themselves which party in these controversies has been cuckoo, which nightingale. At this period it required all the strength of his character, the power of his convictions, the consciousness of the truth of his theories, to sustain him in apparently, if judged by numbers, so unequal a contest; he stood alone. But without intermission continued the thunder of his arguments through the dreary atmosphere of indifference.

Thirteen new chapters (37-50) were added to the "Familiar Letters"; a little book embodied the principles of agricultural chemistry in a short form (1855). Dr. E. Wolff received the attention of a special pamphlet; "Theory and Practice in Agriculture" (1855), discussed the English experiments. Besides he found time to work on purely chemical subjects, and even to found a new industry by the invention of new methods of silvering and gilding glass, with real silver and gold (1856), inventions which now employ a large capital and many hands in a factory of mirrors at Nümberg. Gradually support gathered around him; Reuning, the minister of agriculture in Saxony, published (1861) the agricultural statistics of that kingdom, all of which bore out Liebig. Henneberg, one of his former pupils, entered the lists with a critical lecture which had much effect (1858). Stohmann did the same by a publication of great importance (1863), and at last Liebig himself summarised the whole of his knowledge in the sixth edition of this work, the last one he lived to himself accomplish. "I have arrived at a period of life, when the atoms of the body express a desire for a metamorphosis. This is an incentive for me to say what I have yet to say before going my way, &c." He then rehearses his doctrines with all additions, amendments, or expurgations required by the matured state of knowledge, and adds in a second volume the natural laws of husbandry. He now pressed the necessary conclusions from his teaching home to the mind and conscience of the nations for practical application. He put the thesis: The amount of produce of a field is dependent upon the sum of the conditions of fertility contained in it; the duration of the productive power depends upon the maintenance of that sum. The object of the agriculturist, he urged, must be not only to produce the highest returns at all, but it must also be to ensure a repetition of this highest return for ever. Therefore, the yield of a field is dependent upon that ingredient plant-food, which is present, in a suitable form, in the smallest quantity. If one nutriment is increased disproportionately

the others are removed more quickly. The selling of the produce of the land, without restitution to the land of the exported mineral matters, is to be esteemed equal to a sale of a portion of the land. Such husbandry must justly be called a kind of robbing husbandry (raubwirthschaft); if it is continued indefinitely in any land it must lead to impoverishment, to sterility of entire countries.

The effects of this word "Raubwirthschaft" are described by Stohmann in a drastic manner. If, he says, formerly there had been lively opposition to Liebig, now the words "robbing husbandry" acted like a spark falling into a barrel of gunpowder. A number of agricultural periodicals got into a paroxysm of screaming fury, mixed with hysterics of the genuine kind; the grossest fools, and the most ignorant clowns made free with Thersytian language. To such he utterly disdained replying, nay, he refused to at all read their effusions. To worthier antagonists he replied with a fervour which has been called vehemence. I have even heard it stated, particularly in circles where controversy is eschewed, as capable of betraying weakness, that Liebig had damaged his cause by his vehemence of language. This is highly erroneous. He was a man of the highest moral and intellectual standard, and as you have heard from himself, detested the path of the reptile. To be capable of the prolongation of enthusiasm for the propagation of truth, he must be able to resent misinterpretation of motives and acts. Therefore, his nature, when he was wronged, as often he was, resented with all its power, yet always in a measured manner; as he used to say: "I am going to measure this antagonist with the yard stick of science." And in this process, as far as I know, most antagonists were found too short.

In the second volume of his work, the "Natural Laws of Husbandry," he describes first the laws of the development of the plant in general, of all its parts at all periods of growth. He then collects all evidence accumulated by the experiments of many savants, proving synthetically the truth of his physiology, that is to say, by the growing of plants in merely inorganic media, even in water, to which only the inorganic plant food, without any mould, has been added. He then discusses the soil and its universal properties and all its varieties, and their influence upon plant growth. The third division is given to a consideration of the relations between the soil and the nutriment for plants in the process of manuring. The fourth division discusses the chemistry, use, and economy of stable manure. He shows that most farms are manufactories of manure for which the materials are taken from one set of fields to be concentrated on another, which is to furnish the produce convertible into money. He shows that this leads to exhaustion of the soil, and insists again and again that the mineral materials exported in the crops, or in the shape of live stock, must be replaced, if the fertility of the land is to be maintained. He shows the vast importation into England of corn, meat, bones, guano, oil-cake, ashes, phosphates, ammonia salts, nitre, &c., and how most of the mineral matters thus taken from other countries serve for a time, to be then irretrievably wasted and lost in the streams and rivers of this country in the form of sewage. He predicts the consequences of the exhaustion of the guano deposits, independently of the problem of Peruvian financing. He passes in review the uses of all manures used or proposed, and shows the value, action, or disadvantage of each as far as they can be measured by general principles. In an appendix he gives a great number of experiments and analyses instituted by various inquirers bearing out his theories.

He says himself that his work must not be considered as a system of agricultural chemistry; such could only be written by an experienced and learned agriculturist. He even points out the aphoristic style by which all his writings are so peculiarly distinguished, a style indeed which reminds much of that of Hippocrates; for the beginnings of all knowledge are necessarily incoherent items, which attain cohesion only gradually, as precious stones attain beauty and use only by artistic setting, however great their value in the isolated state.

Thus Liebig roused the intellect of the world to a better appreciation of matters agricultural, and the effect of his teaching, his initiative, his incentive, and his warnings, is felt in a thousand ways in all grades of the social scale, in all countries. Agricultural societies and clubs everywhere appointed or employed chemists to investigate scientific questions which most concerned them; manufacturers of manures multiplied everywhere, and they based their manufacture and their sales on the certificates of chemists; everywhere experimental farms or stations were established to continue research, ascertain detail, adapt science to easy practice. The States of Germany in particular founded such agricultural institutes for teaching and research in almost every province and university, and it has now come to pass that even animal chemistry is advanced from the basis of these largely endowed state-institutes in a manner with which medical inquiry will ere long be unable to compete. The iron ores of Spain and other countries are carried to London and Glasgow to have their sulphur burned out for the production of sulphuric acid to serve in the treatment of phosphates; the mines of Stassfurt and Kaluz furnish thousands of tons of potash and magnesia salts which are used in agriculture all over the globe; the vine grower in the Gironde (I speak from personal knowledge) now draws potash salt from Stanfurts to give to his land in exchange for the tartar exported in his wine; the coffee planter of India (I again speak from personal knowledge) now brings superphosphates and potash salts to his coffee trees to supply them with what he has exported in his coffee beans. No power of darkness will be able to arrest this intellectual movement, for men have found out its benefits everywhere, apart from the nearly universal conviction of its truth. The Prussian and other German universities now teach students of science and agriculture in great numbers, where thirty years ago law and theology filled the auditories; in that time the number of students of Protestant theology has decreased in Prussia from upwards of 2,000 to less than 800, in Hesse Darmstadt from 50 to 13; one-sixth of all parsonages are without incumbents, because there is no one to accept the appointments. Such is the beginning of the great reformation which is now being wrought in human affairs by science.

SPECIAL LECTURES.

The first of a series of lectures on "Unhealthy Trades" was delivered by Dr. B. W. Richardson, F.R.S. (appointed by the Council to make special inquiry into the subject), on Friday evening, December 3rd, as follows:—

Lecture I.

The Influence of Physical Labour on Individual and National Vitality.

The subject to which I am about to direct the attention of the Society in the present course of lectures has been many times considered by your Council. In occasional papers and reports various details of the subject have been read and discussed here, and once, at least, prior to this occasion, the Council has endeavoured to institute a systematic inquiry. In the year 1855 a committee was appointed entitled the Committee on Industrial Pathology. The committee commenced its labours by endeavouring to collect facts bearing on one particular class of disease, namely accidental diseases affecting the eyeball. Upon the results of their inquiry they founded

an interesting and valuable report, which was published in the *Journal* of the Society for January 12th, 1855. The report was signed by Dr. T. King Chambers, Mr. Simon, F.R.S., and Mr. Twining. It is full of useful information and suggestion.

The committee also reported that they had prepared a list of *desiderata* in the Department of Industrial Pathology for the Exhibition of the Society; that is, of inventions required to protect the lives and health of working persons in various occupations.

Lastly, the committee recommended for special inquiry, for the basis of a future report, the following subjects:—

(*a*) The accidents which occur from the faulty construction of machinery, scaffolding, shipping, and other mechanical contrivances; or

(*b*) The injury to health arising from the inhalation of dust, grit, fluff, and similar foreign matters; or

(*c*) The effects of the exposure to damp or cold, rendered necessary by some employments.

The work I am now about to commence is thus, as you will see, but a continuance of the labours of the Society, and in quoting the recommendations of the committee, I have given what may be considered some of the principal texts for these discourses.

I have had another object in making these quotations. There is a suggestion in them I should be glad to see carried out, practically, by those who take an interest in this important national subject, and who have the means at command to render assistance. I refer to the supply for exhibition, through the Society, of inventions required to protect the lives and health of working people in various occupations. It will add greatly to the practical utility of this course, if those who have such inventions at command would favour me with a description of them for the sake of illustration. I feel a hope that a wish thus publicly expressed will meet with a response.

While this Society has been occupied with the task of obtaining information on the influence of injurious occupations on health and life, it has been more than once anticipated that the Government of this industrial country, availing itself of all the means at its ready command, would by an exhaustive and systematised research, conducted by many competent men, collect in one grand record every fact and every suggestion that merits immediate attention. Up to the present time this anticipation has not been realised. It would, however, be unfair to the Governments of our country to charge them with inactivity or apathy on this subject. If they have not instituted a comprehensive inquiry, they have gathered together numerous details which have performed important service for the purpose for which they were designed, and these must be of the greatest value in all future investigations and legislative proceedings. The reports on the working of the Factory Acts, of the Children's Employment Commission, of the Royal Sanitary Commission, are alone sufficient to establish a sense of gratitude for what has been done. The labours of certain of the reporters, of Dr. Headlam Greenhow for example, are of supreme value.

Following upon these investigations, isolated, and in respect to the manner in which they have been called forth, irregular, there comes to us in the present year from one particular department of the Government, a new series of national facts, bearing on individual and national vitality. I refer to an inquiry which, under the direction of Dr. Farr, has been undertaken and nearly completed at the Registrar-General's office, and which, based on the returns of the Census, gives us the relative mortality, and thereby, inferentially, the vitality of the men of different ages in all the leading, numerous, and well-defined professions and callings in England and Wales. I have been favoured with permission to study the facts that have thus been collected while they are yet passing through the press, and I have recast these lectures in order to marshal some of the facts before you. The information they convey in relation to the subject now under consideration is without any parallel in the history of vital statistics in any country at any period. The skill in arrangement and amount of clerical work in reduction of the registration tables are such, it were impossible to describe the tables fairly except by repeating that they too are without parallel in the history of national statistics.

If, therefore, there be a cause of regret that our Governments have not made the subject now before us one of internal national policy, we may, as Englishmen, be glad for the work of detail which, in many directions, has been so industriously carried out. It all tends, naturally, towards growth of knowledge and towards the early time when some Government, seeing that the people are prepared for central action, will undertake the greater inquiry, and will legislate, by universal consent, for a number of evils which can never be touched until enlightened legislative enactments are brought to bear upon them.

Finally, on this topic, it is just to our statesmen to say, that they have let none of any other country precede them in these measures of sanitary improvement. That we have, in this country, taken the lead in most of the great sanitary reforms of modern times is accepted by the ablest sanitarians of Europe and America. Thus, a Belgian publicist, speaking of our advancements in these respects, and treating specially of the repression of abuses once caused by the premature labour of children, says:—"England, taking precedence of all other peoples in the road to industrial progress, was the first to know all the evils of it, and consequently to endeavour to do away with them, and that too at a time when the ruling power was in all its force. It was," he adds, "in 1802, in the reign of George the Third, that our neighbours on the other side of the channel passed the first legislative Act concerning the labour of children." From this early action indeed on the part of the English Legislature, all similar legislation, relating to industrial occupations, take root.

It is while waiting for the grander governmental inquiry, which we must all hope for, that the work of learned societies becomes useful, by forming public opinion on the bases of collected facts. Therefore, I stand here to-night, simply as the exponent of certain information and suggestion which, being related, may lead those who have not studied any part of the subject before us to study some part, and thereby extend the required enlightenment.

The direction I have the honour to receive from the Council is that, in the present course, I am to deal mainly with that part of the inquiry in industrial pathology which treats of disease inflicted by labour on those who work at industrial pursuits.

DISTINCTION OF CLASSES.

That the position of the industrial class may be defined in its relation to the other classes of the community, and in respect to its numerical strength, it will be advantageous briefly to tabulate it in the position it holds in our statistical records. This will enable me to give a useful compendium of the relative positions of our population in England and Wales as it existed four years ago.

According to the official statistical division of men, women, and children living in England and Wales at the present time, there are six great classes, each of which is capable of sub-division into smaller classes called "orders." The great divisions are respectively named and estimated as follows, the calculation of the numbers being based on the Census of 1871:—

1. *Professional class.*—This class numbers 684,102 persons. It includes all civil servants, the army and navy, and every department of art, science, and literature.

2. *Domestic class.*—This class numbers 5,905,171 persons, including all wives and daughters at home, all persons receiving wages for domestic work, and all hotel keepers, publicans, and beer-house keepers.

3. *Commercial class.*—This class numbers 815,424 persons, chiefly men. It includes all who are engaged in buying and selling, and other monetary transactions.

4. *Agricultural class.*—This class numbers 1,657,138 persons, chiefly men. They are engaged as farmers and graziers, as agricultural labourers, as gardeners, foresters, and persons engaged about animals. Fishermen are included in this class.

5. *Industrial class.*—This class numbers 5,137,725 persons, including 1,521,998 women, and 3,615,727 men, all engaged in one or other of the mechanical arts.

6. *Indefinite class.*—This class numbers 8,512,706 persons. It includes 802,303 adults of no defined occupation, 168,895 ladies and gentlemen, *i.e.*, persons of rank and independent means, and 7,541,508 children under 15.

No fact more striking, in proof of the active business life of our English beehive, could be found than the fact above recorded—viz., that out of the whole population there are no more than 168,895 self-acknowledged "ladies and gentlemen" of England.

My observations will chiefly bear on the fourth, or industrial, of these great divisions. Incidentally I shall be forced to make reference to the other classes, because comparisons will have to be instituted, and now and then some branch of labour may be introduced in which two or more classes are concerned, but with these exceptions the pure industrials will form the subject of our mutual study.

In order to supply at a glance the main facts respecting the population, in clear detail, I have constructed from the Registrar-General's report the following useful table:—

ENGLAND AND WALES, 1871.

CLASSES.	MALES.	FEMALES.	PERSONS.	
I.—PROFESSIONAL.				
1. Governing	99,892	6,394	106,286	684,102
2. Defence	136,491	..	136,491	
3. Learned	249,735	191,590	441,325	
II.—DOMESTIC.				
4. Wives and Women of the Household	..	4,271,657	4,271,657	5,905,171
5. Hotel and Lodging-house Keepers	244,728	1,388,786	1,633,514	
III.—COMMERCIAL.				
6. Buyers, Sellers, and Lenders	242,338	44,826	287,164	815,424
7. Transport Service	515,849	12,411	528,260	
IV.—AGRICULTURAL.				
8. Cultivators and Growers	1,372,942	186,095	1,559,037	1,657,138
9. Animal Keepers	97,500	601	98,101	
V.—INDUSTRIAL.				
10. *Arts and Mechanics*	1,086,723	57,848	1,144,571	5,137,725
11. *Textile Fabrics and Dress Manufacturers*	852,268	1,298,523	2,150,791	
12. *Food and Drink*	398,167	65,884	464,051	
13. *Animal Substances*	47,676	8,675	56,351	
14. *Vegetable do.*	137,816	27,524	165,340	
15. *Mineral do.*	1,093,077	63,544	1,156,621	
VI.—INDEFINITE AND NON-PRODUCTIVE.				
16. Purely indefinite	753,921	48,382	802,303	8,512,706
17. Persons of Rank and Property	25,510	143,385	168,895	
18. Scholars and Children	3,704,301	3,837,207	7,541,508	
Population				22,712,266

METHOD OF RESEARCH.

In the mode of conducting the search after truth in the inquiry upon which we are embarked, I have followed two lines.

In the first place, I have sought amongst the industrial population themselves, for the direct and most striking evidences of the value of their lives, compared with the lives of the other classes of the community. In this part of the inquiry I have also endeavoured to trace out when certain injuries were apparent, how far those injuries were dependent:—

(*a.*) On the absolute labour.

(*b.*) On the surrounding details connected with the labour.

(*c.*) On the errors of life in the worker, as distinct altogether from the labour.

In the second place I have sought for information in the returns of the mortality of different occupations of men of different ages of life, and of different callings. I have tried to test the facts of these mortalities by different standards, so as to arrive at some actual or approximative fact. Further, I have endeavoured, as far as it was possible, to combine what has been observed in the work, by what has been gathered from the statistical authority. The statistics taken alone are remarkable in the highest degree, but are only valuable as records of the dead in connection with the records of the living. They supply the outward expression of an unstudied evil. They are like the index of a book which tells the names of the subjects written in the book, but which offers none of the argument, and can scarcely be said to condense the information.

INJURIOUS INFLUENCES, PLUS LABOUR.

The limitations, the sources of knowledge, the general plan of the work we have at present in hand described, I proceed to a preliminary inquiry, which, according to my

judgment, is essential to the correct appreciation of every part of the domain of industrial pathology as a scientific contemplation. I am about to show to you, as well as I can, throughout the course, the pure and simple effects of physical labour or occupation on the vital capacity. In this effort I must strip the argument of all influences that do not belong to labour. I must use for this object all the information that is derivable both from direct observation and statistical table. I must expose, without fear or reserve, the agencies that are at work, plus labour, to give to laborious callings that terribly dark shadow which seems to envelop them in hopeless gloom, and to present them ever as highways to death and the grave. I must depict the vital deterioration which is produced not *by* but *at* work, or after work, from causes altogether apart from physical exercise or calling.

This exposition is due to the industrial classes themselves in order to correct one of their chief errors. It is too common for them to attribute all their maladies and deficient vitality to what they call "the work," by which term they mean the actual amount of muscular exertion to which they are subjected. Indeed, it is quite an exception to hear complaint of any other kind, though there may be ample reason for complaint straight in view if it were recognised. Yet I may at once say that very few instances indeed exist, comparatively speaking, in which serious vital detriment is brought about by muscular labour or mechanical shock. In past times definite forms of disease leading to inevitable death were, truly, induced by muscular effort. The post-boy was subjected so frequently to the disease called aneurism of the aorta—an enlargement of the great arterial blood-vessel which springs immediately from the heart—that the term "postboy's disease" was given to it. Runners, rowers, wrestlers, pugilists, were subjected largely to heart disease from their several excessive muscular fatigues. Various deformities of the body were caused by the fatigue of bearing heavy burthens, too long a time. In these days the evils of the kind named, though they are still in existence, are greatly moderated. In the large majority of instances the deficiency of vital power produced by occupation, though it may be connected with the physical labour, is not from excessive taxation of the animal organs. The observer is obliged, therefore, in every case to differentiate on this subject.

It turns out in some instances, that the differentiation is easy. But this is not always the case. There are some mixed occupations in which a slight excess of labour is carried on in the presence of influences which exert at the same time an injurious action. Here the effect produced may be well marked, but being attributable to two causes progressing equally, and neither with apparent severity, its origin is not readily discernible.

There is another class of case in which the physical labour is not excessively severe, nor the character of the labour marked by any specially injurious attribute, but in which the labour is simply too prolonged, and the exposure to whatever is injurious is, in like manner, too continuous. In these examples the individual life is sometimes seriously, though imperceptibly, impaired. Putting aside for a moment these shades of difficulty we are brought too plainly face to face, in a majority of instances, with at least five major agencies, which over and above labour and occupation introduce vital degeneration.

Intemperance.

The first great cause of vital degeneration, plus industry, in the industrial classes, is intemperance. This wide-spread influence for evil renders noxious many occupations which in themselves are perfectly innocuous. In other instances it renders trifling injuries, resulting from occupation, of greater moment. Again, and this is of common occurrence, it transforms grave injuries into the gravest.

It would be exceedingly difficult to exaggerate the evil influence of intemperance as it is exhibited among the industrial community. It is at the same time only fair to state that the industrial classes are less injured by intemperance than some others.

I cannot illustrate this fact better than by turning to those new calculations from the Registrar-General's office, noticed in my opening remarks, and by contrasting some industrial occupations with one particular occupation, in which, owing to the intemperance that almost naturally surrounds it, the value of life, individually and collectively, is depreciated. The occupation I here refer to is carried on by those members of society who supply the community with drinks, foods, and entertainment in inns. The occupation in which these are engaged demands, it is true, a considerable amount of physical activity. A great many hours of the day are filled industriously by it, and some portions of the work tax the muscular powers rather severely. When, however, this calling is compared with other callings, with that of the carpenter for instance, or the engine and machine maker, or the ship builder, or the iron and steel manufacturer, or the blacksmith, or the miner, or the railway engine driver, it must be accepted as comparatively light, and as exposing its follower to very few of the disadvantages arising from variations of heat and cold, nervous strain, and violent muscular exertion. Yet the hard facts show that the vital value of the publican class is lower than that of some of the most over-taxed members of the community.

To begin with great figures. The mortality in London of all males during the years 1861 to 1870 was at the rate of 2·012 per cent. annually, while that of the publicans was at the rate of 3·466 per cent. annually. In England, exclusive of London, the mortality of all males from 1861 to 1871 was at the rate of 1·182 per cent.; of publicans 3·163 per cent. annually. To pass to detailed figures I may compare the mortality, at the same ages, of the whole population, and with the mortality, also at the same ages, of certain industrial callings which, for risk, and wear and tear, are surely not over favoured.

Age, Mortality, and Occupations.

Years.	All Classes.	Labourers.	Blacksmiths.	Engine Drivers and Railway Servants.	Publicans.
15	·739	·513	·366	.712	·957
25	·985	·872	·918	1·121	1·449
35	1·305	1·080	1·124	1·497	2·044
45	1·853	1·507	1·869	2·151	2·859
55	3·215	2·734	3·225	4·059	4·303
65	6·076	6·060	7·138	7·092	7·465
75	16·584	18·256	19·254	20·543	21·792

As we glance at this Table we need express no surprise to find our greatest authority in vital statistics, Dr. Farr, thus expressing himself:—"The numerous, useful, and as a body respectable men, who supply the community with drinks, food, and entertainment in inns, are shown to suffer more from fatal diseases than the members of any other known class. They might themselves institute a strict inquiry into its causes; but there can be little doubt that the deaths will be found due to *delirium tremens*, and the many diseases induced or aggravated by excessive drinking. It seems to be well established that by drinking small doses of alcoholic liquors, not only spirits, the most fatal of all poisons, but wine and beer, at frequent intervals, without food, is invariably prejudicial. When this is carried on from morning till late hours in the night, few stomachs, few brains, can stand it. The habit of indulgence is a slow suicide. The many deaths of publicans appear to prove this. Other trades indulge in the publican's practice to some extent, and to that extent share the same fate. The dangerous trades are made doubly dangerous by excesses."

These facts, startling as they are, and conveying a lesson from national statistics, which probably very few expected, must not be accepted as in any way qualifying the dangers resulting from intemperance in the industrial world. The diseases arising from alcohol, which I described before this Society last year, are most prevailing among the industrial communities. Those diseases which are organic as distinguished from functional or temporary diseases are, perhaps, more largely presented than they are in any other class. Diseases of the liver, of the kidney, of the lungs, and of the heart, induced by alcohol are common, especially amongst the male sex. That form of disease called alcoholic phthisis, or the consumption of drunkards, which I originally pointed out and named, is so frequently developed that it becomes difficult, in many instances, to distinguish whether phthisis pulmonalis be from this cause or from some other cause connected more directly with the occupation. The diseases of the nervous system, induced by alcohol, are widely spread amongst the industrials, who fall from alcoholic paralysis with special ease when any other injurious influence to which they are exposed is connected with their work.

Lastly, with this class as with others, the effect of strong drink in producing insanity is a solemn fact. Drink is indeed the chief, if not tho only factor, in the production of insanity amongst these classes. I need scarcely add that the evils transmitted from one generation to another from the use of alcohol are equally present in the members of the industrial as in those of the other communities.

It is unfortunate that we have no statistical test by which we can detect precisely the part played by alcohol in producing disease so as to separate its action definitely from the injuries incident purely to occupation. The effects of both causes run often together, and this combination adds largely to the difficulty.

Hereditary Disease.

Another cause influencing vitality, which has to be correctly estimated whenever the effect of physical labour upon life comes under consideration, is that individual peculiarity to which we give the name of heredity, that is to say, the tendency by descent to a long or short vitality. No fact is more conspicuous in the study of vital science than this fact; that some men are born to live a short, others a longer life. The reason of this difference is, I think, exceedingly plain, and is summed up by saying that some men are born without and some with the proclivity to certain fatal diseases. The influences thus presented for good or bad extend through three or perhaps four generations. I mean that it takes these generations to engraft a proclivity, and as many to eradicate it. Throughout the whole of our industrial classes these proclivities are remarkably developed, and unfortunately are most strongly developed on the worst side. We meet occasionally with instances in which the heredity of long life stands out in most striking form, like a fine statue in a heap of ruins. One or two men in a large industrial work where a general vitality is very low, will stand out as old men, hale and strong, in whose lifetime one, two, or even three generations of comrades have passed away. These favoured men have been exposed to the same influences as the rest, and are saved only by that transmitted exception from disease of a destructive kind, which permits them to retain their organic parts and powers intact in the presence of adverse circumstances. Far more frequently the picture presented is of the opposite character. The eye of the vigilant observer rests on men who have an organic construction of body, favourable to the action of every adverse circumstance, and in whom, consequently, some special proclivity is readily lighted up. Scrofula, consumption, rheumatism, become, specially in this way, the agencies of physical deterioration and vital destruction. Cancer, according to my observation, is less common amongst the industrial classes, as an hereditary malady, than it is amongst the professional and domestic classes

We are as yet but in the infancy of knowledge respecting this great question of heredity of life and faculty, but we are beginning to see that what is called descent by blood is an error. That it is not through the ever changing blood the tendencies descend, but through the more fixed, impressionable, nervous centres, those seats of reason, passion, receptivity, by the medium of which we are linked to the external universe and are impressed by its motions. We learn thus that proclivities may be derived from the most common external acts, and that movements, impulses, organic changes, acquired by the parent, may pass direct to the child, influencing its whole life and the worth of its vitality. Watching the development of these proclivities by the light of modern research, I have been led to a conclusion that will sound, probably, to many as of the strangest meaning, but which I am convinced is true; namely, that the occupation of parentage and all that surrounds it, influences, physically, the vitality of the offspring, and to a large extent determines the vital course. Thus amongst our industrial classes, where often from generation to generation the same line of industry is followed, we get those intensified developments of physical disorder which swell so largely the mortality table. The disease, pulmonary consumption, alone, acquired and transmitted as I have described, is a sufficient illustration in point.

Dietary and Cookery.

There is a further element which should enter into our consideration when treating on the physical effects of labour in relation to vitality. I refer to the character of the food out of which the force of the body is produced. Amongst the industrial classes the greatest differences prevail in this respect. Amongst the stocking weavers of the Midland counties we see, as a rule, the most striking evidence of deficiency of food, and the same extends, though perhaps in a minor degree, to the majority of the industrial callings. Together with deficiency there is combined the most serious error as to quality of food, the tendency, for the sake of economy, being towards a too exclusive starchy dietary, to the omission, in great part, of nitrogenous food. Thus the muscles and other nitrogenous structures are imperfectly developed; a thin emaciated state of body is maintained, and a parched and feverish state of the system is engendered. Naturally these conditions lead to dyspepsia, and from the dyspepsia, in those who are disposed to the disease, the phthisical tubercular malady readily commences.

Lastly, on this point, in cases where the food is fairly good in quality as it first comes to hand, it is so destroyed by the various processes of cooking and preparation that half its properties, as digestible, wholesome, and sustaining nourishment, are sacrificed.

It is not until these facts are actually witnessed, it is not until the cold, uncomfortable, indifferently prepared artisan meal is seen that the mischiefs arising from it can be appreciated. The mischiefs extend through all ranks of the industrials with more or less of intensity, and through all periods of life from childhood to old age. We can scarcely wonder that alcohol should be so frequently substituted as a false replacement of a dietary that is so generally objectionable.

While these errors in dietary are the rule amongst the industrial classes, some exceptional errors of an opposite kind are met with in certain localities. Thus to take one example which I have noted. Amongst the colliery operatives of Wolverhampton not only are provisions abundant, but luxuries hold a prominent place. In the early part of the week, when they have their wages in hand, these industrials "play," as they call it, and live in sumptuous style. They select the choicest viands that can be obtained, and will have whatever is in season. Ducks, geese, lamb, game, asparagus, everything that money can buy they purchase, so long as there is a *sou* in the locker. Not unfrequently

they keep up this feast for three or four days in the week, then they fall to work again and live on anything they can get, faring as badly as they before fared sumptuously, the ordinary staple of animal sustenance being pork.

The diet of a population extends its influence almost to the degree of introducing racial peculiarities, and no estimate of vitality resulting from labour is of strict value until the diet is known; for, in truth, labour is the conversion of the force contained in the food into motion and work. How important then is the social problem of discovering the best means for teaching the masses the qualities of foods, the intention, and the proper modes of preparation. With the millions, the natural intention of food is hardly known; they eat as animals eat, from the impulse of instinct.

Moral Influences.

Still another disturbing element has to be considered in calculating the effects of physical labour or occupation on vitality. I refer to the moral influences affecting the industrial classes. The necessity of having to work in masses, in the same building, at the same monotonous ever-repeating labour, in which the muscles are moving with automatic regularity, and the brain is left unemployed except to brood over real or imaginary injuries; these conditions affect life to the core, and exert a fitting effect on the vital value of the working class. The agricultural labourer may work hard, may fare badly, may be housed shamefully, but he has many advantages. He is engaged out of doors in the fresh air; he has all the beauties of the external nature to delight and refresh him. His work is varied. There is the spring-tide season, with its sheep-washing and shearing; the summer, with its hay-time; the autumn, with its harvest; the other months of ploughing and sowing—a constant roundelay of work, with varied change for the mind as well as the body. The artisan has no such pleasures of industry. He passes day by day, month by month, year by year, through the same monotonous labour, until at last his mind recognises but one scene; his hands fall to but one automatic routine. To the end of his career he sees no change, nor chance of being made independent by his skill and his industry. He, therefore, is naturally apt to become fretful, anxious, irritable, the victim of smouldering passions, which wear out his heart, and lessen his nervous resistance to the many external shocks to which he is daily subjected. Moreover, the limitation of his means lead to limitations in the necessary comforts of his home. He who is in these straits is rather to be pitied than blamed if in false measure of the deed he seeks ignorantly still more sorrow in alcoholic indulgence. When we add together these difficulties of existence, the struggle against penury and actual want, the confined dwelling room, the badly ventilated, overstocked bedroom, the indifferent couch, the limited sleep, the ever-returning toil, and the rarity of wholesome relaxation, either of mind or body; when, I say, we contemplate these conditions, we have before us evidence of vital strain which practically is resisted longer than at first sight we could imagine to be compatible with human endurance. Dr. George M. Beard, of New York, in an admirable essay on the longevity of brain-workers, thus felicitously condenses the conditions I have glanced at under this head: "Almost all muscle-workers," he says, "are born to live and die poor. To live on the slippery path that lies between extreme poverty on one side and the gulf of starvation on the other; to take continual thought of to-morrow, without any good result of such thought; to feel each anxious hour that the dreary tread-mill by which we secure the means of sustenance for a hungry household, may, without warning, be closed by any number of forces over which one has no control; to double and triple all the horrors of want and pain by anticipation and rumination—such is the life of the muscle-working classes of modern civilised society; and when we add to this the cankering annoyance to the workman that arises from the envying of the fortunate brain-worker who lives in ease before his eyes, we marvel not that he dies young, but rather that he lives at all."

Uncleanliness.

The last disturbing influence of a major character is the inattention to cleanliness, both of person and dress, which too often marks the industrial class. It is fair to concede extreme indulgence in this particular, for many industrial pursuits are of necessity so uncleanly that the most vigilant cannot avoid being dirty during hours of labour. But the worst feature is that the necessitated uncleanliness begets the habit, and so when labour is not in progress, the process of purification, so essential to health, is forgotten. In this way during meal times poisonous particles are absorbed from the hands through the food that is taken. One telling illustration is yielded amongst the potters, who suffer much from the disease called "lead paralysis." In 1864 I gathered from two very intelligent and experienced workmen in the manufactory of Messrs. Wedgwood, in Etruria, that the cause of this paralysis is very simple. It is immediately connected with the present topic. The evidence was convincing that the lead which produced the symptoms is not absorbed by the skin, but is swallowed. Men of dirty habits who leave the dipping tub which contains the glazing solution—a solution containing lead—wash their hands imperfectly, pick up portions of their food with their hands, and so imbibe the poison. The men themselves state, in fact, that those who take care to wash well before going to meals escape and one man who was a scrupulous washer reported that he had worked for fourteen years on nearly every working day without suffering once from the effects of the lead, but that in the same time not one of his comrades, who had been less careful, had escaped. It has also been observed that when pressure of work is great, so that sufficient time is not obtained for ablution, the number of cases of paralysis largely increases.

It would be speaking in anticipation to quote further examples of this character, and the one given is all sufficient for the present purpose; but I must not omit to add, while on this topic, the encouraging fact that the injurious influence now being noted is slightly on the decline in, I believe, all industries. In three series of investigations in which I have been engaged, in 1857-8, in 1864-5, and within the present year, I have observed from one time to another a distinct improvement in the habits of the industrial class in regard to cleanliness, and a much greater willingness, in this later time, to receive instructive hints on this matter. The appreciation of the truth that "cleanliness is next to godliness" might be extended with unquestionable advantage.

Mortality of Industrial and other Occupations.

After full allowance has been made for the injurious influences above described there remain, unfortunately, certain facts which proclaim that the industrial classes are subjected, by the direct agency of their occupations, to severer penalties than the rest of the community. This is proved by two unmistakeable evidences, viz., the special evidence of disease, and the special evidence of mortality. I shall have to deal with the first of these evidences in considerable detail in after lectures, so it may pass now. To the second I would invite your attention through the following remarkable table which has been calculated out and drawn up for me by Mr. Noel Humphreys of the Registrar-General's office. The table is equally unique in method and in lesson. It includes the whole of the larger industrial callings. It shows the mean mortality of these callings by a natural standard of mortality It shows, in contrast, the relative mortality of other callings.

Annual Death Rate per 1,000 *Males in England and Wales, aged* 15 *years and upwards, engaged in* 70 *occupations, in the three years* 1861, 1862, *and* 1871, *compared with the Death Rate among Males of all occupations in the same years.*

Years of Life in 1861, 1862, and 1871.	Deaths actually Recorded in the same Three Years.	Deaths that would have occurred, according to the Standard Rate.	Occupation.	Deaths of Males aged 15 and upwards, engaged in different occupations, to 100 deaths of Males of all occupations.	Annual Death Rate per 1,000 Males Living, at Eight Groups of Ages. 15	20	25	35	45	55	65	75
9,722	135	215	Barrister	63	...	...	4·75	6·53	13·64	24·46	40 98	97·56
59,084	1,105	1,547	Clergyman	71	...	4·36	4·65	4 28	13·24	22·70	52 08	150·22
24,944	472	626	Protestant minister	75	...	9·90	5·83	7·30	9·33	24 60	56·27	163·93
228,248	3,160	4,173	Grocer	76	3·18	8·39	9·43	9·57	13·48	22·43	47·76	128·66
259,211	3,811	4,951	Grocers and shopkeepers	77	5·61		9·47	9 69	13 82	23·23	48·02	133·90
31,931	503	628	Gamekeeper	80	3·72	7·07	5·10	7·09	8·83	25·96	83·27	217·08
679,483	20,292	23,822	Farmer and grazier	85	10·91		8·84	9·01	12 53	23·39	57·10	169·58
11,829	154	180	Civil engineer	86	1·69	5·77	9·44	15·31	10 49	22·17	53·87	263·89
21,222	335	385	Bookseller, publisher	87	4·55	8 71	7·69	9 75	18·03	24·30	74·84	135·23
88,512	1,505	1,717	Wheelwright	88	2·60	7·37	7 08	10 60	17.01	27·42	66·61	172·34
105,441	1,890	2,114	Silk manufacturer	89	7·10	8·90	8·78	11·03	15·07	27·33	63·40	151·78
4,831,547	88,458	97,737	Labourer	91	5·14		8·82	11·21	15·70	28 32	61·59	182·65
551,399	9,255	10,175	Carpenter, joiner	91	3 61	7·14	8·49	10·73	16·03	29 68	68·39	173·94
4,013	110	120	Banker	92	...	9·39	6·89	13·97	17 72	26 12	60 43	160·00
394,066	5,028	5,386	Domestic servant	93	2·42	5·63	9·01	13 68	18·57	31·84	78 48	227·86
89,693	1,718	1,814	Sawyer	95	3·50	5·71	7·02	10 41	15 42	30 93	74 22	215·47
52,142	693	721	Brass manufacturer and brazier	96	3·80	6·79	8 72	13·90	18 36	39·00	69·38	177·85
22,681	388	406	Paper manufacturer	96	3·08	10·09	8·53	12·68	15 30	27·09	70 81	201·04
16,864	243	253	Musical instrument maker	96	4·21	11·39	7·31	12·99	18 76	28·31	71·09	180 45
31,875	454	469	Gunsmith	97	2·41	6·76	9·12	13·01	18·37	38·06	78·54	183·95
316,713	5,233	5,390	Blacksmith	97	3·66	7·57	9·18	11·24	18 69	32·25	71·38	192·54
594,435	11,576	11,827	Shoemaker	98	5·00	9·27	9.52	11·36	16 64	30·65	68 52	187·93
406,709	5,151	5,231	Iron and steel manufacturer	98	4·15	7·61	8·20	11·72	20 38	39·03	89·50	236·28
63,645	1,142	1,160	Tanner and currier	98	2·82	5·55	8·78	13·94	19·49	35 48	81·13	139·00
141,707	2,356	2,376	Baker	99	2·75	6·43	8·67	13·47	19·79	36·11	71·40	190·45
19,327,887	363,207	363,207	*Males of all occupations used as a standard*	100	6·32 7·39	8·59	9·85	13 05	18·53	32·15	66·76	165·84
257,003	3,406	3,395	Engine and machine maker	100	4·46	8·56	9·22	12 72	17·97	36·75	83·49	203·69
341,872	6,320	6,306	Wool and worsted manufacturer	100	5 04	8·79	8·54	10 32	16 87	32·58	76·48	208 72
422,859	5,532	5,475	Iron, copper, tin, and lead manufacturer	101	6·05		8·39	11·93	20·57	39·66	92 25	240·42
166,983	2,820	2,805	Baker and confectioner	101	4·63		8 66	13 32	20 03	36·33	74·58	192·57
87,608	1,470	1,447	Schoolmaster	102	3·71	9·58	8·91	11·17	14·93	36·28	84 65	212·79
35,086	840	825	Solicitor, attorney	102	...	8·76	8·90	13 46	19 30	30·59	75·22	166·67
90,234	1,679	1,627	Miller	103	3·43	7·07	7·21	12·01	18·43	39 23	86·57	196·58
4,052	82	80	Roman Catholic priest	103	...	8 26	7 66	9 25	9·62	48·98	95·00	222·22
59,517	1,067	1,025	Watchmaker	104	4·53	11·25	9·81	11 99	17·14	38·18	70·21	187·27
23,592	349	333	Tobacco manufacturer	105	2 78	12·51	12·22	14 56	15·66	34·23	57 80	184·21
43,514	1,135	1,067	Physician, surgeon	106	...	11·17	12·87	14 74	20 47	30·46	62·87	184·14
100,574	1,796	1,699	Shipbuilder	106	5·55	8 87	8·65	13·38	20·49	36·85	80 68	178·03
148,644	2,315	2,170	Messenger, porter	107	3·17	7·70	11·09	15 27	24 29	38 65	77 95	173 83
58,676	956	897	Coachmaker	107	3·51	6·10	9·38	11 83	24·39	39·27	80·40	229 69
27,406	571	532	Ropemaker	107	4·03	6·13	7·60	11·03	20 31	41 81	78 63	176 38
141,990	1,984	1,841	Draper	108	4·80	9·27	12·59	14·74	19 32	33·69	66 55	194·21
320,064	6,711	6,157	Tailor	109	6·44	10·87	12 00	13·85	20·06	33·00	69 82	184·51
1,041,473	19,305	17,709	Wool, cotton, flax, silk manufacturer	109	7·14		9·29	11·66	18 55	37·23	85 27	226·17
50,181	782	711	Chemist and druggist	110	3.31	11·26	11·77	17·04	18·41	33 57	83·76	143·38
39,293	676	616	Commercial traveller	110	1·68	5·68	9·81	15 66	23·53	39·88	68·86	165 09
204,040	2,799	2,523	Insurance, service, and commercial clerk	111	3·80	8·06	12·74	17·36	25·06	35 32	79·81	178 91
196,882	3,781	3,412	Butcher	111	2·32	5·89	10·05	17·32	22·45	37·45	82 23	201·02
17,149	279	250	Carver and gilder	112	5 57	8·10	9·15	15·82	26·01	32·17	84·39	184·21
20,044	457	404	Farrier, veterinary surgeon	113	3·54	5·56	14 52	16 25	24·61	32 66	62·98	203·70
916,005	14,440	12,519	Miner (and others connected with mines)	115	8·08		9·84	12·45	20·47	43·59	100 26	248·07
583,079	10,187	8,884	Cotton and flax manufacturer	115	5·47	9·24	9·54	12 10	19·78	42·33	94·78	254·17
95,190	1,396	1,213	Printer	115	4·74	10·79	10·68	16·69	24·24	39 68	75·49	205·48
20,015	351	302	Bookbinder	116	4·33	10·69	10·10	16 49	21 24	48·34	79·74	165·52
41,062	665	557	Glass manufacturer	119	2·98	6·70	11·80	15·27	21 60	44·67	123 95	289·02
30,169	639	536	Fishmonger	119	3·47	7·50	12·64	17·35	22·69	37·09	85·16	181·54
245,269	4,256	3,536	Plumber, painter	120	3·62	7·13	9·44	16·56	27·78	48·68	92·97	181·82
187,324	2,755	2,275	Railway engine driver, officer, servant, &c	121	7·12	11·73	12·21	14 97	21·51	40·59	70 92	205·43
45,222	780	647	Tool, file, and saw maker	121	4·52	8·14	11·36	14·95	26·80	50 33	79·35	206·35
92,656	1,817	1,497	Harbour, dock labourer	121	3·54	8·53	11·16	15·91	24·96	42 53	86 75	181·97
33,989	920	747	Hatter	123	4·56	11·12	9·94	15 93	23 89	42·81	78·68	221·53
16,019	298	243	Coppersmith	123	4 51	10·05	10 98	14 22	20·17	54·26	110·63	130·43
6,189	124	101	Needle manufacturer	123	9·87	10·53	9 50	19 12	21·60	39 72	68·06	223 53
29,425	546	442	Manufacturing chemist, and dye and colour manufacturer	124	6·25	12·77	11·39	15 88	20 73	38 53	98 04	244·60
32,157	712	560	Hairdresser	127	5·18	10·89	11·94	18 63	22·70	43·54	86 99	201·68
87,640	2,098	1,628	Bargeman	129	5·99	9·48	11·47	19·19	23 94	41 36	94 33	209·68
200,663	4,181	3,200	Carman, carrier, drayman	131	4·88	8·99	12·04	16·82	25 41	45·21	101·81	230·04
111,464	2,234	1,702	Horsekeeper, groom	131	3·32	8·97	13 04	20 19	28·71	46·04	78·53	212 95
228,592	7,127	5,167	Inn and hotel keeper, licensed victualler, publican, &c.	138	9·57		14·49	20·44	28·59	43 03	74 65	217·92
69,811	1,320	959	Earthenware manufacturer	138	4·01	10·26	7 08	20·09	33 67	58 04	128·47	233·70
92,142	2,213	1,551	Coachman (not domestic), cabman	143	3·06	10·91	12·18	20·25	29 54	47 24	99·86	200·76

Summary.

In this introductory discourse I have aimed, as the chief object in view, to familiarise the minds of my hearers with the elementary facts touching upon the great question of labour and vitality. I have wished to show how the population of this country is divided into its many sections of industrious workers, what, in simple language, are the compartments and galleries of this wonderful and busy beehive of the world, and what is the vital value of each class in each compartment, as far as we can arrive at a correct estimate.

Turning to the industrial department, in which, at this moment, we are most interested. I have striven to separate from the work of the department those causes of diminished vitality—notably, intemperance, hereditary proclivity to disease, bad food, indifferent moral surroundings, and uncleanliness—from the hurtful agencies belonging purely to the industry.

Lastly, I have indicated that when these perturbing influences are removed there is still remaining evidence of the existence of causes affecting certain departments of industry, by which the vitality of the industrious is seriously depreciated. As we make further progress and analyse the facts that will have to come before us, we shall discover, at least, eight grand causes of deterioration of this order.

When we come to the study of the question—how these injurious influences may be reduced or removed?—we shall find them, in this regard, divisible into distinct groups. We shall discover some that seem at this moment to be altogether irremediable by science as it at present is developed. We shall find some that science could relieve or remove if she were backed up by wise legislation. We shall find some that science could now remove by her present appliances without any legislation whatever, if those who are most vitally concerned would permit her to have her way. And we shall even discover that under this permission the great majority of the fatal causes could be swept aside. But alas! we shall also discover that science is weak at her best, so long as the masses she would benefit fail to see her wisdom and to profit by her teaching; for still the masses hold aloof, and still of them one of their own greatest men, their "Corn-law Rhymer," might sing in his fiercely pathetic strain:—

> "There draws the grinder his laborious breath,
> There, coughing at his deadly trade, he bends.
> Born to die young he fears not man nor death;
> Debauch and riot are his bosom friends.
> Yet Abraham and Elliott—both in vain—
> Bid science on his cheek prolong the bloom!
> He will not live. He seems in haste to gain
> The undeserved asylum of the tomb;
> And, old at two and thirty, meets his doom.

JUVENILE LECTURES.

The first of a course of two Juvenile Lectures was given on Tuesday last, January 4, by Dr. W. B. Carpenter, C.B., F.R.S. The subject of the course was, "The Wonders of the Microscope."

This first lecture was devoted to a consideration of the microscopic forms of animal and vegetable life, which Dr. Carpenter assured his hearers constituted in all a far larger mass of life than that composed of the higher forms. Arguing from this that the study of the innumerable descriptions of living beings whose very existence was only revealed by the microscope was well worthy the attention of the young as well as the old, Dr. Carpenter proceeded to give an account of a few typical species, showing the special characteristics of some of the more important families. He then explained the formation of the chalk and other deposits, and showed how the same process of formation was still going on at the bottom of the great oceans which cover so large a portion of the surface of the globe. This portion of the lecture was illustrated by diagrams, and by a few specimens of chalk dredged up by the scientific expedition in the *Porcupine*, in which expedition the lecturer had taken part. Having thus prepared the way for the exhibition of the objects themselves, Dr. Carpenter showed his audience, by means of an oxy-hydric lantern, a series of photographic slides illustrative of some of the more characteristic forms of diatoms, explaining, as each was thrown on the screen, its peculiarities and manner of growth. The peculiar markings which have rendered the diatomaceæ of special interest to microscopists, as affording test-objects for the higher powers of the microscope, were specially pointed out, and the peculiar—even deceptive—appearance of some of them mentioned and explained. At the conclusion of the lecture Dr. Carpenter announced that in his second lecture (next Tuesday) he would illustrate and explain some of the portions of the structure of insects, especially common insects, such as the house-fly and other familiar species.

NOTES ON BOOKS.

Dyeing and Calico Printing.—By the late Dr. F. Crace-Calvert, F.R.S., &c. Edited by J. Stenhouse, LL.D., F.R.S., &c., and C. E. Groves. Second Edition. Manchester: Palmer and Howe.

When in the year 1863 the Society undertook to apply the bequest made to them under the will of Dr. Cantor, to the establishment of the series of lectures now known by his name, almost the first course of lectures was that delivered by the late Dr. Crace-Calvert, on "Chemistry applied to the Arts." After that he gave a number of courses on other subjects, including one on "Dyes and Dye-stuffs other than Aniline;" in fact, for some years his name appeared almost constantly in the list of Cantor Lecturers. Some of these lectures were published in pamphlet form more than once, and eventually the series above mentioned were, with much other matter, incorporated into a book. Since the publication, however, of this work, so much progress has been made in the development of the coal-tar colours, and, as is well-known, so many fresh applications for them have been discovered, that a need which had arisen for a fresh edition gave a good opportunity for issuing what is to all intents and purposes a new book, forming a memorial of the life-long labours of Dr. Calvert. As a tribute to the memory of one who laboured so energetically in the cause of science, this book will be welcomed by the many to whom its author was personally known. A large portion of it consists of material left in manuscript by Dr. Calvert; some of it has already been published, and the remainder has been added by Dr. Stenhouse and Mr. Groves. Before entering on any account of the aniline colours, the book deals with those dye materials which have been to a greater or less extent superseded by the aniline and anthracene colours, such for instance as madder, indigo, &c., as well as many others for which no substitute has yet been found; after that it passes to what may perhaps be considered its most important part, the colouring materials derived from aniline. In the main the book deals with the history of the different materials, but a full account is also given of the methods of their use and their various applications. The latter portion of the treatise, commencing with a history of the discovery of mauve, by Perkin, in 1836, goes on to give a full account of the results which followed immediately on this great discovery, and brings the history of the subject down to the great development of it during the last few years, and the wide sub-

stitution of mineral colours for those of vegetable origin. A large number of specimens of fabrics dyed with the different materials mentioned are given, besides some woodcuts illustrating the machines employed.

GENERAL NOTES.

National Training School for Music.—A meeting was held at Hastings on December 18th last, with the view of promoting the establishment of local scholarships for the school. Mr. T. Brassey, M.P., was in the chair. The meeting was addressed by Mr. Brassey in favour of the scheme, by Mr. Lionel Benson, who explained its objects and gave a short account of the movement, by the Mayor of Hastings (Mr. G. A. Thorpe), who proposed a resolution approving the establishment of the school, by Colonel Lewis, the Rev. Burrell Hayley, and others. Mr. Brassey announced that he would himself found one scholarship, and an opinion was expressed that two others might be expected. After the meeting a local committee was formed.

Permanent Writing and Printing Inks.—M. Mathieu Plessy, who has long manufactured a peculiar ink much used in France, has taken out a patent for the application of organic matter and a chemical substance which, when united in the ink, can be converted into carbon by the application of heat not sufficient to destroy the paper, parchment, or other substances on which it is used. The inventor claims to use any organic matter soluble in water or any other vehicle, such as cane sugar, caramel, glucose, or any of the vegetable substances which give glucose by reaction, such as sugar of milk. To accelerate the carbonisation, with heat, of the above substances, acid or neutral salts with alkaline earthy bases, or metallic oxides which do not affect the paper or parchment, or other similar substances are employed. The heat of a hot air stove at a temperature between 110° and 114° Centigrade, a plate of heated metal or a hot iron, may be employed for the carbonisation according to circumstances.

Collapsible Boat.—Some experiments have recently been made at Portsmouth with two collapsible lifeboats on Mr. Berthon's system. Each boat is 32 ft. long and 11 ft. broad, and can be compressed into 2 ft. of breadth. They were expanded and lowered into the water, with their crews on board, with great rapidity in consequence of their extreme lightness. Eighty men were put into one of them, and, as there was even then a large surplus of buoyancy, 20 more were added, so that it was crowded in every part. It is stated to have borne the test remarkably well, and, notwithstanding the weight on board, it exhibited a freeboard of 1 ft. 9 in. above water-mark. In this condition the crew used the ten oars with which each boat is fitted with perfect ease. Sails were afterwards hoisted, and the lifeboat was put through a sailing ordeal in the harbour with equally satisfactory results. The double skin is divided into watertight compartments, the purpose of which is to localise the effect of fracture. This was tested during the course of the experiments in an entirely unexpected way, for, the outer skin getting accidentally pierced, the influx of water was so confined that there was no perceptible reduction of buoyancy. It is the intention of the Transport Department to supply each of the five Indian troopships with four of Berthon's collapsible boats of increased dimensions. The Department has also ordered the construction of two experimental boats on the same principle for the landing of cavalry.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Juvenile Lectures.

Dr. Carpenter's second lecture will be delivered on Tuesday next, January 11, commencing at 7 p.m. The tickets issued for the first lecture are available for this also, and no further issue can be made.

Ordinary Meetings.

The following arrangements for the Wednesday evening meetings have been made:—

January 19.—"Proposed Heads of Legislation for the regulation of Sewage Grounds," by Alfred Smee, F.R.S., F.L.S., F.C.S. On this evening Dr. Letheby will preside.

January 26.—"Iceland, its Scenery and its Rocks," by W. L. Watts, Esq. Illustrated by numerous Photographic Transparencies.

February 2.—"Condensed Beer," by Dr. Bartlett.

February 9.—"The Cultivation of Hardy Fruits, with a view to improvement of quality and ensuring constant and abundant production," by Shirley Hibberd, Esq.

February 16.—"The Combustion of Gas, and its application to Heating Purposes," by John Wallace, Esq.

February 23.—"Contagious Diseases of Animals as affecting the Health and Wealth of the Country," by George Fleming, Esq., Royal Engineers.

Cantor Lectures.

The second course of Cantor Lectures for the present Session, "On Iron and Steel Manufacture," by W. Mattieu Williams, Esq., will be delivered on the following Monday evenings:—

Lecture I.—January 17. — Iron Ores and their Reduction.

Lecture II.—January 24.—Pig Iron.

Lecture III.—January 31.—The Purification of Pig Iron.

Lecture IV.—February 7.—The Operations in the Mill Forge.

Lecture V.—February 14.—Steel.

Lecture VI.—February 21.—Tool Steel and Edge Tools.

Tickets for the course are issued with the present *Journal*.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. W. D. Gardiner, "The Present State of the Law Relating to Lights"
Royal Geographical, Burlington-gardens, W., 8½ p.m. 1. "Letters from Lieut. V. L. Cameron, R.N., on his Journey from Lake Tanganyika to the West Coast of Africa." 2. Capt. G. L. Sulivan, "Survey of the Lower Course of the Rufiji River."
Medical, 11, Chandos-street, W., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Dr. Carpenter, "Human Automatism."

Tues. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 7 p.m. Dr. Carpenter, "The Wonders of the Microscope." (Juvenile Lecture.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. President's Address.
Photographic, 9, Conduit-street, W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C. Dr. James Hector and Mr. W. S. W. Vaux, "The Maori Race of New Zealand; with Exhibition of certain early forms of Stone Implements."

Wed. ...Graphic, University College, W.C., 8 p.m.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 4½ p.m.

Thurs ...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Somerset House, W.C., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Ella, "Lyrical Music." (I.)
South London Photographic (at the House of the Society of Arts), 8 p.m.
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W. Mr. C. H. Rew, "Trades Unions."
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.
Royal Historical, 11, Chandos-street, W., 8 p.m.

Fri. ......Astronomical, Somerset House, W.C., 8 p.m.
Quekett Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m. Annual Meeting.
College of Preceptors (at the House of the Society of Arts), 2 p.m. Conference of Teachers.

Sat. ......Physical Science Schools, S. Kensington, S.W., 3 p.m.

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FRIDAY, JANUARY 14, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

DEATH OF MR. DAVENPORT.*

The Council deeply regret to have to announce to the members the death of their esteemed Financial Officer, Mr. S. T. Davenport. Mr. Davenport's long connection with the Society, his intimate knowledge of its affairs, and his untiring devotion to its interests, rendered him a most efficient and valuable officer. It is felt that the large number of members to whom Mr. Davenport was personally known will sympathise in this expression of sincere regret for the sudden and unexpected loss which has befallen the Society.

AFRICAN COMMITTEE.

A meeting of this Committee was held on the 11th inst. Present:—Vice-Admiral Erasmus Ommanney, C.B., F.R.S. (in the chair), Hyde Clarke, Rev. R. A. Currey, J. J. Pratt, C. P. Rigby, T. A. Rochussen, Trelawny Saunders, P. L. Simmonds, with P. Le Neve Foster (Secretary), and Dr. R. J. Mann (Secretary to the African Section).

CANTOR LECTURES.

The fourth Lecture of the first Course of Cantor Lectures for the present Session, "On the Discoveries and Philosophy of Liebig, with especial reference to their influence upon the advancement of Arts, Manufactures, and Commerce," by J. L. W. Thudichum, M.D., was delivered on Monday, December 13th, 1875, as follows:—

Lecture IV.

Physiology of animals and the laws of their nutrition in particular.—Foods and food extracts.—Works and their influence upon professions and associations.

Mankind in general cares little for the explanation of the phenomena of nature, even of those which most concern the individual body. In general it prefers mysterious sentiment to clear conception, and seeks happiness in poetry addressed to the moon, rather than in the study of scientific data concerning it, evolved by astronomy. It prefers to carry on eating and drinking as a free art without the intervention of chemical analysis, or the trouble of thinking about causes and effects. These predilections are suspended only at intervals for short periods, namely, when numbers or individuals are threatened by dangers inimical either to their bodies or their estates. Then they run for help to the wise man, the doctor; then there are heard inquiries after proximate, nay after final, causes; then any pretended remedy is swallowed, physical and metaphysical, nauseous and absurd, healing and inert, true or quack. Only the man of science is the same, composed; he has foreseen, perhaps predicted; he knows that the Deity works by immutable laws, and that all causes shall have their proper and necessary effects, and no others, and that all sentimental intercession with the Supreme power is self-deception.

But even when driven to ask for aid mankind little understands that there should be persons who make it their life-business to be prepared to give their aid in evil times; and more particularly disinterestedness is valued cheaply; perhaps thought insincere. The technical man on his part becomes over-professional, and thereby less intelligible, and the elements which might aid each other's object to great advantage, assume an attitude of indifference, nay of hostility towards each other.

In such conjunctions an expositor is wanted, *par exemple*, to rouse the world to the appreciation that the human stomach is an inexorable fact, and has for its law the consumption of a certain number of ounces of carbon and nitrogen in a given time, and cannot be satisfied with sheep's heads or offal, or scraps from the dusthole, however disguised by cheap cooking or cheaper talk.

We have seen in the last lecture how Liebig explained the laws of the production of food with the view of insuring its permanent supply, and its constant increase. We will now consider what he taught regarding the nature of food, and its uses and destinies in the animal body.

Two years after his work on "Agriculture," he published his work on "Organic Chemistry in its application to Physiology and Pathology" (1842). It consisted of three parts, of which the first treated of the chemical process of respiration and nutrition; the second of the metamorphoses of the nutritive and formative matters; while the third discussed the phenomena of motion in the animal organism. He started with the admission of a vital force, which he allowed to direct the evolution of all germs, eggs, and seeds into final forms. But the assimilation of mineral matters by the plant, and of organic matter by the animal, he conceived to be effected by merely chemical processes, which he termed vegetative action; the phenomena of motion in animal bodies he conceived to be always under the control of nerve-apparatus, and these he termed animal functions; and the phenomena of the higher mental life he did not attempt to reduce to any proximate or remote causes. This system was no doubt eclectic and inconsistent in parts, and produced the severe criticism of Henle: "With consummate skill he (Liebig) draws a few crystalline threads out of the tissue of life, and holds them up to admiration as the share of chemism; he then throws us the lump which he cannot unravel as the share of vitalism." These men were seen to walk arm in arm after this passage, and the truth of the criticism probably effected an approximation of views of individuals, such as has been effected between microscopical and chemical science by and after long contention. The science of one day has applied the method which Liebig used most successfully in the contemplation of what he termed the vegetative functions to nearly all the others. Instructed by anatomy, it considers the organism as a system of separate centres, endowed with the power of con-

* An obituary notice of Mr. Davenport is given on p. 139 of this *Journal.*

tinuance, increase, or multiplication: cells and fibres. These have contractile power independently of a central nervous influence: though their power in this respect is not independent of nervous matter, which they contain always, perhaps in position central to themselves. They consist mainly of the matter prepared by the plant out of the sixteen elements which chemistry finds by their destruction; these are in a constant state of molecular vibration, either holding each other in equilibrial tension, or acting upon each other so as to produce a change, the equilibrium being in no case continued beyond a certain limited time. All these parts are subject to all the laws of chemical action besides, and to all the physical influences of weight or earth attraction, heat, electricity, to osmose in opposite directions, capillarity, elasticity. The chemical and physical powers therefore act conjointly within the organism, and within the smallest elements of the organism according to the same laws, and upon (a selection of) the same materials as those upon and according to which they act without them in nature at large.

Liebig supposed that the plant did not produce the matters which are found as immediate principles of nerve matter, but that they were the result of animal synthesis. This has become doubtful by late researches, and seeds in particular seem to contain these or similar matters. On the other hand, most chemists have overlooked that the red colouring matter of the blood has never been found in any plant, and this organo-metallic compound is, therefore, strictly of animal origin. Again, the assumption of Liebig, that plants possessed no nerves, has become doubtful by the phenomena to which Darwin has lately drawn attention. And if the power ascribed to certain plants of digesting small animals is really existant, the paradox of carnivorous plants will constitute a transition from non-sensitive, or less sensitive, to nerve and muscle-endowed plants engendered by ordinary plant development, but rising at certain periods to the dignity and function, as regards nutrition, of animals.

The fact that animal respiration is mainly an absorption of the oxygen of the air, and its combination with parts of the body, and an analogue of ordinary combustion, resulting also in the production of carbonic acid, &c., was appreciated and investigated by Lavoisier and Laplace. Subsequent inquirers investigated the phenomena quantitatively, and accounted by the heat produced for nine-tenths of the matters burned, but they admitted a loss unaccountable.

This loss Liebig denied, and explained the observation as the result of a lower temperature of the animal body. He taught that every motion of the animal body must have as a condition a corresponding amount of waste of its constituent material. The contractile tissues are nitrogenous, like muscles, and their waste in action can be replaced only by nitrogenous food. This latter is therefore the true nutritive, reparative, or plastic food; its value is in general proportionate directly to its contained nitrogen. Matters, which like fat, starch, sugar, &c., contain no nitrogen, cannot support the growth of life of any animal. But they are consumed in the body in large quantities, and serve the purpose of heat production by oxidation. They are warming, heat-producing foods, or respiratory nutriment With every breath the animal takes in a certain quantity of oxygen, which unites with its blood, afterwards with other matters. The heat engendered by final oxidation is communicated to the blood and distributed throughout the entire body. Expiration is the expulsion (by an act of specific secretion), of the products of oxidation of heat-producing food, of carbonic acid and water. Every breath, therefore, diminishes the carbon and water and oxygen contained in the body. The intensity of respiration stands in proportion to the density and temperature of the air and the frequency of the expiration.

Liebig then discusses the differences between the nutrition of the carnivorous and the herbivorous animal. Unacquainted with the specific digestive unformed ferments, which have been isolated only in late years (*pepsine, pancreatine, coaguline*), he ascribed more to mere chemism than we now see to belong to it. He appreciated the main features of the economy of the liver and bile, with regard particularly to its nitrogenous constituents, even at a time when the fact of sulphur being an ingredient of one of the bile-acids was overlooked by all inquirers, including Demarçay and Dumas. Not having any quantitative method for directly determining the elements excreted in the lixivium of the blood, and little confidence in the methods which determine other secretions, particularly the breath, he adopted the method of chemical statistics for attaining his object. Instead of determining the results of the respiratory process during hours or days upon individuals, with all their fluctuations from age, sex, or disposition, he took for objects of inquiry entire families, or the inhabitants of entire military barracks and prisons, and determining the consumption of elements in the food eaten and drunk, he concluded what must be the quantities of carbonic acid and water excreted, and of heat produced. We here behold one of the most audacious generalisations possible. His classification of foods was the result of his analyses, not of direct observation, and accordingly direct observation produced a correction.

It is known, from the researches of Bischoff and E. Smith, that motion produces an increase in the consumption of carbonaceous food and none in the production of nitrogenous waste. Therefore Liebig's definition of heat-giving food remains only partially true; but the principal part is true, as Bischoff says, and the names may therefore be left to stand. The heat-givers are never plastic, except in disease; the nitrogenous foods give heat mainly in fever also; hence they change parts in a certain degree in disease. The classification will retain its use of pointing out, in the briefest manner, the essential difference in the usual varieties of food.

The consideration of the changes of food in the body led him to inquire after the origin of fat. He showed by the statistical method that a hive full of bees, consuming nothing but sugar, produced a certain weight of wax far above what could have been furnished to them by the albuminous matter within their bodies. He therefore concluded that the formation of fat in general is a function of the animal (as well as of the vegetable) body, and that the materials from which the fat is formed are the carbohydrates, sugar, amylum, gum, &c. This production he admitted to take place mainly when respiratory food was present in excess; the formation of fat itself also evolved some heat, as the removal of oxygen and hydrogen could not take place without the evolution of caloric.

These views were controverted mainly by Dumas and Boussingault, who maintained that animals received all their fat ready formed from the plant. They examined many parts of vegetables, and found, indeed, quantities of fat greater than had previously been known to exist in them; but it still remained insufficient to explain the large accession of fat in animals subjected to a process of artificial fattening and cramming, and the result of these inquiries therefore went in favour of Liebig's view. The idea was further supported by collateral metamorphoses, such as that of sugar into butyric acid by fermentation with cheese. Much discussion has taken place on the question whether the albuminous substances may not also yield fat; certain it is that their presence in the food is necessary, by the side of the carbohydrates, if adipose tissue is to be manufactured. Liebig himself suggested that albumen in putrifying might yield fatty acids, such as butyric and valeric. But he never adopted the hypothesis, and I believe with good reason. There is at present not a single physiological fact which speaks for the hypothesis that fat in the animal body is ever made from albumen.

I have termed this first edition of his animal chemistry an audacious performance, While full of original conceptions, reforming and building anew, it contained at the same time an amount of hearsay, and of formulæ, equations, and propositions, about which their author in late years laughed as heartily as any critic. He compared them to old feathers, which the bird sheds at moulting time, to grow new wings, and to take better and higher flights; or to old jam-pots in the corner of kitchen cupboards—they had done their duty, and were now useless. But the effect of the work on the medical profession was very great indeed. It was universally studied, and many attempts were mado to apply its teaching directly to practice. But here the world had to endure a great disappointment. If physiologists themselves were not prepared to receive the new teaching, how could their pupils be so? Prout had classified food according to the ingredients of milk, into three classes, those varieties corresponding to caseine, those corresponding to sugar of milk, and those resembling butter and fats. But the celebrated Burdach, author of the best and largest work on physiology in the early part of this century, did not agree with this division, and would rather have the varieties of food fixed by common characters than divided by differences. In 1840 he said of substances serving for food, "They are indifferent towards the organism, that is to say, they produce no tangible changes in the composition and life-action of the body, cause no prominent excitement of a single system, and never induce any chemical decomposition. They are mostly similar to tho chemical indifference as it appears in water, but tho basic properties prevail in them."

Of breathing, Burdach gave a definition which beats the nonsense which Hegel said about it. "Respiration is a universal process, that is to say, it is not peculiar either to the organism, or to life, or to particular organs. Water breathes because it absorbs gases from the atmosphere; quartz-sand, gypsum, chalk, &c., breathe because they are capable of condensing air; dead organised matters, plants, and animal corpses breathe because they absorb oxygen and exhale carbonic acid."

Heat, according to Burdach, is produced anywhere where there is life; but heat is not identical with the principle of life, and is not produced by this principle alone. Its essence is included in the definition of life, but it can be produced by life only by the mediation of the general cosmical powers. Heat appears as the expansive powor, which is evolved free from its conflict with the contractive power. It is called forth by conditions causing contraction, mechanical, chemical, dynamical, by the directing influence of the earth upon the light of the sun, and by the conflict of positive and negative electricity, the indifferentiation of which is made difficult." Of plants he still believed, Saussure's researches of 1804 notwithstanding, that all their substance was produced from the water.

The physiologist, J. B. Wilbrand, represented disease, not badly, as the battle of the chemical process with the organic process of life. The chemical process is victorious in death. Respiration is to him a function of the sun, conditioned by the elements of the material of the earth, tho air, and the water, and this function is continued in the individual. So-called oxygen, *i.e.*, the purity of the air, is not that which gives life in breathing, but it can only be the contained light, dissolved light, which puts vitality into breath. Therefore the difference between arterial and venous blood is not caused by the difference in the contained oxygen, but by an internal metamorphosis. These physiologists had caught the phraseology of Schelling and Hegel, but were destitute of the power of imagination and verbiage of these men. Listen to Hegel's definition of blood, lung, and liver:—"The blood is the motion which runs round an axis, carreering round itself; this absolute tremor in itself is the individual life of the whole, in which nothing is distinguished—the animal time. Then this motion round an axis splits up into the cometary, the atmospheric, and the vulcanic process. The lung is the animal blood, which has a relation to the atmosphere, and produces this interrupting and restoring, in and expiring process. The liver, on the other hand, is the returning from the cometary into the particular being by itself, the lunar; it is the being by or for itself, which seeks its centre; the heat of the being by itself; the anger against the being different, and the burning of the same."

Where such nonsense had to be encountered, Liebig could well say that it would be objectless to give to his conclusions greater extension than they deserve; they do deserve, he said further, however hypothetical they may appear, attention only in so far as they indicate the way which chemistry follows, or which it must not leave if it desires, indeed, to do services to pathology and physiology. It did not leave that way, but it did not succeed in leading the philosophers of the time after it. As in Harvey's time no man older than 40 years was known to adopt his discovery as truth, so philosophers and physiologists remained unconvinced. The entire generation had to die and make room for a new one before the new science could take its place at the council board of intelligence.

The number of papers embodying researches and theories which Liebig published, bearing upon the chemistry of animals, is very great. The chemistry of the cyanogen compounds had well prepared him, as a transition from inorganic to organic things. In 1829 he published (25) an article on hippuric acid, the first paper on an animal subject. Organic analysis soon led him to investigate many substances having relation to the animal body: strychnia, brucia (35), benzoic acid, narcotine, piperino (39), vesical calculi (47), formic acid (48), on cholera (61, 1833), chinic acid (62), atropia (63), nitrogen in organic bases (64), meconic acid (69), and jointly with Mitscherlich (1833), on lactic acid (71*a*). Lithic acid he began in 1834 (75); hippuric acid he resumed in 1835 (15); nicotin (93), the research with Wöhler on lithic acid, appeared in 1837; in the same year the article on Marcet's xanthic oxide (106 *e*) a rare constituent of calculi; in tho same year on Marsh's apparatus for arsenic detection (105); in 1838-9 he published several papers on organic bases or alkaloids; in 1839, a paper on the phenomena of fermentation, putrefaction, and decomposition, and their causes (129-131), which was afterwards appended to the "Agricultural Chemistry," but omitted from the seventh edition, and the part on fermentation was published separately; in 1820 he wrote in support of the contact theory (150); in 1840, on fats, soaps, and plaisters (153), on blood-lixivium (155), on the albuminous matters (159), on the formation of fat in the animal body (161), several other articles containing tho matter of his second treatise (163, 164); in 1843 he wrote on bile (178), again on fat (180); then came, in 1844, the article on the constitution of the renal emunction in man and carnivorous animals (182); in 1845, on animal heat (192); in 1846 valerianic acid and a new body from caseine (tyrosine) (200), the chemical process of respiration (204); in 1847 he showed that kreatine and kreatinine occurred as normal ingredients in the renal emunction (207); in the same year he published the article on the constituents of the juices of meat (212).

This led directly to the establishment of the manufacture of extract of meat as we have it now. In 1850, he wrote on the fibrin of muscular fibre (229); also gave a new method of determining prussic acid (230); 1851, on the form in which oxygen is present in blood (233); in 1852-53, he published the paper on the quantitative determination of the lixivium of the blood (239). This furnished the desideratum for which physiologists and pathologists had been for a long time sighing in vain. Now the effects of all imaginable conditions were determined, a new literature arose, and pathology was roused to new hopes. I myself published a treatise under the influence of that movement. But the hopes

of insight into the nature of disease by the quantitative method remained unfulfilled. All diseases had this in common, that more animal matter was oxidised while they lasted; the febrile process burned up, perhaps, double the amount of albumen that was burnt up in health. But chemical specificity there was none in the lixivium. The research had to begin anew.

Liebig had given a peculiar theory of the process of fermentation. The albuminous substances were highly alterable bodies, and in vegetable juices quickly decomposible. Now, he said a body in a state of motion as regards its chemical molecules or atoms is capable of communicating this motion to others, which by themselves are at rest. This is contact action.

Of the same kind, continued Liebig, is fermentation by yeast, the albuminous body in change communicates its motion to the sugar, and alcohol and carbonic acid is the result. The formation of oxygen on the other hand, engendered by platinum black, or wood shavings, is an oxidation at the expense of oxygen, a merely chemical process. Other fermentations he explained similarly, the transformation of starch into dextrine and sugar by diastase, of amygdaline into oil of bitter almonds. By generalisation he arrived at the conclusion that processes of disease, contagions, infectious processes, and poisons of animal origin, such as snake poison, are of the same kind of action; namely, contact action or fermenting processes. This idea was eagerly accepted by physicians, and now acute febrile diseases, such as typhoid, small-pox, scarlatina, are termed zymotic diseases.

The idea of contact action, as defined by Liebig, is negatived by many. Indeed it is difficult to admit it in the case of ordinary fermentation, when the material seems to be under no great degree of tension. But in the case of gun-cotton and a fuse of fulminate the idea is admissible enough. But in the case of the shapeless ferments which can be extracted from animal and vegetable matters, if the contact action does not hold good, no theory whatever can be at present advanced. In these cases the effect is so enormous, and the active material (ferment) so small in amount, that the power exerted, and exerted apparently indefinitely upon ever increasing quantities of material, admits of no explanation on ordinary chemical grounds.

In our days fermentation is most commonly believed to be the effect of the life of a fungus, the *torula cerevisii*, the idea to which Pasteur has given the greatest currency, though it was held already by Mitscherlich, Lehmann, and others long before. Pasteur enlarged the idea of fermentation by ranging under it certain unfavourable changes of wines, such as viscosity, bitterness, and the acetous change of all fermented liquids. Each of these he pronounced to be the results of the vital action of certain specific fungi, which he described. He arrested the changes by the application of heat.

Upon this some botanists, notably Hallier, conceived the idea that all diseases were the products of fungi introduced into the body, and he described sixteen varieties of fungi as specific to as many diseases. Thus we have again the analogy generalised which Liebig originally propounded, but it has been generalised contrary to his view of fermentation. At present we find microscopists admitting the existence of specific fungi, here and there, in diseased tissues, *e.g.*, small-pox pustules, but they by no means admit Hallier as being correct. We are thus in danger that each botanist or pathologist will have his own set of fungi as disease causes. To the chemist there will remain a pretty occupation, namely that of finding out the vital products of the chemistry of each fungus, for, of course, the fungus by itself does not much harm; it causes disease mainly by the poison which it excretes as part of its life-action, says he microscopist. Logically, fungi once in the body annot be killed, therefore they must run their course, and the wonder is that that course can be supposed to ave a spontaneous termination. Now the poison has again to be accounted for as regards its action, contact or other, and pathology is not only not advanced, but has only the vast difficulty of these competing fungi to contend with. The cure must still come from the chemist, whether for killing the fungi or neutralising their poison.

In 1853 Liebig discovered kynurenic acid (241); in 1854 he proposed a cold extract of beef as a restorative food in certain conditions of low nutrition (246). This contains the albumen and myochrome, and is not cooked. Its use is great in proper cases, but it is only taken by patients under medical prescription, as a medicine, not as a dietetic. In the same year he applied lime-water to rye-bread, to make it less firm (247). In 1858 and 1859 he writes yet on kreatin and kynurenic acid (268); in 1860 an article of a defensive nature against imputations by Du-Bois Reymond on the acid reaction of muscle-tissues (275). In 1862 he finds alloxan in an animal secretion in disease (280). Then there is the article on *extractum carnis*, already alluded to (1868). Further, he gives a new soup for children now termed "Liebig's food for infants (288)." Wheat-flour, or powdered malt, is transformed into dextrine by diastase, at the proper temperature, while milk and some potash carbonate are added. The principle is to produce a food as much as possible similar in composition and action to woman's milk. This exquisite mode of preparing food for infants (which I have employed for years with the most perfect success) would be a much more suitable lesson for schools of cookery than the preparation of offal into the semblance of savour. The problem of feeding the young and the poor physiologically is not easy, but it is simple if considered from the scientific point of view. The bulk of the food of the lower classes must always be bread; it is perfectly idle to believe that this can be altered. Peas, beans, and other like leguminous plants, however rich in albumen, can never compete with bread; first, because they require steeping in water and boiling for hours; next, they become hard so easily, and then are indigestible, while at all times they are not so easy to be digested as bread. But bread is not so good a food as meat; here chemistry comes in, and, as Liebig says, shows that bread soaked in broth made from extract of meat is as good food as the best meat diet. In this, as a practical proposition, I fully agree. A man who is physiologically fed, though without regard to much taste in the food, may be in the best possible physical condition and vigorous. He has the privilege of the animal, which is contented with and thrives upon things which have no prominent taste, and require no spice. The fowl can taste nothing of the whole corn which it eats, yet how eagerly does it eat of it? It knows its nutritive value as a matter of inner consciousness. Thus when our populations will use more meat extract, and perhaps a little less tea, and more Liebig's food for their children, they will increase their strength, health, and vitality, and will find out for themselves that the greatest good of life is health, and that no artifices of small cookery will be worth having, which are, as they must be, unable to maintain the body in vigour.

Once more, in 1870, Liebig returned to his favourite theme, the chemistry of nutrition and the source of muscular power. Then he hung up in the halls of Æsculapius the lyre to the strains of which he had sung the great hymnos of the rise and fall of organic bodies.

SPECIAL LECTURES.

The second of the series of lectures on "Unhealthy Trades" was delivered by Dr. B. W. Richardson, F.R.S. (appointed by the Council to make special inquiry into the subject), on Friday evening, December 10th, as follows:—

LECTURE II.

Agencies Producing Physical Injury during Industrial Labour.—Classification of Injuries.—Details of Injuries inflicted on the Lungs.

In the present lecture I proceed to consider the various agencies that are at work in producing physical injury on the human organism during the performance of industrial labour. I shall treat the subject, first, in general terms of classification and management, afterwards in detail. By this means I shall hope to offer a comprehensive survey of the field of industrial pathology, so that when we come to the study of special occupations we shall be prepared to understand and appreciate the particular evils incident to them.

CLASSIFICATION OF INJURIES INCIDENT TO INDUSTRIAL PURSUITS.

The classification I should venture to offer of the injuries springing purely from industrial pursuits, as we find them in this country, is included under the following heads:—

I.—INJURIES FROM INHALATION BY THE LUNGS.

(*a.*) *Of fine particles of solid matter.—Dusts.*

(*b.*) *Of gases and vapours.*

II.—INJURIES FROM EXPOSURE OF THE BODY TO CHEMICAL AGENTS.

III.—MECHANICAL INJURIES.

(*a.*) *From Impact of Foreign Bodies.*

(*b.*) *From Burns and Scalds.*

IV.—PHYSICAL INJURIES OF THE BODY.

(*a.*) *From Unnatural Positions.*

(*b.*) *From bearing Weights and Loads.*

(*c.*) *From undue Atmospheric Pressure.*

(*d.*) *From Mechanical Concussions.*

V.—INJURIES FROM EXPOSURE TO DAMP AND TO IMPURE AIR.

VI.—INJURIES FROM CONTACT WITH PARASITIC ORGANIC FORMS.

VII.—INJURIES FROM MUSCULAR WORK.

(*a.*) *Local.*

(*b.*) *General.*

VIII.—INJURIES FROM EXPOSURE TO EXTREME VARIATIONS OF TEMPERATURE.

These series of injuries occurring from the various sources specified may be considered as special to the industrial classes. They are additional to those which befall the other classes of the community as well as themselves. They are additional to those five injurious influences which I described in my last lecture, viz., intemperance, heredity of disease, imperfect food, indifferent moral surroundings, and uncleanliness.

FACTS IN DETAIL.

From the general classification above rendered I may pass at once to some of the facts of detail connected with the respective classes specified. I will, if you please, proceed in order from the first head on the list. This, I fear, will yield subject-matter enough of itself for the present short course of lectures.

As I progress from one line of facts to another I shall pursue the following method. I shall state the nature and character of the injurious influence, and shall then trace out the phenomena of disease that occur from it. This done, I shall place the phenomena under the name which they take in the calendar of disease in what we physicians call the nosology. In this manner I shall, so to speak, extract the pathology out of the industry, and so fix the phenomena in the mind, that the subject, as far as we follow it, may be perfectly intelligible to those who have no technical knowledge of disease and its causes.

CLASS I.—INJURIES TO THE BODY FROM INHALATION OF FOREIGN SUBSTANCES BY THE LUNGS.

Order 1.—*Injuries from Inhalation of Dusts.*—The term dusts, as I would here apply it, includes all those fine, solid particles which are thrown off from various substances in the processes of manufacture or treatment of articles in common use in daily life, such as earthenware utensils, knives, needles; or mechanical instruments, like files or saws; or ornamental things, such as ornaments of pearl, ivory, and turned wood; or articles that are worn, of silk, cotton, hemp, fur; or things that are used for food, such as flour; or for creating warmth, such as coal; or for using as a supposed luxury, such as tobacco and snuff. These are only a few illustrations; many others will naturally occur to those who think on the subject.

The dusts which inflict injury are of varied quality, as will be seen from the brief sketch just given. They are also of varied effect in regard to the specific injuries which they produce. We may profitably study them divided into different groups, according to their physical characters, as follows:—

(*a.*) Cutting dusts, formed of minute hard, crystallised particles which have sharp, cutting, and pointed edges. These dusts are composed of iron or steel, of stone, of sand or glass, of dried silicates in earthenware, of lime, of pearl.

(*b.*) Irritant dusts, derived from woods, from ivory, from textile fabrics, fluffs of wool, of silk, of cotton, of flax, and of hemp, from hair, from clay.

(*c.*) Inorganic poisonous dusts, derived from some poisonous chemical compounds used for colouring artistic products, or for preserving organic substances, such as furs. These dusts are charged with arsenical salts.

(*d.*) Soluble saline dusts, derived from soluble crystalline substances used for dyeing purposes. The sulphate of iron, copperas, yields a dust of this class.

(*e.*) Organic poisonous dusts, which are thrown off during the making-up of tobacco into cigars and snuff. These dusts carry with them particles of the dried tobacco-plant.

(*f.*) Obstructive and irritating dusts, composed of carbon, of fine particles of coal-dust, of scrapings of carbon or of soot, of dust of rouge, and of flour.

Whatever may be the kind of dust to which the workman is subjected, to whichever of the above-named he may be exposed, the primary cause of danger lies in the circumstance that the fine particles are borne by the air into the lungs. They pass, wafted by the air, through the mouth and nostrils into the windpipe; they pass along the bronchial tubes; in some instances they reach and traverse the bronchial passages which lie between the larger bronchial tubes and the minute air vesicles, or they even reach the air vesicles themselves.

We are all of us at times exposed to inhalation of dust, and much harm, even under ordinary circumstances, might occur from such exposure, had not nature provided certain simple but effective measures of protection. These measures are three in number, viz., cough, bronchial secretion, and ciliary motion. Let me for a moment explain these facts.

When a foreign substance or whiff of dust is inhaled, and impinges on the opening into the windpipe—the glottis—an irritation is produced upon the nervous filaments, and a message is sent up to a nervous centre indicating the fact of irritation. The response is a reflex movement upon the muscles, and the expulsive muscular movement known as cough. Then, if it be possible, the foreign agent producing the disturbance is coughed up, and the irritation ceases.

This is the mode of action of the protective measure of cough. At the same time that the substance which causes the cough irritates the nervous fibre so as to

produce the muscular expelling effort, it also, by another act, excites, through nervous fibres, these mucous glands of the throat, which are so well depicted in a diagram here before you. The glands thereupon throw out a profuse secretion. As when an irritant applied to the eye brings tears, so an irritant in this part brings secretion of mucous or phlegm, and on the tide of that secretion the foreign substance, if it be not too excessive, is carried away, and is coughed up.

To these two protective means is added the third of which I have spoken, the ciliary motion, a provision exquisitely beautiful.

Throughout the whole of the respiratory mucous surface the epithelial lining of the mucous membrane is studded with minute filaments, or striæ, which line the surface, and are attached to the epithelial cells of the membrane. These filaments are called "cilia," from *cilium*, an eyelash. They are very minute, being from the $\frac{1}{1000}$ to the $\frac{1}{10000}$ of an inch in length, and they are in constant movement in one direction, from within outwards, towards the direction of the windpipe and larynx. They move in that direction as far as they can bend, and then they return to their natural erect position. Thus, in a wavy motion (which some anatomists have compared to the waving of corn in the corn-field), they carry the bronchial secretion and any foreign substance that may be mixed with it from the lowest part of the bronchial surface to the outer opening. They exert their movement independently of our will, and independently, it would seem, of nervous force, and they continue in movement for a time even after death.

In damp, foggy days, we breathe in this London air great quantities of fine carbon as smoke, and we notice that for some days afterwards the secretion from the lungs is greyish dark, or even black. That grey colour is due to the carbon, which, in combination with the secretion, has been carried by the ciliary motion out of the lungs, and is removed by cough. The ciliary action is so rapid that some experimental observers have argued against the introduction and retention of any large quantity of matters of dust in the lungs under any circumstances. Unfortunately, the records of industrial pathology prove that the beautiful natural provision for the expulsion of foreign substances, under ordinary circumstances, is not sufficient to meet unnatural pressure of work, and that, in spite of it, men die from dust inhaled into the respiratory tract. In those who are exposed to any one of the kinds of dusts I have named, the foreign particle is received by the lungs, is unduly retained, and is a source of danger, from the local mischief it excites.

At the same time, the greatest differences prevail as to the nature and extent of the danger, the differences being dependent upon the character of the dust. In other words, the character of the dust determines the severity of the injury. This is so true that, other things being equal, we may predict the fate of the workers by the nature of their work, when their labour is carried on without efficient protection from danger.

Effects of Cutting Dusts.

When the particles of dust are made up of steel, of fine stone, of sand, of glass, or pearl, the danger is most immediate and most active. These particles, exceedingly minutely divided, are insoluble, and are edged or pointed, so that they actually cut through the ciliary processes, and the epithelial base on which the processes rest. I call them, therefore, cutting dusts. They are also heavy particles. From both these causes the amount of injury they inflict is as acute as it is terrible. Hence the rapidity of the fatal mischief on the knife grinder, the stone cutter, and the sand or glass paper maker. The symptoms induced are technically called symptoms of consumption. They are like the ordinary symptoms of that disease, and are, indeed, practically the same, except that the foreign irritant which calls them forth is an inorganic particle, as distinguished from the organic tubercle of the natural affection. The rapidity of action of the particles of steel on the lungs is notorious in the cases of the grinders of Sheffield. The late Dr. Alison, of Edinburgh, recorded of the masons of Edinburgh that he did know an instance in which a hewer of stone, who had regular employment in Edinburgh, was free from consumptive symptoms until the age of fifty.

The most typical forms of disease of the lungs produced by these cutting dusts which I have met with have been amongst those who are employed in sand-paper making. I am happy to state that great improvements have been made of late years in this process by means of machinery, but at one time the danger was most imminent. The fine sand, or a mixture of finely-powdered sand and glass, was placed in fine sieves, and youths were employed to distribute the powder equally over the paper. The work is light, and the young, therefore, were reckoned as competent for its performance. In one instance of a youth, who was under my observation from the early stage of his illness until his death, I traced the symptoms from the commencement. The youth was quite well until he went to this occupation, and on the first day he coughed severely from the irritation produced by the dust. When he returned home at night he coughed still, and complained of severe pain in his side and chest. He continued, nevertheless, to toil on in his fatal work, but in a few days was quite stricken down with all the symptoms of acute pulmonary consumption. In the course of three weeks the symptoms had become so severe that life was rendered impossible, and within the month death took place. The symptoms were so closely allied to those of ordinary pulmonary consumption, it would have been impossible to distinguish them from the ordinary disease but for the knowledge obtained as to their cause. The expectoration gave evidence, under the microscope, of the presence of the foreign irritating substance, and after the death of the sufferer, the diseased lungs, in their minute vesicular structures (for the mischief was nearly equally spread over each lung) gave the same fatal evidence of the presence of the foreign particles.

The millstone-cutter, the potter, the needle-grinder, the pearl-cutter, and the turner suffer in like manner from this consumptive malady, similarly induced. In the case of the pearl-cutters there is also, as I am reminded by Mr. Bartleet, of Redditch, an additional danger from their work, viz., that in Birmingham and other large towns where the pearl working business is carried on, the industrials conduct their labour in their own small, ill-ventilated rooms, where bad air adds to the risk of the mechanical injury.*

Thus we have to place first on our list of diseases induced by industrial occupation, that formidable malady *phthisis pulmonalis*, pulmonary consumption It would be a distinctive and no false appellation to give to this type of disease that of mechanically-induced consumptive disease, or, better still, of *industrial phthi is.* This term would fix the malady, in regard to its specific origin,

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* I am indebted to the same intelligent observer (Mr. Bartleet) for the following letter on the subject of the diseases of needle pointers:—

December 14, 1875.

MY DEAR SIR,—In reply to your inquiry about needle-grinders, technically called in the trade "needle-pointers," I have much pleasure in informing you that their occupation may now be considered very nearly, perhaps, taking all things into account, I may say quite as healthy as the other branches of the trade. The work is now chiefly done by machinery, the workman having merely to keep the stone over which the needle wires are passed in proper order and shape, by frequently applying a piece of ironstone to it, and to see that the said wires are kept in proper order for travelling over the stone. A fan of considerable power is used to draw the dust away from the workman, so that it is his own fault if he inhales it. Careless men no doubt still suffer to a small extent, when not closely looked up by their employer or a foreman.

These pointing machines have been in use about ten years, but the fans have been in use more than twenty years, and since their introduction it has been the fault of the men if they have suffered to any extent. Prior to the introduction of the fans the men seldom were able to continue work after about 30 years of age.

I am, my dear Sir, yours truly,

R. S. BARTLEET.

Dr. Richardson.

on the official mortality tables, and a more correct record of industrial diseases would be obtained.

From the inhalation of fine particles of pearl, there has been observed on the Continent a peculiar inflammatory disease of the bones, to which the name of "osteitis" has been given. This disease, first described by Englisch, as attacking mother-of-pearl turners, has since been studied by Gussenbauer, Klauser, Hirt, and Merkel. Gussenbauer and Klauser have made an analysis of the three different layers of which the pearl shell is composed. The most internal layer is the one used by mother-of-pearl turners. It contains of organic matter insoluble in water 5·57, of organic matter soluble in water 0·11, of water 0·47, of carbonate of lime 93·555, and of alkaline salts 0·295 per cent. The disease of the bones that has been observed as incidental to the turning of this substance attacks only youths, before the skeleton is fully developed. It is characterised by sudden pain, which is neither increased by pressure nor motion. A swelling, first from the periosteum, or covering of the bone, and afterwards from the bone itself, shows itself at the ends of the bones at what are called the epiphyses. The soft elastic swelling is sometimes fluctuating. Its development is accompanied by fever; it enlarges in the direction of the length of the bone; in time it becomes harder, and it rarely suppurates. As a rule the tumour resolves. It often attacks several points of the skeleton at the same time, and it has a tendency to return. The bones that have been observed as affected in seven cases under the observation of Gussenbauer, in youths of from 14 to 16 years, are the radius of the arm, the ulna, the lower jaw-bone, and the thigh bone. In one instance several bones were attacked successively in the same subject, viz., the left metatarsal and cubit bones, the left shoulder-blade, the left arm-bone, the humerus, the cuboids, and the right astragulus or heel bone.

Gussenbauer, to whom I am indebted for these descriptions—the disease not yet having been described in our country—is of opinion that the malady is produced in the following manner:—The dust enters the lungs, penetrates the cellular structure of those organs, enters the lymphatic vessels and glands, and is decomposed. Under the influence of the carbonic acid of the venous blood, the calcareous carbonates are dissolved, the insoluble organic matter remains, and is the substance called conchyoline, discovered by M. Fremy. This penetrates the vessels, and is carried by the current of the arterial blood into the minute vessels. In the reduced vessels of the bone at the epiphyses, it finds resistance and deposits there, causing the swelling and the other symptoms which have been described above, and which continue until the foreign body is resolved and removed. Such is the ingenious theory of the origin of the bone disease of the pearl-turner. We need not discuss the theory, it is sufficient to have before us the facts at this moment.

Thus *osteitis* is a second special malady added to the list of the industrial diseases.

Effects of Irritating Dusts.

Dusts of Wood and Ivory.—The dusts of some kinds of wood, to which turners of wood and fine cutters of wood are exposed, are causes of much irritation of the lungs and of bronchial cough. The dust is fine and penetrating, and when it is from coloured wood it imparts its own peculiar colour to the bronchial secretion. I have seen these phenomena, markedly in the case of mahogany carvers, in those who carve ornaments for couches and other articles of furniture. The work gives rise to a great quantity of wood dust, which is constantly inhaled. In carving, the artisan has to keep up a blowing process with the lips, in order to blow away the small portions of wood which he removes with the chisel. This process is very wearying. but the chief complaint made by the worker is of the dust he draws back in inhalation. The mischief is greatly increased in the rooms where the ventilation is imperfect. The cough is usually attended with copious secretion from the bronchial tubes, and I have more than once known the loss from this cause so copious as to cause other symptoms of wasting and exhaustion allied to phthisis pulmonalis and constituting what has been called *bronchial phthisis*. As a rule, however, those who suffer from this form of disease recover when they are removed from their occupation and are placed in favourable circumstances for recovery.

These same observations extend to the phenomena observed as resulting from ivory dust, but I do not think I have ever seen in ivory turners or carvers symptoms equally severe with those that are presented by the artisans in wood.

Dusts of Textile Fabrics.—The particles of textile fabrics vary in their action, according to the substance of which they are composed. The particles of wool, fluff of wool, appear to induce no really deleterious effects on the lungs; indeed, looking at the comparative mortality of workers in wool, we might almost say that they are favourably exempted from disease; as if the soft, oily dust of the wool rather protected the bronchial surface from irritation than irritated it.

To a considerable extent this same rule applies to the dust or fluff of silk; but I have seen an exception to this rule. In the trimming manufactories, where the business of carrying on silk trimming is conducted in close rooms, I have found the workers suffering from the same kind of bronchial irritation as that which obtains from the dust of wood. According to my observation this only occurs when coloured silk is used by the trimmer, and it is therefore possible that the dye stuff used in the colour may be the actual source of the mischief.

My attention was first attracted to this point by the circumstance of a young woman being brought to me, who was supposed to be suffering from hæmoptysis, or spitting of blood. She was, in fact expectorating freely something that seemed to be, at first sight, deeply tinged with blood, At the same time, she exhibited no symptoms of disease which indicated consumption or other serious affections of the lungs. Indeed, she was so healthy, generally, except for a slight cough, it might have been assumed against her that she was simulating the very serious malady from which it was presumed she was suffering. I took the precaution to examine the coloured secretion microscopically, and detected in it the fibre of silk, coloured with red substance. On inquiry upon this, I found that the young woman was engaged in a trimming manufactory, in which red silk was being, at that time, largely used, and that she derived the red particles from the dust or flue which she inhaled; other women in the same business were, I discovered, similarly affected, but suffered only from irritative cough when they were using red or other coloured silks. White silks did not cause irritation, from which fact I draw the inference that the dye-stuff rather than the material is the irritant.

The fine particles, or dust, derived from cotton, flax, and hemp are very different in their action from those of wool and silk. The cotton flue produces some bronchial irritation, but the worst injury results from the dust of hemp during the process of dressing. The quantity of dust lost in hemp-dressing may be inferred from the fact that for every 112 lbs. weight of hemp employed there is a loss of 4 lbs. This dust produces a most severe irritation, which, however, is purely bronchial, attended with painful expectoration and strangling cough. Russian and Polish hemp both produce these effects. Neapolitan hemp does the same, and something more. In the dust of the Neapolitan hemp there is distributed a peculiar odorous substance, the dust of some vegetable or grass, the inhalation of which causes shortness of breath, constriction of the throat, and spasmodic cough in recurring paroxysms which continue for many hours after the inhalation ceases. For the sake of experience I obtained a specimen of this hemp, and, after shaking it in a large bottle, I inhaled the dust. The symptoms induced, and as I have described them, were immediate. They re-

sembled almost completely the symptoms of the disease known as "hay fever." I was unable by any examination of the hemp, microscopical or chemical, to detect the specific agent that was at work. Even dressing the hemp does not remove this substance, for the symptoms are common to the spinners of the hemp after it is dressed, although they work in the air. The dust from flax-dressing, which is in fact but a continuance of the hemp process on a finer material, is equally irritating, and the loss of flue in flax-work is nearly the same as in the preparation of hemp.

The ordinary symptoms produced by the dust of the hemp, and which are felt by the spinners as well as the dressers, are merely those of bronchial cough. They are not alike in all. In some the cough is dry and husky, in others it is a loose cough, with profuse bronchial secretion. One worker in this business, who had been engaged in dressing flax for thirty years, twelve years in the country and eighteen years in London, told me he had never met with a single fellow-workman who had not suffered more or less from this irritation; but those who worked in the country suffered much less than those who worked in London; he had known a few who had lived to a fair old age. The work he considered to be much more easily carried on in warm and dry than in damp and cold weather. He had himself been a sufferer from the very first, and had been obliged, temporarily, to leave his employment on several occasions.

It is worthy of notice that these injurious effects from flax-dressing and spinning were noticed by one of the first sanitarians. They were very carefully described by Ramazzini, in his work *De Morbis Artificum*, published as far back as the year 1717.

Thackrah, in his famous work on "Effects of Arts, Trades and Professions, on Health and Longevity," observes the same order of facts, and adds that the operatives seem to suffer most on leaving their work at night; that they are peculiarly susceptible to atmospheric vicissitudes; that the cough is harsh, and is not cotemporary with a difficulty of breathing, but precedes it by months, or even by years. He adds, further, that dressers of flax "are subject to indigestion, morning vomiting, chronic inflammation of the bronchial membrane, inflammation of the lungs, and pulmonary consumption. The dust, largely inhaled in respiration, irritates the air-tubes, produces at length organic disease of the bronchial membrane or of the lungs themselves, and often excites the development of tubercles in persons predisposed to consumption." I am obliged to draw the satisfactory inference that, since Thackrah wrote the above, now forty-three years ago, improvements have taken place in the health of these industrials; certainly some of the severest maladies of which he writes are now greatly reduced.

In my *Journal of Public Health*, for January, 1859, Mr. J. Jardine Murray, then of Edinburgh, and now of Brighton, reported a very valuable inquiry bearing on this same subject, viz., on the health of those who work among rags—those who in "the inferior streets and alleys of the metropolis put out the tawdry stump doll, or the dirty bunch of parti-coloured ribbons over the signboard which indicates that the keeper of the dingy store is ever ready to give the highest price for all descriptions of rags and bones."

Mr. Murray expected, very naturally, that he should find amongst the workers in these tattered and filthy stores some suffering from contagion, others from the products of decay of the animal and vegetable constituents of the rags, others from inhaling and swallowing dust. An inquiry made by him at twenty-three paper-mills to which rags were sent, and of twenty-three rag collectors in Edinburgh, led to the curious return, that epidemic or contagious disease from this source was practically unknown amongst workers in rags, that there was no evidence of disease from the decomposition, but that some workers suffered from bronchial affections, cough and shortness of breathing, from inhaling the dust, which is cast-off in large quantities from the rags when they are made to revolve in the wire-cloth cylinder to free them from dust.

I have brought down, for those who would like to see them, Mr. Murray's abstract of statistics from paper-makers and rag-collectors. The paper-makers admit of no other affection incident to working with rags, except from the effects of the dust, and on this very few of them comment unfavourably. The rag and bone collectors tender an unusually fair bill of health. One of this class, who had been in business thirty years, who employed, on an average, ten hands, and who collected two hundred tons of rags, on an average, every year, reported that there had been only one death among his rag-workers during ten years.

The dust from corn, consisting principally of the residue of dried husk, is rarely present in sufficient quantity to create serious evil; but such mischief as it does create is of the character of bronchial irritation.

The dust which is diffused in the rooms where earthenware is manufactured, dust of clay, or rather the dust of a silicious material which is mixed with the clay, produces an action of two kinds. The dust which is given off in the earlier part of the manufacture, while the clay is but partly dried, acts rather as an obstructive than as an irritant. In a later period of the process, when the earthenware is becoming hard-dried, and the dust firmer, finer, and drier, more serious mischief is effected, for now the dust partakes almost of the character of fine sand or powdered glass, and the mischiefs induced are the same, in character, as those which affect the sand-paper makers and stone cutters. Amongst workers in earthenware, during the stages of drying and turning, are implanted bronchitis, pulmonary consumption, and asthma.

My friend, Dr. Cholmeley, has recently observed a peculiar bronchial irritation brought on in the carrying out of a comparatively new industry, namely, that of hair-brushing by machinery. The fine particles of hair carried off by the brush in its rapid revolutions, give an atmosphere of dust which is extremely irritating, and which is carried into the very face of the operator. Dr. Cholmeley has known three hairdressers who have been obliged to leave their occupation, owing to the injuries that have been inflicted upon them from this cause. The wig-maker and hairdresser is, as I have myself observed, subjected to a similar danger, and the unhealthiness of his occupation is shown by the rate of his mortality, which, from the age of twenty-five onwards, is greatly above the average.

Reviewing the effects of these simple irritating dusts, we find added to our industrial pathology three more diseases:—*Chronic Bronchitis and Bronchial Phthisis; Spasmodic Asthma, resembling Hay Asthma; Asthma.*

Effects of Inorganic Poisonous Dusts.

In some parts of the paper-staining process, and in the colouring of artificial flowers, the dust of arsenical colouring compounds is thrown off. This dust is more than a simple irritant to the lungs; it is dissolved, in some cases, in the mucous secretions of the mouth and throat, is swallowed into the stomach, and sets up the irritative symptoms of slow arsenical poisoning, viz., pain in the stomach, redness and soreness of the throat, and irritability of the skin. I have seen one instance of this kind, where the symptoms amounted to a modified form of gastro-enteritis. In the mildest of these irritative states of the mucous membrane there is created a persistent dyspepsia, so long as the excitant is at work. Arsenical salts are employed for the preservation of some organic substances, as, for instance, for the preservation of the skins of stuffed animals; and, under some circumstances, where the preserving process is not carried out with proper skill, particles of the salts are thrown off, float in the air, and so become inhaled. I have twice seen symptoms of arsenical irrita-

tion produced in this manner in persons who have the dusting and cleaning of stuffed animals, in close and badly-ventilated rooms.

Salts of mercury are likewise employed in preserving furs and skins, and from these the poisonous particles of the metallic compound are given off. In this manner packers of furs are affected, sometimes very seriously. A typical case of this character is related in the Guy's Hospital Reports, in 1864, by Dr. Taylor. The man affected was thirty-two years of age, and was admitted into Guy's Hospital in December, 1863, under the care of Dr. Owen Rees. He had been engaged four years in packing the skins of animals that had been prepared with an acid solution of mercury, and then dried. Until the skins were perfectly dry he had nothing to do with them. His duty was to pack them afterwards. He was salivated for three months, recovered, and remained in good health until twelve months before he was admitted into the hospital. At that time his hand became unsteady, and he could not shave himself; a little later he lost power in his limbs when standing or moving, and afterwards began to have twitchings and tremors when in bed. Soon he was unable to walk without assistance, and a day or two after admission into the hospital he was seized with delirium. He became paralysed and unconscious, and died within fifteen days from the time of his admission. Mercury was detected in the organs of the body of this man, and some portion of the fur with which he had worked exhibited, on analysis, abundant evidence of mercury. Dr. Taylor is of opinion that, in this instance, the mercury was absorbed by the skin, as well as inhaled.

To the schedule of industrial pathology, we must add three more conditions of disease, viz:—

Gastric Irritation and Gastro-enteritis; Mercurial Salivation; Mercurial Tremors and Muscular Paralysis, ending in fatal Cerebral Exhaustion.

Effects of Soluble Saline Dusts.

Fine particles of some of the soluble salts of iron, especially copperas or sulphate of iron, are sometimes inhaled. This salt, sulphate of iron, is used in fur dyeing, for dyeing skins black. After the skins have been treated with a solution of the salt, they are dried and beaten with a bat, and thoroughly brushed. The copperas dust diffused freely through the air is an excessive temporary irritant to the lungs, but the solubility of it seems to reduce its power as a promoter of permanent disease in the lung tissue. Its action on the bronchial surface is therefore less permanent than is that of many other irritating substances. Owing to its solubility, and to its corrosive action on bony substances, it is extremely destructive to the teeth, which are almost invariably affected by it. The teeth are rendered brittle, and generally carious. The grinding down of the colour stuffs from the large crystals into the state of fine powder leads to similar bad results. We add, therefore, to the list of industrial diseases—*Caries of the Teeth.*

It is right that I should mention on this point what great improvements have been made in the drying process. Many years ago, twenty years at least, the Messrs. Appold introduced into their manufactories a ventilating shaft, which proved of great service, and Mr. Davenport informs me that in all the better manufactories now, the bat with which the skins formerly were beaten has been replaced by a machine which acts more efficiently, and which entirely protects the workman from the dust. Except in the small and worst conducted shops and factories the evils I have described have ceased to exist.

Effects of Organic Poisonous Dusts.

The dusts arising from tobacco leaf, during the process of making cigars, is most injurious. While the leaf is being rolled up, unless the ventilation of the room is exceedingly perfect, the dust from broken leaves and siftings is inhaled, and proves most irritating. In the course of drying, the dust and vapour from the drying-room act in combination, and lead not only to oppression of breathing but to dryness of the throat, and, in the young, to giddiness and nausea. One workman told me that he never got over the bronchial irritation produced by this dust until he left his work at night, then the effect subsided.

The dust produced in the various processes of snuff-making is still more injurious. The tobacco leaf, finely cut up, is mixed with lime-water, salt, sometimes even floor-dust sweepings, and, in yellow snuff, with red lead. These ingredients, placed in a bin and heated twice or three times, to give sharpness to the snuff, are frequently turned over, in order to facilitate the process of drying. While this turning is in progress, there arises a dust with a smoke, which affects the younger workmen, so that they become faint and vomit, until, by use, they are rendered tolerant of the poisonous matters they inhale. In the further process of finishing the snuff, after it has been ground and dried, there is a practice of what is called sifting, preparatory to adding "liquor," viz., salt and water, to make weight, and scents to give perfume. The sifting charges the air with dust, which is as injurious as the smoke, and which produces the same symptoms in the young, viz., retching, faintness, and great irritation of the bronchial passages. The rooms in which these works are carried on are too often close and unventilated, and thereby the irritation of the throat, the cough, and the nausea are much increased. Sifting the "shorts" is more hurtful than rolling the cigar. The consolation of the workman is that he gets accustomed to the poison, if he only keeps to the work, and at last gets over the symptoms. In so far as the acuteness of the symptoms is concerned he is generally correct in this respect, but it is not to be presumed that the mischief stops at this point. The system of the workman becomes tolerant in some measure, but the tolerance is partial only. Chronic maladies are induced by continued application, which are of serious and even fatal import. Those workmen who are disposed to pulmonary consumption suffer readily from that disease, and in others, of better constitution, less serious, but still serious derangements are manifested, the most common of which are a persistent dyspepsia and that pale and bloodless condition to which the technical term *anæmia* is applied by the physician. Another common symptom is a rapid and irregular action of the heart. Palpitation of the heart, and intermittent action, in which the organ hesitates in its beat, are marked phenomena. I think I may indeed say that in these workmen the action of the heart is never at its full power, never perfectly regular so long as they are following their employment. In cases where the chronic effects are most intense, the muscles of the body share in the feebleness and disturbance. The hands become tremulous, the lower limbs unsteady. In two examples I have seen the breathing muscles influenced, and a peculiar spasm of an extremely painful kind produced through the chest, followed by a faintness, as if the sufferer were about to die. Lastly, the organs of the senses become impaired from these occupations, and there is deafness and imperfect vision, so that light becomes extremely painful to the eye. It is unfortunate, that this occupation leads often to abuse in the habits of smoking and chewing tobacco. When this occurs, the evil consequences are greatly increased. I believe few workmen escape altogether the dangers I have named. Not many are able to carry on their business beyond the fortieth year.

A long list of diseased conditions are added to industrial pathology under this head. They include:—

Giddiness, Nausea or Vomiting, and Faintness; Dyspepsia and Anæmia; Irregular Action of the Heart, Palpitation, Intermitency, and Feebleness; Muscular Unsteadiness and Chest Spasm; Derangements of the Organs of Sense; Impairment of the Senses, of Sight, and of Hearing.

Effects of Obstructing and Irritating Dusts.

The inhalation of carbon in the form of fine powder is a common evil attached to industrial labour. The coal miners, the carriers of coals, they who are exposed to dense smoke, and they who are exposed to some other occupations, such as walking-stick making, suffer from this irritant. In the miner, the lung may become actually charged with the dust, so as to present, in very extreme examples, the appearance of a carbonised lung, but the carbon, as a rule, is to be considered as less destructive than steel dust, powdered glass, or stone.

The effects of carbon dust are characteristically seen in those who are engaged in charring and shading walking-sticks. The stick having been charred over a coke fire, the shading is conducted by removing the charred part by means of a fine rasp and sand paper. An atmosphere of fine particles of dried carbon is produced, and the irritative action of it on the lungs is extreme. In the first stages, the cough is attended with acute suffering, but in time the cough loosens, and if the workman can be relieved of the irritant with the secretion, the acute symptoms give way to a chronic cough. One of these workers, who was greatly reduced by the disease, excited in this manner, told me very simply and clearly the facts in a sentence which I repeat. "It is all right," he said, referring to the charcoal dust, "it is all right, when we can cough it up. If a man get that way he can stand his work for many years; but eventually the cough always masters us, and we break down."

I must reserve details of the major evils arising from the inhalation of carbon, such as the diseases developed in coal-miners, in order to continue the general survey on which we are at this moment engaged.

In some occupations where the burnishing of metallic substances is carried on, much irritation and some obstruction is produced in the bronchial tubes, by inhalation of the dust derived from the soft impalpable powder with which the polishing is carried out. The powder of rouge is commonly used for this purpose. The powder is placed on a circular brush, which is made to turn in a lathe, and as the brush rapidly revolves an atmosphere of dust is thrown in the face of the worker. The inhalation causes a slight bronchial irritation, and the expectoration of a phlegm which is often tinged of a rouge colour; but the difficulty I hear most complained of by the workmen is a peculiar oppressiveness and obstruction of breathing which, when it is once experienced, lasts for a long time, and is the cause of an all but persistent chronic cough.

Flour dust is another of the obstructive as well as irritative dusts, and men who work in flour-mills afford, I think, the most striking illustrations of obstruction of breathing from the inhalation of minute particles of solid matter. The particles of flour produce, comparatively, but little irritation, but they are carried readily into the bronchial tracts, through the minute ramifications of the bronchial surface, and render the breathing irregular through parts of the lung. Thus an irregular pressure of the inspired air is brought about, an undue pressure is exercised upon some portion of the lung structure, there is rupture or break of the minute vesicular structure, and therewith the development of that disease of the lung which is technically called *emphysema*. The symptoms attendant on this condition are those of suffocative breathing and spasmodic cough. They constitute the disease commonly called "miller's asthma."

To the diseases incident to industrial labour, *emphysema*, and the suffocative cough which attends it, may therefore be added.

JUVENILE LECTURES.

The second of the course of two Juvenile Lectures was given on Tuesday last, January 11, by Dr. W. B. Carpenter, C.B., F.R.S. The subject of the course was, "The Wonders of the Microscope."

In this lecture Dr. Carpenter dwelt entirely upon the forms of insect life shown by the microscope. He began by giving a short account of the general characteristics of insects, and of the orders into which they are divided for purposes of classification, explaining the chief differences on which the division was founded. This portion of the lecture was illustrated by the diagrams and by prepared specimens of the insects themselves, shown under a low power of the microscope. Next followed a description of the various organs of insects, their uses and adaptations, with an account of the metamorphoses they undergo, and the different way in which the metamorphosis takes place in different species. Specimens illustrating what was described were shown on the screen. Dr. Carpenter concluded by a reference to the valuable results which had followed the introduction of the "Society of Arts Microscope." This, the first cheap microscope, had caused a revolution in the science by its influence in popularising and extending it. All over the country there were Microscopical Societies, doing valuable work, and it could with truth be said that nearly all of these owed their origin to the movement first started by the Society.

At the conclusion of the lecture, a vote of thanks was passed, on the proposal of Major-General F. Eardley-Wilmot, R.A., F.R.S., to Dr. Carpenter for his most interesting and instructive lectures.

MISCELLANEOUS.

PHYSICAL TRAINING AND NATIONAL EDUCATION.

The recent burning of the training ships in the Thames has given occasion for the following letter by Mr. Edwin Chadwick, C.B., to the *Standard*, on the importance of including in the scheme of national education provision for physical culture:—

"The primary moral qualities," Mr. Chadwick says, "specially required for our population are those denoted by the term discipline—prompt and complete attention, patience, and self-restraint, order, punctuality, and exact obedience to command, 'duty' in action. Dean Stanley, in a recent eloquent sermon to children, having held up the example of the display of these qualities by the boys on board the *Goliath*, is reported to have said, 'This is what the school and education can do.' Now, on an examination of the outcome of different long-time schools, which might be understood as coming within the description, there are few primary schools as now organised, and little of the primary education as now given in them, which can do the like of that which was done in the *Goliath*. I, for one, can speak from an examination of the different outcomes of different modes of school teaching of the very class of children on board the *Goliath*—the waifs and strays of the streets of the metropolis, namely, in common schools under parish vestries—that although they have been carried through the 'three R's' passably well, yet as runaway parish apprentices, or as juvenile delinquents, they furnished a large contingent to the population of the prisons. Fully 60 per cent. of them went in one way or another to the bad, whilst it has been proved, on a recent examination of the outcome of the *Goliath* and other similar half-time schools, that all except an inconsiderable percentage (and these mostly from defects in the earlier stages and their late coming into the schools) go to the good and are doing well. It is proverbial that book precepts and word instructions for the inculcation of the qualities required, have for the most part a very

transient effect. Discipline can only be securely impressed by act and deed, by visible and manual exercises until they are made habitual.

"Some time ago I related to a meeting of clergy and head school teachers the vindication of a drill-sergeant of the superior efficiency of his services as against theirs. 'They tell their pupils to be obedient, and what they tell them passes in at one ear and out at the other. But I see that they are obedient.' The justice of the drill-master's boast was acknowledged. I consider it, however, the best that drill should be imparted to the trained school teacher, that he may cause it to be exercised in all the daily operations of the schools. The good boys whom Dean Stanley probably addressed, untrained boys of the common long-time schools, on the occurrence of such a frightful event as that on board the *Goliath*, would probably have to recall their confused recollection of what they ought to do, and would commonly be subject to wild disastrous panic. As corroborative of the example of the *Goliath*, I may state an incident mentioned to me, that a short time ago a fire broke out in one wing of the Central District Half-time Pauper School at Hanwell. Mr. Hilliard, the manager, went to arouse the boys in the nearest dormitory. Upon opening the door he found them all up and dressed. The little tot of an officer, a boy of about 12, in charge there, had seen the light, and hearing a stir he at once judged that there would be something to be done, and had ordered them all to fall in, and there they were in rank and file, all silent and ready, himself at their head, waiting for orders. The fire happened to be immediately extinguished, and there was no further manifestation required of their discipline.

"It has been declared that the boys of the *Goliath* behaved 'like men.' Yes, but it is men who have had a good training in the most impressionable period of infancy. The men of the *Vanguard*, it has been noted, did not, as their first thought, go to the pumps to try and save their ship, but crowded to the boats to save themselves. The boys of the *Goliath* went at once to the pumps, to the hose, and faced the fire with their blankets, and but that the extraordinary character of the fire (almost an explosion) prevented a fair fight, they would, as their commander believes, have done really good and effective battle with it.

"After prolonged representation from our Council of the Society of Arts and elsewhere, an allowance for drill-masters was obtained from the Education Department. But the school managers are left to do as they please in the matter, and without such instructions and arrangements for the application of the principle as a competent acquaintance with the subject would suggest. The military members of our Council agree that a specially organised inspection is needed for the efficient application of the public expenditure; to brigade the schools of a town and bring them in order for competitive display. Good drills are considered to be at present exceptional."

Mr. Chadwick then proceeds to cite authorities in support of his views, some of which have already been referred to in the *Journal*. The reports of the Rev. B. J. Binnes, Mr. Matthew Arnold, and the Rev. Mr. Clutterbuck, and a letter from the Rev. W. N. Molesworth, are thus quoted to show the low quality of the results obtained; and also the last report of the department, showing that to these long-time common schools only about one child in thirty is got up to the sixth standard, "to read with fluency, ease, and expression, and to write a short letter or an easy paraphrase." Mr. Chadwick then goes on to discuss the comparative results of the half-time and whole-time systems, and specially their results as regards physical training:—

"What," he asks, "is the extent of attendance held to be necessary, and for which compulsory powers are held to be needed? Five and six hours daily for seven years up to the thirteenth or fourteenth year. In the great majority of the schools, as organised, proficiency in the standings of reading, writing, and arithmetic cannot be attained in less than seven years. But the wage classes must have the services of their children between their tenth and eleventh year, or two or three years before the expiration of the required long school time, involving a sacrifice of two or three years' wages of the children, now generally amounting from three to four shillings a-week. Against this exaction the people in the agricultural districts have rebelled, and in consequence the agricultural standards have been lowered, and it is made a matter of reproach that their children are taken away half taught. Supposing, however, the requirements of the system complied with, and the attention daily to five or six hours' desk work up to the thirteenth year, be compelled, it will certainly be injurious to them in deteriorating them bodily, and unfitting them for manual labour, as I ascertained on examination of runaway apprentices in the Bridewell, who had been through the long school time course and who ran away because labour was severely painful to them. The long-timed attention, moreover, practically excludes most farmers' sons and the sons of the lower middle class from secondary education, and, as is complained at the Society of Arts, from arts and science education, as they cannot afford to allow their children to remain at school beyond those years.

"The Chambers of Agriculture have petitioned Parliament for the return to the principles of the Poor-law of 1833. One of those principles, which has generally fallen through, was the dealing with the children, not in small groups and in the same houses with adult paupers, but in separate houses, with divisions of labour in special teaching and training, even to the separate teaching and training of the blind. There has been a return to this principle in the metropolis in the schools of district unions, of which the *Goliath* is one, and also in the separate schools of large parishes. They are all half-time schools, in which the pupils are under tuition, instead of six hours every day, four hours on alternate days, or some more correctly, not more than three hours each day. Mr. John Buckle, the recorder of Worcester, offered, through the Society of Arts, a prize of one hundred guineas to the teacher of that school on this principle in which the best results were effected at the least cost and in the least time. Eight of the half-time schools, of which the *Goliath* was one, competed for the prize. Circumstances prevented the award being made on the first competition, but the mean time in these schools was four years in getting through the same stages as in the majority of the State-aided schools require seven. But the children in these are as a class of the lowest type bodily, and to a great extent mentally, slow and difficult to be got on. In day schools of the like organisation, with the ordinary type of stronger children, the time of teaching is reduced to little more than three years.

"To explain this apparent anomaly, it may be stated that the majority of the State-aided schools are small schools with the assistance of a public teacher. This school will usually have six classes, and he can only give direct instruction to one class at a time, whilst all the rest are obliged to wait. Now, it is this waiting, the enforced quiet, against which the child's nature rebels, that occasions perpetual conflicts. On the part of the master it is a condition of irritation, and on that of the children a condition of mischievousness and disobedience. In the large school there is a hierarchy of teaching power. There is a teacher to every class, and all are kept going. No time is lost in mischievous stagnation; from the moment the pupil enters the school to the time he leaves it he is kept to brisk and yet not exhausting work. This is a fundamental condition of the superior *morale* to which this principle of simultaneous class teaching on the half-time principle conduces.

"The contract is not less in direct money expense than in the time of obtaining results by the different principles

of administration. The expense of the single mastered school is not less than £2 per head per annum for trained teaching power. The expense of the district schools will be only £1 per head for trained teaching per annum, though the head master may have a salary of £200 per annum, a second master £150, a third £100, and a staff of pupil teachers, a total cost of £500 per annum. But it is £1 per head for about three years, or, as in the case of these district schools, it is less than £1 per head for four years, as against £2 per head for seven years. The cost of teaching on board the *Goliath*, including four masters, or instructors, and pupil teachers, was a total of £4 per head, that is to say, £4 per head for superior mental and physical accomplishments and a superior *morale*, as against £14, or at the least £10, per head for a teaching detrimental to bodily capabilities, and to a considerable extent demoralising.

"The Government contribution, which was, in 1873, 11s. 9d. per head, would on the one system have been £2 7s., on the other £4 2s., or as much as the entire cost on the original principle of administration properly executed. Some of the inspectors cannot make out how it is that the teaching is so slow, and that the teachers seem not to care how long they keep their pupils in the several stages. One inspector expresses a wish that some system could be devised of giving the teachers an interest in getting the children on quicker; the great problem of public administration is to make interest coincident with duty, and I have been one of the foremost to recommend payment for results.

"But here the principle has been so applied as to pay for results in slowness chiefly, for the longer the children can be kept in school the more money is got, at least from the Government.

"School teachers of high honour, and the foremost in their profession, have expressed to me their deep concern at the demoralisation which they know to be produced by the existing system."

After a few remarks on the military bearing of the question, and the effect of early drill in producing a better class of army recruits, and upon the sanitary provisions of training ships, Mr. Chadwick concludes:—

"With such a clear testimony from the government school inspectors, with the general evidence, so conclusive from the department itself, as to the failure of the measure which it has long devised and administered, a frank avowal might be expected from it to the effect, 'We have done the best we can in the matter, and with such manifest ill success that we are not prepared to advise a double expenditure, or to have between one and two millions more of children brought to compulsion under the like defective conditions; and we are ready to give up our charge to any other executive organisation that Parliament may in its wisdom devise for the attainment of the object.' It is to be hoped that at all events some member of our Society of Arts who is in Parliament will be enabled, in the interest of arts, manufactures, and commerce, to draw attention to the conditions of extensive misfeasance and malfeasance under which the public grants for elementary education are now expended. There will be no difficulty in showing at once, as respects the orphan and destitute children, from which a largo contingent of public force, such as those displayed on board the *Goliath*, may be derived, that seven-eighths of them are kept with adult paupers in union houses, in contravention of proved administrative principles originally laid down, and are sacrificed to wasteful ignorance such as that encountered by the Rev. Mr. Clutterbuck; whilst, as shown in the last returns, 12 out of 13 of all the State-aided schools are destitute of the provision requisite to insure the strength of body and mind needed to maintain properly the productive force of tho country."

An art building has been erected at Melbourne, Australia. The walls of the galleries have a superficial area of 26,000 square feet. The cost of the structure was about £8,000.

AMERICAN OYSTERS.

Considering the popularity of the oyster as an article of luxury, and the fact that of late years good English varieties have become very scarce, and consequently very dear, it is somewhat strange that the public has not paid more attention to those which for some time past have been imported from America. It is now, about six or seven years ago that an enterprising dealer in Billingsgate obtained a large consignment of these oysters, but for some reason or other, the experiment was not persevered in. In 1872, Messrs. Miller and Co., of Liverpool, revived the attempt to introduce American oysters to the English public, and some success attended their efforts; but, in consequence, probably, of several other dealers putting bad specimens into consumption, the prejudice, which always existed against them, increased. The Conway Company, however, persevered in the matter, and relaid large quantities of American oysters in the Conway River, from which it takes its name, but it being found that the land water from time to time caused the beds to be sanded over, the company transferred their operations to Cleesthorpes, at the mouth of the Humber, whence the dealers now obtain their supplies, though a large quantity of oysters are consumed without their being relaid at all. A further attempt to popularise American oysters in this country has more recently been made by the "Wheelbrand" Company, of Liverpool, some samples of whose oysters were recently submitted to some members of the Food Committee of this Society.

The "Wheelbrand" Company import the oysters in bulk for the wholesale trade, and also in kegs of 100 or boxes of 50, for private customers, which are delivered just as they are packed in America. The oysters will keep alive for about a month after being dredged, so that after their voyage of about ten days across the Atlantic there is a fortnight or more left to dispose of them. By the way, it would be interesting to know how the Romans in olden times transported British oysters, of which they were very fond, to Rome. Whether the American oysters show much improvement after relaying in English waters may be a question, an eminent pisciculturist being of opinion that though the shells grow, the fish inside do not, at least to any appreciable extent. He also maintains, what, if true, is a curious fact in natural history, namely, that American oysters will not breed in our waters. Nor, indeed, is there any apparent necessity for relaying them, for being hardy oysters, they suffer but little by being out of water for a month. The varieties of oysters imported some years ago by Messrs. Miller, included the "Morris Cove" from New Jersey, the "Norwalks" from Connecticut, the "Saddle Rocks," a particularly fat oyster, the "Blue Points," a small oyster, and others from the coasts of Virginia and Maryland, and these probably form the main bulk of tho American importation at the present time. But after all it does not matter much what kinds are imported, for American oysters do not differ in quality and price like our own, and therefore it appears hardly worth while for the importers to give the names of English, Scotch, and Irish varieties to their importations. As to the character and flavour of the American oysters, it may suffice to say, that they are full of meat, which is very tender, the cartilage and beard being particularly soft, thus showing a strong contrast to many of our home varieties, while the flavour in very distinctive. The distinguishing taste of our own oysters may be described as "coppery," but that of the American has a decided flavour suggestive of the English mussel. This may not seem a commendation; but, after all, the old adage, *de gustibus*, &c., must be borne in mind. Americans prefer the flavour of their own best "natives," and, perhaps, after becoming accustomed to it, the English public may learn to appreciate the peculiar flavour of the American bivalves, which, by the way,

is not so pronounced if the oysters are eaten in any cooked form. The price of the American oysters averages, retail, about one penny each, and this price compares very favourably with that of our common varieties. In order that any readers, who may feel disposed to experimentalise on American oysters at an oyster bar, may be sure that they are getting what they ask for, it may be mentioned that there is a black mark about the size of a sixpence on both shells where the cartilage adheres to them. This is a "trade mark," as it may be called, whereby all American oysters may be infallibly known.

It is to be hoped that the attempt to familiarise the oyster-eating public with the American rearing will be persevered in; and, in the meanwhile, there seems much need of improvement being made in the modes of transport, in their treatment on arrival here, and relaying in English waters. The oyster is so excellent a luxury, and so digestible and nutritious as an article of food, that it is well worth considerable trouble being expended on it with a view to increase the supply. A large and regular importation from America would enable us to spare, in a measure, our own home resources and give our own beds further opportunities of recuperating themselves.

It may be as well to mention that the Conway Company's oysters can be obtained from Messrs. Sleaman and Co., Thames-street, and those of the "Wheelbrand" Company, at 160A, Fleet-street.

THE CHANNEL TUNNEL AND RAILWAY.

Amongst the ordinary commercial reports published by the Foreign-office, there is one containing the correspondence between the representatives of the Governments of France and England with respect to the proposal for the construction of a submarine tunnel and railway. The documents and letters that passed between the heads of the different public offices consulted upon this matter, furnish an account of the progress made up to the present time in this long projected enterprise. At the latter part of the year 1874, the Count de Jarnac, when addressing Lord Derby, notifies the pressure which had then but recently been put upon his Government by Lord Robert Grosvenor and Mons. Michel Chevalier for the purpose of obtaining a concession for the making of the submarine railway beneath the bed of the Channel; and the Count expresses, likewise, the readiness of the French Government to favour any undertaking that has for its object the improvement of existing communication between the two countries. The project, which had received the sanction of the Anglo-French Commission, had been submitted to a committee of inquiry formed in the department of the Pas de Calais, and by them placed before the Conseil-General des Ponts et Chaussées. The latter body, after mature deliberation, arrived at conclusions sufficiently favourable to admit of the projectors executing certain preparatory works for the sake of demonstrating the practicability of their plans.

In the report presented to the Minister of Public Works in France, we are informed that in 1868, for the first time, serious attention had been drawn to this proposal for uniting the French and English railways. The close of the Exposition of 1867 presented a favourable moment for the inauguration of any scheme that promised to cement the union of different nations. The success of the Suez Canal was at that time assured; the construction of the Mont Cenis tunnel likewise approached its completion, and engineers were already preparing to open through the St. Gothard a new route between the north of Europe and the basin of the Mediterranean Sea. It seemed only natural that the Pas de Calais should in its turn appeal to the powers of modern scientific industry to aid in removing the barrier that separates England from the Continent. The events of the Franco-German war retarded the operations, until in 1872, when the matter was taken up with renewed vigour, and it was upon the report of Sir John Hawkshaw that the inquiry was held under the direction of the Minister of Public Works. This Commission having concluded its sittings on Decembe 14th, 1873, pronounced in favour of the plans submitted to them, expressing at the same time their wish that measures might be taken to improve the harbours of Boulogne and Calais.

The projected tunnel works were essentially of a character that demanded the attention of the Governments of France and England, and to their representatives was entrusted the task of settling many questions, political and military, that could only be arranged by diplomacy. The Secretary of Foreign Affairs, on behalf of the British Cabinet, had declared that in principle he saw no reason for offering any opposition to the construction of the tunnel, but it was further thought desirable by the projectors that the committee of directors should be formed into two groups, one acting on the part of France, and the other of England, and both united in the furtherance of one common project. The period of time required for the concession and the tariff of prices being determined, the difficulty of certain strategical questions were not overlooked: for it is evident that this tunnel when constructed would have an importance far beyond all similar works, and in case of war its possession would be warmly contested by the belligerents. In addition to the plans for fortifications at the mouths of the tunnel, which were considered necessary, particular attention was given to the soundings in the bed of the Channel. The ultimate success of the undertaking depended upon the continuity of the layer of chalk, and after this had been tested, the Commission, subject to certain reservations, did not hesitate to report favourably upon the project. The Conseil-General des Ponts et Chaussées were thereupon required to give their opinion in the first place, as to whether the circumstances of the cases were sufficient to warrant an official declaration in favour of the public utility of the scheme; and secondly whether it would be expedient to grant the applicants an eventual concession under certain specified conditions.

In a communication between Lord Tenterden and Mr. Farrer, the Secretary of the Board of Trade, dated November 7th, 1874, we find that both the Conseil-General and the Commission were unanimous in opinion that any declaration of public utility should for the present, at any rate, be deferred; and they were equally of opinion that facility should be afforded to the company to carry out certain preliminary works, which, if pronounced sufficient to establish the practicability of the scheme, should entitle them to an eventual concession. The attention of the Board of Trade was called to the proposal for making the concession for ninety-nine years, to date from the time when the submarine railway should be opened for traffic; and further, that no concession should, for a period of thirty years from that time, be granted for the construction of any other submarine railway between the shores of England and France, it being the opinion of the Commission, as well as the Conseil-General, that the amount of protection which it was thus proposed to extend to the company in their projected undertaking against the competition of other parties was only such as might properly be accorded, whilst still keeping in view the principle of discountenancing any scheme which should assume the character of a permanent monopoly. From a subsequent communication made by Earl Derby to Lord Lyons, we learn that from information given by the authorities at the Board of Trade, the notice of a Bill had appeared before Parliament to enable the promoters of the tunnel scheme to acquire lands at St. Margaret's Bay. The time had therefore arrived when it was desirable that Her Britannic Majesty's Government should determine whether they ought to encourage the undertaking, and if so, upon what conditions. Of the utility of the work in question, if successfully carried out, there was, in the opinion of Lord Derby, no room for any doubt, and no opposition would

therefore be offered, provided the Government were not asked for any gift, loan, or guarantee. As to the physical probability of the undertaking being completed, or as to its probable financial success, the Government would not offer an opinion; on this latter point it was for the promoters to weigh well the consideration of the large sum that will be required for this work, and of the competition by sea, as regards the carriage of merchandise, if not of passengers, which must always be expected to exist.

At this stage of the proceedings it appeared that a *projet de loi*, or draft Bill, was laid before the National Assembly by the French Government, and upon the 5th February, 1875, a Commission of fifteen members, all believed to be favourable to the tunnel scheme, was formed to sanction the execution of the project. For the purpose, therefore, of arriving at an understanding with the French Government upon the relative position of the two countries with reference both to the inception and the conduct of the enterprise, a proposal was made by the Board of Treasury and communicated to the Duc Decazes, having for its object the establishment of a small joint committee composed of the representatives of both nations. The necessity for such was apparent, since many points of difficulty might arise, not only between one or the other Government and the promoters of the undertaking, but also between the two Governments themselves, if no agreement were entered into and no means of solving questions were provided beforehand. This proposal was most cordially received by the French Government, who urged that it should be adopted immediately, so that no delay should arise either in the formation of the committee or in the conduct of either of the Bills before the separate legislatures. Three gentlemen, MM. Kleitz, Gavard, and de Lapparent, were named to represent the interests of France, and on behalf of England, Messrs. Wade, Kennedy, and Capt. Tyler, were named, and the place of meeting was fixed in London; whilst a short despatch from Lord Lyons, dated August 6th, 1875, announced the proclamation, by the President of the Republic, of the law sanctioning the submarine railway between France and England.

PHORMIUM TENAX, OR NEW ZEALAND FLAX.

Amongst the smaller plants of New Zealand, the *Phormium tenax*, or New Zealand flax, is of especial value. In the preparation of this fibre the province of Marlborough has been from the first introduction of the industry, one of the principal exporting districts. At the present time there are about eight mills with from two to six machines in each. Many men are also employed in cutting and carting the raw material to the mills, for which they are usually paid by the load. The operations of stripping, washing, and bleaching are carried on by men and boys, who receive wages varying from 10s. to 15s. a week for boys, and from 20s. to 25s. a week for men, board and lodging being also found. The scutching of the fibre and packing it into bales for export is generally undertaken by contract, the ordinary price given being at the rate of 30s. per ton. Whenever practicable, water power is employed to drive the machinery necessary for the extraction and preparation of the fibre, and this has, of course, a considerable advantage over steam power, in the saving of the fuel and labour required for the latter. The state of the flax trade at present cannot be considered as satisfactory, owing to circumstances affecting the English market, but there can be no doubt that a little time will remove the difficulties retarding its development, and that it will ultimately prove one of the largest and most remunerative articles of export. In abundance and quality of the raw material, and facilities for producing the manufactured product at a paying price, no other province is believed to possess so many advantages.

In the province of Canterbury, the lower hills, and more especially the peninsula, are rapidly being covered with English grass and clover, which spread of their own accord, killing the native pasture, and are, in consequence, every year able to carry larger numbers of stock. In the wetter and richer lands, large quantities of *Phormium tenax* grow, and these require to be destroyed before the land can be ploughed; but the soil underneath is usually so productive as to well repay this cost, and moreover, the plant itself may, in many localities, be made a source of profit by sending it to a flax-mill. The difficulty of obtaining a supply of skilled labour has hitherto prevented the establishment of many industries, and various proposals have been made with a view of promoting them. The preparation of the *Phormium* fibre has been hindered by the high wages, and many of the mills which were in operation have been closed for this cause. Still, if a sufficient number of labourers were introduced, this industry, for which a practically unlimited supply of raw material is available, is capable of being largely extended and profitably worked, especially as it does not require highly skilled artisans. Ordinary labourers are quite equal to the general work of a flax-mill, as at present arranged. The province of Taranaki, from the sea for several miles inland, is, as a rule, beautifully level, smoothly clothed with grass or clover. The land adjacent to the coast is generally open and covered with fern, *Phormium tenax*, or clover, for a distance varying from one to fifteen miles inland, while the interior is densely wooded. Among the industries that would require capital to develope, would be the establishment of a factory for fibre spinning and conversion of the material into sackcloth and bagging. A rope-walk would be found a profitable speculation where there is such an immense quantity of the *Phormium*, and very little capital would be needed for either of these undertakings.

The manufacture of rope from prepared *Phormium* is now an industry of some importance in Auckland, but might be more extensive. In consequence, it is said, of the opposition of the English ropemakers to the use of *Phormium*, or at least to paying for it a price proportionate to that given for Manilla hemp, it has been found more profitable to manufacture the ropes in Auckland than to export the fibre in bales. The cordage thus manufactured has been tested on her Majesty's war vessels visiting the port, and has been highly commended; and similar commendations from the officers of an American and Italian war vessel, which visited the port, have been published. It has also been put to the most trying tests in ordinary wear, and has come out satisfactorily. During a severe gale it was found that the rope, when subjected to the same strain as Manilla, remained unbroken, while the other gave way. This industry is worthy the attention of practical ropemakers contemplating emigration, the cheapness and plentifulness of the material being of the utmost importance while the market in this and the neighbouring colonies is almost unlimited. During 1872 cordage to the amount of 1,057 cwt., and in value £2,406, was exported from Auckland. There was, of course, a large quantity used within the province or sent to other parts of the colony. The flax is found in all parts of the province of Westland, the moist climate being favourable to its growth; yet nothing has been done to utilise it. On the banks of the rivers, and in the swamps, flax grows luxuriantly. Samples of the only kind dressed by the Maories, have the appearance of delicate glossed satin. Another kind, the *tai*, is remarkable for its length of fibre and great strength. The making of flax into rope and all kinds of cordage could be carried on advantageously, as the supply of flax is inexhaustible. If properly cultivated, by stripping only the outer leaves of the plant twice a year, each acre of land would yield more than two tons of marketable flax.

It is probable that the tow and refuse fibre from the *Phormium* plant will be available for the manufacture of

paper, an article for which a large market is open in the colony. This industry, it is hoped, will also before long be established there.

OBITUARY.

S. T. Davenport.—The Society has just sustained a very heavy loss. How great that loss is can only be fully appreciated as time goes on, and those on whom the duty falls of supplying, as best they may, the place so long filled by Samuel Thomas Davenport, miss the active and ready help, the suggestive and sensible advice that was never wanting on behalf of the Society he served so ably and loved so well. For the bond between him and the Society of Arts was no common one. When, just over thirty-two years ago, ho first entered its service, its fortunes were at their lowest ebb. That since that time the Society has steadily increased in prosperity and usefulness, is in no small degree due to the energy and ability of him whom it has just lost. As he devoted to it his entire life, so he at last came to love and cherish the Society as if it were a part of that life. His single-minded devotion to its interests was such as few men give to any but personal concerns. His thoughts were always for its prosperity. He was for ever planning out and suggesting fresh schemes for its advantage. In every case his first thought was for the Institution, his second only for himself. All this is indeed well known to those who, on the Council of the Society, or as members of its permanent staff, were brought into intimate personal relations with Mr. Davenport, but it is probable that the great bulk of the members hardly knew how many of the advantages provided for them by the Society were due either to his suggestion or to his executive energy. The keen interest he took in any subject which came before the Society, or was included in its scheme of operations, led to the acquisition of a very extensive and varied store of information. Aided by a naturally retentive memory, he succeeded in acquiring a knowledge of so many and such diverse subjects that there could be few matters—of the kind naturally falling within the scope of the Society—on which he was not competent to speak with more or less authority. In such a position as he occupied there could be few more useful characteristics than this universality of information, which was on certain subjects really extensive, and sufficient for practical use on very many. Thus in his official capacity to the Council, and individually to very many of the members and others who sought his advice, he was a trusted and valued counsellor. Not only in his own special department of finance, but on all matters which came under discussion, was his opinion sought with care and received with respect, either at the meetings of the Council, or privately by its individual members. But it was not only in regard to the affairs of the Society of Arts that the extent of Mr. Davenport's varied knowledge was useful. Many are the inventors who have been saved expense and labour by his acquaintance with the history of invention, and his consequent ability of pointing out instances in which some apparently new discovery had really been long since anticipated. Many also are there who have been enabled to perfect their ideas by the pertinent suggestions which that same knowledge enabled him to give. It was tbis peculiar fitness for the post he held, joined to a minute knowledge of the history of the Society, that makes the void caused by Mr. Davenport's death so difficult to fill. It is indeed true that much of his work will not perish with him. It was of too sound a character for that. It will endure and strengthen with years—will indeed produce tho most fitting tribute to his memory in the continued prosperity of the institution in whose service he died. To attempt any account of the career of our lost friend would be to give a history of the progress of the Society during tho time of his connection with it. It must be sought in the whole series of the Society's records, not in the narrow space of such a notice as the present, the last poor tribute of respect and affection from the fellow labourers who now deplore his loss. In no idle spirit of panegyric is this attempt made to estimate the value of his services, nor is it merely a natural feeling of affection for a colleague so suddenly snatched away, that speaks in words of praise, which, even if it were excessive, would be at least excusable. What is here set down is but the sincere conviction of those who know best the value of the friend they have lost, and who esteem his memory too highly to attempt to claim for him any credit that is not his just due. Of none is it to be truly said that his place can never be filled; the loss of no man can be absolutely irreparable, but at least we may acknowledge that that is no wasted life whose end makes, in its own sphere of action, so large a void as that caused by the death of Samuel Davenport.

It only remains to add a few words of personal history. Mr. Davenport was the son of Mr. S. Davenport, who had attained some reputation as an engraver. He entered the service of the Society in 1843, while Mr. Whishaw was secretary. As he was then little more than a boy, it was in quite a subordinate capacity that he first came. nor did he intênd his situation to be a permanent one. He merely hoped that a temporary connection with the Society of Arts might be useful to him in his business as an engraver. However, fate willed it otherwise, and he went on gradually taking more and more of the work of the Society upon himself, till he attained the responsible position he held at his death. He thus served under Mr. Whishaw, Mr. Scott Russell, Mr. George Grove, and Mr. Le Neve Foster. His death was very sudden, for although he had been for some time at intervals subject to attacks of the disease which ended fatally, his last illness only extended over four days. He died on Friday, the 7th inst., having been at his post on the previous Monday, to all appearances in his usual health. He was 54 years old at the time of his death.

GENERAL NOTES.

New Textile Substance.—M. Isidore Pierre, on submitting to the action of retting some stalks of a malvaceous plant of the genus *Lavatera*, obtained therefrom some fibres, very long and tough, and which appeared to him suitable for manufacturing purposes. They are at present too thick for spinning or weaving, but might be improved by a better cultivation of the plant, and even now they serve perfectly well for making paper.

Oil versus Gas.—A novel and unexpected danger, says the *Engineer*, threatens the prosperity of the gas companies of the United States. Mineral oil is so plentiful that at present it is almost a drug in the market, while coal gas is comparatively dear. We learn from our American advices that, as a consequence, there has been a revolution in the manner of lighting shops in Brooklyn. Kerosene is now used in most of the stores and business places instead of gas in many parts of the city. The gas companies are becoming alarmed, and it is more than probable that the change will cause a heavy reduction in the price of gas. As an instance of the difference in the cost of using gas and oil, the case of the American District Telegraph Company is cited. The bill for gas for September was 30 dols , now the office is lighted by kerosene oil, the number and quality of the lights are, it is said, greatly increased, and the total cost for the last month was only 2·85 dols. It is well known that a very large proportion of fires occur in the States from the use of mineral oils, but we have not heard that any increase has been made as yet to the strength of the Brooklyn Fire Brigade.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

ORDINARY MEETINGS.

The following arrangements for the Wednesday evening meetings have been made :—

JANUARY 19.—Adjourned discussion on the Paper on "Proposed Heads of Legislation for the regulation of Sewage Grounds," by ALFRED SMEE, F.R.S., F.L.S., F.C.S. On this evening Dr. LETHEBY will preside.

JANUARY 26.—"Iceland, its Scenery and its Rocks," by W. L. WATTS, Esq. Illustrated by numerous Photographic Transparencies.

FEBRUARY 2.—"Condensed Beer," by Dr. BARTLETT.

FEBRUARY 9.—"The Cultivation of Hardy Fruits, with a view to improvement of quality and ensuring constant and abundant production," by SHIRLEY HIBBERD, Esq.

FEBRUARY 16.—"The Combustion of Gas, and its application to Heating Purposes," by JOHN WALLACE, Esq.

FEBRUARY 23.—"Contagious Diseases of Animals as affecting the Health and Wealth of the Country," by GEORGE FLEMING, Esq., Royal Engineers.

CANTOR LECTURES.

The second course of Cantor Lectures for the present Session, "On Iron and Steel Manufacture," by W. MATTIEU WILLIAMS, Esq., will be delivered on the following Monday evenings:—

LECTURE I.—JANUARY 17th.

Iron Ores and Crude Iron.

The more important ores of iron: their natural history and distribution.—The reduction of the natural oxides. —Charcoal iron.—Ancient iron making.—Dud Dudley and the introduction of pit-coal iron.—Problems involved in the reduction of complex of iron ores.—The difficulties of modern iron making.—The modern blast furnace: its construction and appliances.

LECTURE II.—JANUARY 24th.

Pig Iron, Refined Iron, and Puddled Bar.

The theory of the blast furnace.—The hot blast.—The utilisation of the waste gases of the blast furnace.—The advantages and disadvantages of the modern blast furnace.—The impurities of pig iron, and how they affect its quality and market value.—Grey, mottled, and white pigs.—Spongy iron and its properties.—Is the blast furnace likely to be superseded?—The refinery and its action on pig iron.—Cort's invention and subsequent improvements.—The construction of puddling furnaces and the operations of the puddler.

LECTURE III.—JANUARY 31th.

Finished Iron.

Puddler's "physic."—The theory of puddling.—Mechanical puddling.—The intelligence of the puddler. —Modern attempts to supersede puddling.—Reheating.—Squeezing.— Shingling. — Rolling.— Bar iron.— Rail making.—Angle-iron.—Iron wire, &c.—Piling.—Plate rolling.—Boiler plates.—Ship plates.—Armour plates.—Sheets.—Fibre of iron.—Hot and cold shortness.—Lamination and blistering.—Testing of wrought iron.—The tenacity, elasticity and toughness of iron.—Cast and wrought iron compared.—Malleable cast iron.

LECTURE IV.—FEBRUARY 7th.

Direct Steel and Semi Steel.

What is steel? The composition of different kinds of steel.—The difference between steel and cast iron, and the mischievous consequences of popular and learned fallacies concerning it.—Steel making directly from the ore, and the conditions demanded for its success.

LECTURE V.—FEBRUARY 14th.

Shear Steel and Cast Steel.

The indirect, or Sheffield method of steel making, and why it has been adopted.—Cementation.—Shear steel.—Cast, or pot steel.—The Bessemer process.—The Siemens-Martin process.—The Uchatius process.—Other processes recently proposed and adopted.—Different qualities of steel and their uses.

LECTURE VI.—FEBRUARY 21st.

Tool Steel and Tools.

The composition and properties of the best steel.—The welding of iron and steel.—The hardening and tempering of steel.—Case hardening.—The hardness, tenacity, and toughness of steel.—Steel rails and tyres. —Steel ships.—Steel bridges and the use of steel for structural purposes generally.—Theory of the constitution of steel.—Edge tools, the general principles of their construction and the quality and hardness of steel required for them.

MEETINGS FOR THE ENSUING WEEK.

MON. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Mattieu Williams, "Iron Ores and Crude Iron." (Lecture I.)
British Architects, 9, Conduit-street, W., 8 p.m.
Medical, 11, Chandos-street, W., 8 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Dr. Carpenter, "Human Automatism." (II.)

TUES....British Scandinavian (at the HOUSE OF THE SOCIETY OF ARTS), 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "The Classification of the Vertebrated Animals."
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. G. J. Morrison, "The Ventilation and Working of Railway Tunnels."
Statistical, Somerset House-terrace, W.C., 7¾ p.m. Mr. Robert Baxter, "The Currency Laws and the Rate of Interest."
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.
Royal Colonial, Pall-mall Restaurant, S.W. Lieut.-General J. Bisset, "South Africa and her Colonies."

WED. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Adjourned Discussion on Mr. Smee's Paper, "Sewage Grounds."
Meteorological, 25, Great George-street, S.W., 7 p.m. Annual Meeting.
Geological, Somerset-house, W., 8 p.m. 1. Professor P. M. Duncan, "Some Unicellular Algæ, Parasitic within Silurian and Tertiary Corals, with a Notice of their Presence in *Calceola sandalina*." 2. Prof. A. C. Ramsay, "How Anglesey became an Island." 3. Mr. William Ramsay, "The Influence of various Substances in Accelerating the Precipitation of Clay Dissolved in Water."
Archæological Association, 32, Sackville-street, W., 8 p.m.

THURS...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Rev. A. H. Sayce, "Comparative Mythology and Babylonian Myths."
Chemical, Burlington House, W., 8 p.m. 1. Mr. G. H. Beckett and Dr. Wright, "Narcotine Cotarnine and Hydrocotarnine." (Part IV.) 2. Mr M. M. Pattinson Muir, "A Method for Estimating Bismuth Volumetrically."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Professor Ansted, "The Influence of Climate and Scenery on the Development of Art in Ancient and Modern Times."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gladstone, "The Chemistry of the Non-metallic Elements."
Numismatic, 13, Gate-street, W.C., 7 p.m.

FRI.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Special Lectures. Dr. Benjamin W. Richardson, "Industrial Pathology." (Lecture IV.)
Royal Institution, Albemarle-street, W., 8 p.m. Weekly Meeting, 9 p.m. Prof. Tyndall, "The Optical Deportment of the Atmosphere in Relation to the Phenomena of Putrefaction."
Philological, University College, W.C., 8 p.m.

SAT.......Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. P. Pullan, "His Excavations in Asia Minor."
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,209. Vol. XXIV.

FRIDAY, JANUARY 21, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

COMPETITION FOR ADMISSION TO THE NATIONAL TRAINING SCHOOL FOR COOKERY.

The Society has established five Scholarships, entitling the holders to free instruction in this school. These will be competed for on Saturday, 12th February, at 10 a.m., at the School at South Kensington.

Qualified teachers are now urgently wanted for schools, and when they have obtained their diploma, they may earn from £1 to £2 weekly.

Candidates must not be under 18 or above 35 years of age. They must be sufficiently educated to perform the duties of an instructor in cookery after special training.

The examination questions are intended to test the candidates' knowledge of the first principles of cookery, and the reasons on which they are based; to prove their acquaintance with the essentials of good cookery; and to discover what the candidate can cook, and in what manner.

Every member of the Society of Arts is privileged to nominate one candidate, and members desirous of doing so are requested to fill up the form issued with this *Journal*, and to send it to the Secretary of the Society of Arts on or before February 5th.

FORM OF NOMINATION.

Society for the Encouragement of Arts, Manufactures, and Commerce,

John-street, Adelphi, London, W.C.

NATIONAL TRAINING SCHOOL FOR COOKERY.

I, the undersigned Member of the Society of Arts, hereby nominate

Name ....
Age ....
Address ....

As a Candidate to compete for a Scholarship.

Member's Signature ....
Address ....
Date ....

INDIAN COMMITTEE.

A meeting of this Committee was held on the 18th inst. Present:—Sir George Campbell, M.P. (in the chair), Dr. Boycott, Andrew Cassels, W. Maitland, J. T. Wood, with P. Le Neve Foster (Secretary) and Col. E. A. Hardy (Secretary to the Indian Section). The Committee agreed to re-assemble on Tuesday, the 25th inst.

CANTOR LECTURES.

The fifth Lecture of the first Course of Cantor Lectures for the present Session, "On the Discoveries and Philosophy of Liebig, with especial reference to their influence upon the advancement of Arts, Manufactures, and Commerce," by J. L. W. Thudichum, M.D., was delivered on Monday, December 20th, 1875, as follows:—

Lecture V.

Therapeutic agents as collateral discoveries, chloroform and chloral.—The way from detailed labours to general scientific principles and laws.—Liebig's philosophy as influencing mode of thinking of present generation.

Organic chemistry is the child of medicine, and however far it may go on its way, with its most important achievements it always returns to its parent. In ancient times medicine was the mother of philosophy. Thus Aristotle was a medical practitioner, a man whom now-a-days, and in this country, you would term an apothecary. He compounded and dispensed medicines and philosophy; he practised only, so to speak, as a collateral pursuit. During the whole of the Middle Ages all natural science found its refuges and starting points amongst medical men. Even after the rise of learning, about the time of what is ordinarily called the Reformation, physicians were the men who cultivated science, collected facts, compared them and worked out theories of science. Such a man was Stahl, the originator of what you know as the phlogistic chemistry; such a man no doubt Leibnitz would have been if whilst secretary to the Society of Alchemists at Nuremberg, he had not been discovered and appropriated for political purposes by that clever Archbishop of Mayence, the Count of Schönborn. Coming to later times we find that the greatest chemists, such as Boerhaave, were also physicians, or in our own days it has been observed that physicians left the subjects of their early studies and became chemists exclusively. Wöhler, for example, did not turn pure chemist until he had completed the study of medicine, and had at the University of Heidelberg taken a price for a physiological essay.

This short introduction will serve to give you a reason for the peculiar fact that the most important applications of chemistry have reference, not only to the improvement of man's estate by the enlargement of manufactures and the improvement of agriculture, but more particularly to the removal of those evils with which mankind is so terribly afflicted, and with which it has to keep up so constant a battle. We do, of course, admit that one of the principal objects of science in its application to the physical wants of human life is the engendering of healthy growth, the augmentation of muscular power, and the maintenance of that power for the longest possible time. Of necessity science will teach the proper mode of using the strength so obtained, for science I hold, with Socrates, is of necessity the highest morality, and the highest morality is, in its turn, the highest usefulness. Hence it follows that the higher the science the greater its usefulness. Or, putting it in another form, science is virtue; virtue is usefulness. Tried by the contraries, we find the proofs very easy. Vice is never useful, either to the individual who commits it, or to anybody else. Ignorance is never useful, notwithstanding the English adage, that it may be bliss.

I shall, by-and-bye, have to quote to you a passage from Liebig bearing on this point, but I will first draw your attention to the remarkable circumstance that science has attained its present position almost without conflict with the powers political or clerical. Neither has it to deplore in its progress any of those aberrations of the intellect which defile the history of theology and jurisprudence. It has neither burnt heretics nor destroyed witches. This arises from the fact that it does not possess zeal. It knows that the attractions of zeal are the snares of that unsuspecting being which complacently terms itself common sense. It recognises that mere goodwill is a clown, or a fool, who requires strong means before he can be made to see his iniquities. Now in this sense zealous and vindictive theologians and jurists have exterminated the intelligence of nations; if judged by their uselessness they had no virtue; if judged by their vices they had no science. No age is free from zealotism, that is, zeal transformed into a system, and sustained by long-continued effort. At the present time, for example, you have the little burlesque upon orthodox zealotism going on in the shape of societies for the suppression of vivisection, or even for the wider purpose of the suppression of experiments upon animals. This kind of zeal, which shows itself now-a-days in the shape of antagonism to physiological and medical inquiry, is only a covert attack upon science at large. You need only to look upon it in that way and you immediately have an explanation of it. Of course this movement will cease without anybody lifting a finger to put it down, because the propositions which are made in its course are so utterly contemptible and ridiculous, that nothing can save them. At the same time I mention the fact to show you that the intellect of man has to take the utmost care to protect itself from the tyranny of zealotism, even in times when liberty of thought and action is claimed to have reached its ideal climax.

It was Leibnitz who taught the world the wretchedness of its belief in witchcraft; and the same great philosopher laid, in his writings, the foundation of modern geology; and the great object of his life, which he propounded to himself, was the spreading of a reasonable mode of thinking amongst men. I think, if we were to form a resolution, each of us, to devote the time and efforts which are left us after the necessary business of life, to the effecting of that proposition, the world would be very much better off than it is at present.

Now as regards these objects, Liebig was very much like Leibnitz. He, too, upset, as he called it, the altars of the lie. In his early days (he said) he supposed it was sufficient to study, to work, and to teach the truth, but painful experience had convinced him that that was not enough, that he had found that when the young truth appeared at the door, and wanted to be let in, the old lies stood there and would not allow it to enter, and therefore he found it necessary to use violence to force his way, and to upset the doorkeepers of falsehood. When, for example, professors of medical jurisprudence and medical experts gravely taught and believed, and swore to, the possibility of a process called spontaneous combustion of the human body, Liebig unsparingly exposed their ignorance of the elementary laws and facts in physics, and by a process of analytical inquiry into all the alleged cases of spontaneous combustion proved that the most conspicuous ones amongst them were the inventions of newspaper writers in want of better employment. These cases appeared in the *Gazette des Tribunaux*, and the fact of their being *canards* was made out by diplomatic agency and inquiry, conducted through the French Police at Paris.

I now come to the discovery by Liebig of those two remarkable bodies which have obtained a world-wide celebrity as beneficial to man, namely, chloral and chloroform. In the year 1832, Liebig published a short announcement on the decomposition of alcohol by chlorine. He said: "In a research on the action of chlorine upon alcohol, I have obtained the following results:—1. When dry chlorine gas is conducted through hot absolute alcohol until hydrochloric acid is no longer formed, the alcohol is ultimately transformed into a white crystalline mass. These crystals consist of a peculiar body, which I will meanwhile term chloral, from chlorine and alcohol. 2. Pure chloral consists of chlorine, carbon, and oxygen. 3. This liquid is heavier than water, and soluble in it. 4. Chloral forms with water two compounds, of which one is crystallisable, and the other a white powder insoluble in water. 5. Under the influence of watery alkalies chloral is transformed into a new chloride of carbon and formic acid. 6. The new chloride of carbon is also produced by distilling chlorinated lime with spirits of wine (this chloride of carbon we now term chloroform). 7. It is also formed by the influence of chlorinated lime upon "pyroacetic spirit" (the body we now term acetone). This was the preliminary announcement of this writer in the presence of the discovery which was to be so momentous to the well-being of man. In a manner it is not dissimilar from that in which the first scenes of the great dramas introduce the play to the audience. On page 182 of the same volume of the *Annalen*, which contains the foregoing announcement, published a few months later, we find a complete essay, in which Liebig discusses the results of numerous inquirers who had acted with chlorine upon alcohol, and showed that the objects of those labours had not been attained because their authors had started with the preconceived notion (which had been declared to be improbable by Berzelius) that the product would be identical with the so-called liquid of the Dutch chemists, or Dutch liquid. He discusses the differences between the oil from alcohol and chlorine (chloral), olefiant gas and chlorine (Dutch liquid), the heavy salt-ether, and the indeterminate mixture produced by chlorine in watery alcohol, and gives the opinions of other chemists. We then find a statement characterising the man. He had repeatedly made experiments to solve these questions, but unsuccessfully on account, he said, of the many products, and partly of his going the wrong way to work. But he continued to study all the collateral matters which could throw light on the subject, and amongst these was the question of the products of the action upon each other of manganese peroxide, sulphuric acid, and alcohol. One of the first products he showed to be the well-known wine oil ethyl-sulphuric acid. He allowed that the question of the relation between ether and alcohol required a new research, but he, nevertheless, defines the body which we now term aldehyde. He now discusses the features of the process which takes place when chlorine acts upon alcohol. He shows that alcohol had never yet been tried with as much chlorine as could be got into it, and had never been completely decomposed. Step by step he eliminates difficulties, and then in a new chapter describes the mode of producing chloral. The apparatus consists of a retort in which there is a chlorine mixture. Then there is a drying tube for the gas, and the alcohol to be acted upon is contained in a tube which, in this case, no doubt is an element of success. The invention of the tube he ascribes to Gay Lussac. A narrow descending tube ends in a larger tube which is carried upwards in a slanting direction, and then terminates in another small tube. In the slanting tube the alcohol is placed, through which the gas passes; the vapours which escape are collected in a proper apparatus at the end. At the beginning of the operation of passing the chlorine gas the slanting tube requires to be cooled down, because every bubble as it enters causes a yellow flame and produces a deposit of carbon. At a later period, however, the reverse obtains, and the action becomes so slow that it is necessary to heat the alcohol almost to the boiling point. Under these circumstances a complete decomposition of the alcohol takes place, while a large quantity of hydrochloric acid is evolved. The following are the proportions of the materials and amount of time required

in the operation:—8 ounces of alcohol take from eleven to thirteen days' time and attention on the part of the chemist, and during that period the retort has to be filled from eight to ten times with chlorine mixture, amounting in quantity to 8 lbs. each charge. Therefore each ounce of alcohol requires the chlorine from 10 lbs. of chlorine mixture in order to become chloral. When the action is completed, and there is no further absorption of chlorine, and no further evolution of hydrochloric acid, the tube is allowed to remain at rest during two or three days, and at the conclusion of that time it contains a mass of crystallised chloral hydrate. The mode of purification is very simple. The matter is shaken up with concentrated sulphuric acid, whereby liquid anhydrous chloral is produced. I will show you, experimentally, that chloral consists of a liquid combined with water; by withdrawing the water from it by means of sulphuric acid, the sulphuric acid remains underneath, and the choral rises to the top as a liquid. The liquid chloral thus obtained, is further freed from some impurities, a little hydrochloric acid, and a little more alcohol and water, by means of being shaken up with sulphuric acid. The chloral must be quickly separated, as it has a tendency to be transformed into an insoluble modification, which is white like china clay, and not at all soluble in water, and requires a laborious process to retransform it into the crystalline modification. It is ultimately rectified over a little caustic lime to remove any trace of sulphuric acid which may remain in it. Thus prepared and purified, chloral was found by Liebig to be a body containing carbon, chlorine, nitrogen, and oxygen. In his analyses Liebig missed the hydrogen; and the very same happened to him with regard to chloroform, which he also believed not to contain any hydrogen. And the true formulæ of both these bodies were not made out by the discoverer of the bodies themselves, and were only found out subsequently by means of the determination of their vapour-density, by Dumas. The properties of chloral are the following:—It is a rather thickish liquid of the specific gravity of 1·5, or about half as heavy again as water. When, therefore, a little is poured into water, it sinks to the bottom, and after a time it dissolves in the water, if the water be in sufficient quantity. If, however, the quantity of water be very small, the liquid chloral combines with the water and crystallises instantaneously. I will drop a little chloral into a bottle containing only ordinary air; the bottle has been dried, and in consequence no crystallisation will take place. But in order to make the bottle a little moist I will blow some breath into it, which will cause a little dew to be formed. Now, on letting it stand a while, the walls of the glass will be seen covered with a dense network of crystals; they are already forming. This shows that chloral is somewhat volatile at ordinary temperatures, and combines with this little water to form chloral hydrate, which you see here. There are various other remarkable reactions of chloral, such as that it can be distilled in a dry state over caustic lime without being changed, but if it does not completely cover the lime a very remarkable action takes place. It is decomposed, and the lime becomes red hot, carbonic oxide is evolved, and the chloral is destroyed. Far different is the action of alkalies when water is present. There we have a saturated solution of chloral in water. We will now pour caustic soda into it and observe the effect. The mass becomes milky, and the heavy liquid will settle at the bottom, forming chloroform. We have therefore transformed chloral into chloroform on the one hand which falls down, and into another body, formic acid, which remains in solution. I will prove to you that that is actually formic acid. Here we have some neutralised solution, here is some mercury chloride, the so-called corrosive sublimate; when we put the two together, a white precipitate is formed, which is made black by the addition of ammonia. The reduction of the bichloride into calomel is thus effected. If the vapours of chloral are conducted over heated metal they are decomposed, and charcoal results, which adheres to the metal, and various gases go away. The experiment is more complicated than in the case of chloroform.

In order to prove that during the decomposition of chloral by alkalies, the chlorinated portion of chloral goes into the chloroform, we have here another experiment. In this glass there is some of the chloroform produced from chloral. We pass it through a little chloride of calcium in order to dry the vapour, and then through a red hot tube in which are contained pieces of an ordinary clay pipe. Under these circumstances it is decomposed, and you see the tube is filled with black matter, pure carbon, and a crystalline matter, chloride of carbon. You see that out of the point of the tube a gas is streaming, which is hydrochloric acid. The fact of its being acid is shown by its colouring litmus paper and by its giving white vapours of sal ammoniac or chloride of ammonium with ammonia gas in a bottle. We prove to you, therefore, that in the decomposition by heat of chloroform made from chloral there is produced hydrochloric acid, free carbon, and solid chloride of carbon. In the process of the analysis of chloroform Liebig had great difficulties to overcome, because, as he said, the body is so similar to the Dutch liquid, that to most people it would have appeared the same. But he gradually, by dint of perseverance, established the diagnosis, particularly by the different specific gravities, and the different boiling points.

With this I close the account of chloroform and chloral, so far as their chemical discovery is concerned. You will see that none of these discoveries were made with a view to any useful application whatever. The question was one of the most theoretical chemistry, an abstract question regarding some of the changes which alcohol undergoes by various agents, and those changes were exercising the minds of all the chemists of Europe. I have already alluded to Doebereiner's researches, in which he noticed aldehyde. I have spoken of the Dutch liquid which was discovered by a society of Dutch chemists in the last century, and from whom it took its name. Chloric ether had been discovered, and several chloric ethers had been described, yet there was such an amount of confusion, that no regular conclusions could be drawn as to what were the actual changes which alcohol underwent when subjected to these various processes, only one thing was well-known, namely, that when alcohol is treated with sulphuric acid it forms ether, thence called sulphuric ether, so well-known in the last century as the product of the alchemists, and which was used in medicine largely under the name of Hoffmann's liquid, or the anodyne liquor of Hoffmann. Liebig had not the intention to discover some useful agent, something which would remove pain, or make him rich, or which could be manufactured into something that could be eaten. The question was one simply of theoretical chemistry—what changes did alcohol undergo when treated with chlorine? In that inquiry he adopted a very energetic process, and that process led him to discover these two substances, which (the one until 1847, and the other until 1865 or 1866) remained mere curiosities in the museums of chemists. Indeed, Professor Hoffmann has asserted that in 1865 there were not in the whole of the laboratories of Europe as many specimens of chloral as would make one pound; but in the present day the quantities of chloral daily made in the town of Berlin alone amount to more than 100 kilos. I insist a little on that, with a view to make it clear that science must be allowed to go entirely its own way, that in research, one point, one *aperçu*, comes in to aid another, no proposition out of a general list can be advanced by research, it must have antecedents either in the form of individual work, or in the form of the knowledge of what has gone before. The intending inquirer must have before him a certain number of *aperçus*, original or elementary observations, to enable him gradually to ask questions and answer them experimentally. Discoveries "to order," so to say, are impossible.

The Royal Society several years ago charged its secretary to find out new experiments, and paid him for a good many years a salary of £600 a-year for that purpose; but after he had taken the salary for eleven years, and had tried as hard as possible to make new experiments, the Society were so disgusted that they withdrew the salary for experiments, and he had to hide his diminished head. If Liebig had been charged to compound a substance which should be volatile, and which could be inhaled to make a man unconscious, he would, I am sure, have utterly failed, and I think if the whole scientific world had been charged with the problem it would have failed. If, in a similar manner, it had been proposed that a remedy should be found which could be taken and produce sleep without producing the objectionable effects of opium, and yet be free from danger, that proposition could never have been solved. But the proposition has been solved in a different way, and these solutions, which appear to us very decided achievements, have been discovered, not by being searched for, but actually by a side light, by researches made with no intention whatever to find out anything of a very particularly practical use.

At this time chloral and chloroform are largely used. Here is an apparatus which has been devised for the purpose of administering chloroform to produce unconsciousness. A little cotton wool is placed here, which is saturated with chloroform. Here is a valve, through which the air goes in; and here is another, which allows the respired air to pass out. Thus, in a very short time, a drachm or two of chloroform will send a man into a tranquil sleep, in which he will perceive no pain which may be inflicted upon him by the most fearful amputations, removal of tumours, cutting out of nerves, and other necessary operations. The chloroform will also remove much of that very great danger, which arises from injury to the nerves, which we call shock. Besides that, the surgeon while operating has a perfectly tranquil patient before him, and is not agonised by the convulsions and struggles of the victim. As to chloral, the application is different. The medical application of chloral is mostly in solution, which has to be swallowed. The dose is from 15 or 20 grains to 30, 40, and sometimes 60, when a state of tranquillity of the brain is produced, and a kind of sleepiness, which ends in complete sopor. If sufficient be taken, a person is as if under the influence of chloroform, completely insensible to pain, and, as in the case of chloroform, if administration be continued sufficiently long, or a sufficient quantity be taken at once, even the action of the heart stops, respiration ceases, and death takes place. But with chloral, the accidents which take place in the case of chloroform, are not so common, and it is probable that, in the course of time, some operations which require a long time will be effected under the influence of chloral rather than of chloroform. In such cases the chloral has not to be given internally by the stomach, in which it acts rather uncertainly, but has to be dissolved in water, and injected into the veins, when its effect is, to a very great extent commensurate with the quantity injected. Some Belgian and French surgeons have already shown very remarkable results by means of this application of chloral, and I have no doubt that in course of time it will be more frequently used in practice.

My time now draws to a close. I have on several occasions read from the list of papers which Liebig wrote during his active lifetime. The number was 303, independently of those, more than 50, which he composed jointly with other chemists. In his later years he rose to a generalisation of the most remarkable kind, and his philosophy, such as it had developed itself by the various researches and works, came, in my opinion, to the highest climax of perfection in the paper which I find numbered 292, in the list entitled, "On the Development of Ideas in Natural Science." This essay he gave to the world in the form of an oration at the Academy of Sciences at Munich. He goes through the history of science in antiquity, in the Middle Ages, and in the present time, and does not coincide with the general opinion of the historians, according to which the Middle Ages had been entirely barbarous and produced nothing. He shows that the matter which was collected in the first books printed with moveable letters was actually the achievement of the so-called Dark Ages; that those men who collected those facts and generalised them were the fathers of modern science. In his philosophical development he came to certain conclusions which differed very much from those commonly received, and at one time he offended Englishmen very much by publishing a direct attack on Bacon. That was based upon a study which he then made of the peculiar condition of philosophy in England, and how deep that study went you find from a letter written to him by an Englishman at that time about the condition of natural science in England, which was printed in the first volume of his "Chemistry applied to Agriculture." After that letter he began to study Bacon with a view to find out whether it was really true that Bacon was the father and originator of science, as we know it now, and he came to the conclusion that he was not. He produced various quotations from "Silva Silvarum," "The Advancement of Learning," and other works, and showed that he could by no means be considered as having had so great an influence as was generally attributed to him by modern writers. I have myself given some attention to the subject in years gone by, not with reference to these lectures, and I came to conclusions similar to those of Liebig. Bacon denied the Copernican theory, and, as is stated in the description of his life, throughout the whole of it including the time he studied at Cambridge hated Aristotle; throughout the whole of his life he made but one experiment, and constructed one model, and that was, as he expresses it, "a wire which goes in a spiral line, and upon which I move the globe which shows the movements of the heavenly bodies in spirals and not as Copernicus would have it, in circles." We need not on that account deny the great influence which Bacon had upon the spread of learning among certain classes of society. That he was a man of immense power of disquisition, of learning, and, in fact, a philosopher of the deepest convictions, I do not for a moment deny. But I cannot help thinking myself that he was not the originator of what we call inductive science, and that the originators of that science were the men who, like Copernicus, observed the heavens, like Vesalius, dissected bodies, and, like Stahl and the alchemists, made experiments. I once entered into a correspondence with a German philosopher on that subject, and he gave me a very epigrammatic explanation of my difficulty, and a very good definition of the character of Bacon. I had stated in my letter that I could not understand how a man of his marvellous power could have put aside the convictions which must be impressed upon any man by reading the works of Copernicus on the revolution of the heavenly bodies. He wrote to me with reference, also, to my astonishment that Bacon should have hated Aristotle. "I can solve that difficulty for you. Aristotle was a thinker, and Bacon was an enthusiast." That exactly expresses the relation of the two men to each other, and if you will think over the subject for years, and read the whole of their works over again, and if you want to find out the reason why this great man, in this one particular, namely, astronomy, failed so completely, you will find that that was the reason that he was an enthusiast, not a man of science.

Then we come to the present day. In my second lecture I gave my opinion of Kant, and how, as long as his teaching was based upon physical science, upon astronomy, and mathematics, he advanced philosophy in a wonderful way, but that after he became divorced from that basis, and went to the so-called speculative philosophy, he became a mere rope dancer in philosophy, so to say, who used words for the purpose of showing his power over them rather than of conveying sense. In this

manner, if we very closely and carefully, dispassionately, and without prejudice study the philosophers who have come before us, we shall find that we can apportion to each his true merit, we can derive from each the most powerful lessons; but it is necessary for our own safety, and for the correctness of our own understanding, that we should not be under a misapprehension as regards the guidance which any one of them can give us. And here I must say that we should not in this country repeat constantly the phrase that Bacon was the father of inductive science, and that inductive science was the master key of intelligence. That is not so.

This retrospect consists of aphorisms rather than of a connected string of thoughts; they are drawn from the mass of ideas floating before my mind, and are the result, mainly, of my reading the works of the man on whom I have lectured to you. What, looking now from the past to the future, can we hold as being the probable consequence of the teachings and achievements of the past? Here I will let Liebig speak for himself, by reading a few sentences which close the essay I have already alluded to, namely, that on "The Development of Ideas in Natural Sciences."

"Our view of the future shows a picture full of life, an endless activity, rich in success. The past appears now in a totally different light. We see that the conflict of the scholastic philosophy in the Middle Ages and of the clergy with natural science are purely unimportant events. Their resistance was caused by the circumstance that at that time a doctrine could not be distinguished from a fact; the united power of the spiritual and of worldly authority was unable to prevent the discovery of the telescope, of the compass, of oxygen; it was unable to prevent the effect which these discoveries have, and will always have, on the human spirit. A book may be burned, but a fact cannot be burned. With the proof that the earth is a small planet which turns round the sun, the former idea of heaven is dispelled; with the explanation of fire as a process, the idea of hell loses its force; with the discovery of the pressure of the air, the belief in witchcraft and sorcery ceases to have a foundation. For with the horror of a vacuum nature loses its will, its love, its hatred. With these discoveries man could feel his position and his power in the universe. Concerning scholastic philosophy we may say that if Aristotle and Plato could rise as living men from their graves, and could teach in the scholastic schools of the Middle Ages, they could not increase their recognition, because there would be too large a deficiency of ideas derived from experience. The logic of the scholastic school and the mental gymnastics based upon this logic, were the best which that time could produce. Its hostile position towards the inquiry into nature at a subsequent period was without the slightest effect on progress. If the full power of Church and State had been in union with natural science these would not be a single step further than they are, and they could not have developed themselves differently. If anybody would like to make a calculation of the united effect on the condition of our time, which we may ascribe to Luther and to the men of science of his time who made the great discoveries in nature, and if another one were to make a calculation of the effect which those men of science and their discoveries would have produced without Luther, a very peculiar balance would be produced. We now know that the ideas of men develop themselves according to determined laws of nature and of the human spirit, and that they developed themselves originally from small to large. We see the tree of human recognition, which has been planted by the Greeks, grow on the soil of civilisation and cultivated by civilisation, and we see it prosper in the sunshine of liberty, and see it bear fruit at the proper season. We have experienced that its branches can be bent by external violence but they cannot be broken, and its fine and numberless roots are so deeply hidden in the earth that their silent activity is completely withdrawn from either the benevolence or the malevolence of man. The history of the nations gives knowledge of the impotent efforts of the political and clerical powers to maintain the physical and spiritual slavery of man. The history of the future will describe the victories of liberty which many have achieved by investigating the causes of things and the influence of truth; victories with arms that are not soiled with blood, victories achieved with weapons in a battle in which morals and religion have always been only feeble allies."

SPECIAL LECTURES.

The third of the series of lectures on "Unhealthy Trades" was delivered by Dr. Richardson, F.R.S. (appointed by the Council to make special inquiry into the subject), on Friday evening, December 17th, as follows:—

Lecture III.

Injuries from Inhalation of Gases, Vapours, and Fumes.

From the study of injuries arising from the inhalation of fine particles of solid matters, or dusts, named as Order *a* of Class I. in our classification, I pass now to Order *b* of the first class, namely to the injuries which are induced during industrial labour by inhalation of gases, vapours, or fumes.

Definitions—Physiological Varieties of Action.

By a gas, is meant a substance which is only known to us from the first in the gaseous form of matter; which is, in fact, like the gases of the air we breathe, and which is incondensible into liquid under the ordinary atmospheric pressure, at common temperatures.

By a vapour, is meant a substance which has taken the gaseous form from a liquid, which is diffused in the air, as the vapour of water may be diffused, and which is derived from the volatilisation of some volatilisable body, such as turpentine or bisulphide of carbon.

By fumes, are meant matters which are given off at a high temperature from different solid substances used in the arts, such as the fumes of mercury or zinc, or the fumes evolved from heated resin. The fumes may be considered, generally, to be composed of solid substance, diffused in fine distribution, through the agency of heat, in the air. They are condensable, and when they are derived from metals they are usually oxides of the metals.

Gases and vapours, when inhaled by the lungs, act in a different manner from those solid particles of dust which we have considered in the previous lecture. Some of them, when they pass into the larynx and windpipe, are irritating and produce cough; some of these also cause free bronchial secretion, in which respect they resemble dust in the effect they excite. But here the analogy stops. The gases and vapours, diffused within the bronchial passages, are not, as far as we know, influenced by the ciliary motion. Some of them may possibly impede or destroy that motion, but they are not themselves brought back by it. Diffused with the air, and existing in the same gaseous condition, they reach the blood which has been sent by the right side of the heart to the lungs, which has been distributed over the pulmonary capillaries, and is coming in contact, through the fine walls of the air vesicles, with the atmosphere those vesicles contain. In this manner the foreign gases or vapours reach the blood with the air that is breathed for the purpose of sustaining life, and the blood absorbs them as it does the oxygen of the air.

The gases and vapours, when they are inhaled, exert, as you will see, a deeper influence than the mechanical

dusts. They enter the blood-stream, in which they are condensed, in the same manner as the vapours of chloroform, methylene, or ether enter when administered to produce anæsthetic sleep, and so their action is extended from the lungs into the system altogether. They have, in short, a general as well as a local action, and the general action of many of them is so active that they would prove at once fatal, by the constitutional mischief they establish, if their inhalation were long continued.

They differ, also from dusts, in their effects, in respect to the methods that are available for preventing their entrance into the lungs. Dusts may be prevented entering the lungs by various mechanical means of filtration. Gases are not as yet capable of filtration, at all events not by such means as are practically applicable in the arts at this present stage of our scientific progress.

What I have called fumes approach nearer to dusts in their mode of action than the gases and vapours do. Some fumes are quickly condensable on the respiratory tract, and these act almost after the manner of dusts; others, which are more easily sublimed, diffuse more freely, and partake, therefore, rather of the quality of vapours.

It would be impossible for me to undertake the description of all the foreign gases, vapours, and fumes to which they who are engaged in industrial pursuits are exposed. In fact, there may probably be many which are not yet known to men of science. Following, therefore, the plan I have hitherto pursued, of endeavouring to extract the pathology out of the industry, I shall notice only those bodies of the class under consideration which are known to be capable of producing certain well-defined phenomena of disease.

Some of these agents are derived from the simplest sources; they give no evidence to the senses of taste, sight, or smell, that they are injurious; and those who are injured are subjected for long periods of time, possibly for the whole period of time they are employed, without being conscious of the cause of injuries they distinctly feel.

Effects of Gases.

Carbonic Oxide.

As a first illustration, let me refer to the gas known to the chemist as carbonic oxide.

Carbonic oxide is the product of the imperfect combustion of carbon in oxygen. It is produced in large quantities whenever charcoal or coke is burned in common air, as is so often done in the chafing dish and stove in various industrial occupations. The gas is inodorous, and is most poisonous. I found by direct experiment that one part in three thousand of this gas produced, by inhalation, extremely painful symptoms, namely, giddiness, drowsiness, unsteady movements of the heart, tremulous and convulsive movements of the muscles, and nausea. I also discovered, some years ago, viz., in 1862, the curious fact that prolonged breathing of this gas gives rise, temporarily, to the disease known as diabetes.

Amongst the industrials exposed to carbonic oxide, certain of the symptoms I have named are frequently induced when the workers use burning coke in a closed room. I have found tinmen and braziers suffering from this cause, and the influence of the same is felt by walking-stick makers, and all others who are obliged to stand over the fumes of incandescent coke. After a time the body seems to become, to some extent, accustomed to the gas, but the bad effects are not therefore mitigated, though they may be less severely felt. The chief symptom complained of may be summed up in the one word vertigo. The sufferer tells you he is giddy, that he feels cold, and that his hand becomes unsteady at his labour. He leaves his work for a time, enters into a better atmosphere, obtains relief, and returns to his work again to feel the same symptoms. In the case of a brazier who worked in a small, close shop, and who kept a chafing dish at all times on his bench when he was using heated irons, the symptoms were, at first, those of nausea which passed even to vomiting, flushing of the face, giddiness, as if he were spinning round, and faintness. He became inured to some of these symptoms after a time, but lost appetite, and said he could not help feeling giddy, do what he would, until he was out of doors. Things seemed to be moving before him, and his hand was unsteady. An improved system of ventilation, with a shaft for removing products of respiration, put a stop to these dangers, but he suffered for a considerable time after the cause was withdrawn.

The women who work at the lace frame suffer from carbonic oxide, under some circumstances. In cold weather they are led to place a chafing dish of burning coke beneath the frame, and directly under their own nostrils, the object being to keep their hands warm for performance of their work, which requires delicacy and precision of hand movement. In this way the women are made to breathe an atmosphere charged with carbonic oxide, from which they suffer severely, at first with acute, afterwards with chronic symptoms. The acute symptoms are headache, giddiness, nausea, faintness, flushing of the face, and irregular action of the heart. The chronic symptoms are, failure of appetite, fœtor of breath, a nervous, hysterical condition, and anæmia, with great depression of muscular power.

It has not as yet been ascertained whether diabetes has been excited by this means, in those who work in an atmosphere containing carbonic oxide, but it has been observed, in corroboration of the experimental evidence I before mentioned, that some men exposed, by accident, to the gas, were rendered diabetic for a period after their recovery from the narcotic effect and from the other immediately dangerous conditions into which they had been cast. Carbonic oxide forms a part of all coal gas, existing in the purest coal gas in considerable proportions, 7·85 per cent. It thus becomes diffused in the air of badly ventilated rooms and shops in which gas, supplied through unsound fittings, is largely employed for lighting and warming. I believe that in this manner carbonic oxide is a common cause of nervous derangement and dyspepsia.

Sulphurous Acid Gas.

Sulphurous acid, the gas produced by the burning of sulphur, is used for bleaching purposes, and especially for bleaching straw for bonnets. The plaited straw is brought in lengths to the bleacher. It is first soaked in an alkaline solution of potash or ammonia, and afterwards is exposed to oxalic acid; it is subsequently washed in soap-suds, and lastly is bleached by being subjected in a closed chamber to the fumes of burning sulphur. Into the bleaching chamber the workman enters to turn and change the straw. The air is irrespirable, but by learning to hold the breath for one or two minutes, the operator becomes skilful in avoiding a dangerous inhalation of the fumes. He rarely escapes altogether from the effects of the gas, and he feels the effect still more after the straw is removed and dried.

The more active symptoms induced by sulphurous acid are those of suffocative cough, which is of short duration when the gas is withdrawn, and does not seem to lead to any serious bronchial mischief. After frequent and prolonged exposure to the effects of the gas, the system is influenced through the blood. The blood is rendered unduly fluid, the diseased condition known technically as anæmia is developed, and biliousness, amounting even to jaundice, is an occasional added disorder.

In connection with the effects of sulphurous acid, I find another class of workers who suffer from it, in conjunction with effects arising from a different cause of injury. The class I refer to are the "fellowship porters." I discover in these men, who are employed in landing merchandise, corn and fish especially, that the workers amongst the corn are affected not only by the dust, which is a source of much irritation, but also by the escape of vapour of sulphurous acid, which exhales

from oats that have been bleached by the acid. Oats coming from Ireland are often bleached in this way, and smell strongly of the gas. The admixture of gas and dust is exceedingly irritating to the lungs, and is a cause of bronchial coughs and spasmodic asthma.

While speaking of this compound of sulphur and oxygen, sulphurous acid, I may mention, incidentally, some curious facts bearing on the effects of sulphur. In the great vine-producing district of tho Herault sulphur is employed to destroy the minute fungus called the oidium. The oidium is injurious to the vine, upon the stem and leaves of which it fixes, and sulphur is dispersed over the leaves of the vine, either with a fine sieve or with bellows which are made to blow it over, in order to destroy the parasite. The effect of this process is to induce in the work-people who are employed in this task an ophthalmia, or inflammation of the eyes. The pain, redness, and swelling of the eyes is most distinct and distressing in the middle of the day, when the heat and solar radiation is most intense. Women and children are the severest sufferers, We are indebted to M. Bouisson, of Montpelier, for the first description of this induced disease.

One or two other singular points deserve a passing notice in connection with this subject, the oidium and disease. The oidium itself has been assigned as a cause of disease. M. Collin reported to tho Academy of Medicine, in the year 1864, that three persons who were cutting vines, by an accident cut themselves, and were poisoned by the oidium. They all suffered after a few days from loss of appetite, shivering, and fever. Their wounds, which originally were slight, became gangrenous, and their limbs swollen. In all of them there was "*muguet*" of the mouth, which consists of a cryptamous product called the "oidium" of the mouth. From this circumstance it has been inferred that the parasite cryptogamic oidium may become by inoculation a cause of disease in the human subject. This theory which was not a little strengthened by a discovery made in May, 1858, by Professor Laycock, the distinguished professor of medicine in the University of Edinburgh, of the *oidium albicans* in the pellicle or false membrane that had formed in the throat in a case of diphtheria.

Lastly, it deserves note that a similar parasite fungus —*oidium aurantiacum*— was discovered by the late Dr. Robert Dundas Thomson in a specimen of bread made from that inferior kind of flour which so easily becomes acid when it is exposed to moisture, and which emits the well-known sour smell, even after it has been turned into bread, if it be for a short time exposed to moist air. It has been inferred that disease may be taken from the use of a bad flour containing the parasite. The evidence on this point is as yet entirely speculative, and I am diverging from the subject proper of my lecture in referring to it. It opens an interesting side view into causes of diseases. We must return now to the natural causes of inquiry we are pursuing, adding, on our own way, the disease *ophthalmia* to the list of industrial pathology.

Sulphuretted Hydrogen.

In some occupations, as in certain of the chemical manufactories, the operatives are exposed, at times, to the action of sulphuretted hydrogen gas. This gas is evolved in certain processes of chemical decomposition, and it is also evolved in some forms of organic decomposition, as, for example, in the organic decomposition of sewers and cesspools. The gas is an active poison, and death is an occasional result of its inhalation. Its action on living functions has been very carefully studied by myself, by the late Dr. Herbert Barker, of Bedford, and by other observers. The gas, diffused in breathing air in the proportion of 1·714 per cent. is immediately fatal; and in the proportion of 0·205 per cent. it produces quick insensibility, with feebleness of respiration and muscular tremors. Even when diffused in the much more minute proportion of 0·056 per cent.—in which solution it is after a time indefinable by the sense of smell—it produces, when inhaled for a short time, diarrhœa, rapid pulse, heat of the surface of the body succeeded by coldness, and after-symptoms of low continued fever.

These are the physiological effects of sulphuretted hydrogen, as they have been experimentally determined; but I have been unable to discover whether they are definitely traceable in the human subject amongst those who are employed where this gas is liberated. In sewer air the gas is present, and the concentrated air from the cesspool, in which the gas is also present, has been found, experimentally, to produce, when it is inhaled, symptoms like to those which are caused by the gas itself. I have inquired carefully whether amongst men working in sewers the symptoms observed in experimental research are specially manifested, but have been able to arrive at no certain affirmative result. The same applies to manufactory work where the gas is used, and I suspect it only becomes injurious when, by accident, it is breathed in such large quantities as to prove rapidly fatal.

When it kills in this direct way it induces a form of *apoplectic coma*, and under this name we may characterise the industrial accident of disease which occurs from its presence in large quantity.

Chlorine.

The vapour of chlorine is another gas used in bleaching, and in some other industrial processes. The vapour, when inhaled by the workmen, is productive of suffocative cough and temporary embarrassment of breathing, with headache, and at first nausea. It is remarkable that chlorine, when it is being inhaled, does not produce more decided constitutional effects. The workmen affirm that they become accustomed to it, and after a time it ceases to cause them any pain or anxiety.

Ammonia Gas.

In many occupations ammonia is liberated in free quantities. In the process of hat-making shellac is dissolved in a weak solution of ammonia. The felt is then steeped in the solution, and the ammonia, volatised by heat, charges the atmosphere with its vapour. In other occupations ammonia is liberated in the decomposition of ammoniacal salts. In a third class ammonia is given off from decomposing organic compounds. In all cases the workers are exposed to the ammoniacal gas.

Considerable difference of opinion exists on the question of the harm that is inflicted by the inhalation of ammonia. Some observers have arrived at the conclusion that the gas inflicts no injury, and I am of opinion that the injury is much less than might at first sight be supposed. When, however, the inhalation of ammonia is long continued, certain physical effects result which must be considered injurious. The blood is rendered unduly fluid, the corpuscles of the blood are changed in form, and are made crenate, the oxidation of the blood is reduced, and the disease anæmia, which has already been designated, is developed.

There are some occupations in which decomposing organic remains are present, and which yield to the air of the place where the labour is carried on an ammoniacal-sulphur odour which is most offensive, and which even taints the clothes and person of the worker. Those who are engaged in the labour of making cat-gut strings and cords; those who are engaged in dressing skins into rugs, &c., fellmongers; and those who act as bone-sorters and boilers are specially subject to these odours. A woman who was engaged in the first of these occupations, and who came to a public dispensary, to which I was physician, for medical advice, was so offensive she could not be tolerated in the waiting-room with the other out-door patients, and she had to come in after all the rest had gone. The odour from the fellmonger's yard, and from the bone-boiler's premises, is detectable even at long distances from

the place. It would be assumed, at first thought, that the operatives, breathing for many hours every day such an atmosphere, must needs suffer from some marked disease. I am bound to say that the evidence in support of this suspicion is all but negative. I have been unable to discover any definite symptom of disease connected with these callings as the result of the labour. Neither can I find any statistical facts that illustrate an unusual mortality from such labour.

Effects of Vapours.

Vapour of Turpentine.

We are indebted to M. Marchal de Calvi for the first intimation that the vapour of turpentine produces a specific effect on those who are engaged in painting in oil and lead colours. Before his time it was considered that the lead in paint was the cause of disease. De Calvi proved that, when the lead is fixed, the emanations from the painted surface, which consist purely of turpentine, are exceedingly poisonous. He further pointed out that some workmen are what is called idiosyncratically affected, in other words, that certain workmen are specially affected, but that all are liable to suffer. My own observations, made at various times since Calvi's announcement to the Academy of Sciences in Paris, on December 9th, 1855, fully confirm his discovery. Turpentine vapour produces, I find, very marked symptoms of disease in workmen, especially when they are engaged in the process of flatting. The symptoms are those of prostration, coldness, constipation, giddiness, disturbed nervous function, intense headache which lasts for many hours, impairment of appetite, and anæmia. These symptoms are produced from the use of turpentine varnishes, as well as from paints. Some workmen escape the action almost altogether; others are so susceptible that they will rather pay more favoured men to perform the job than do it themselves.

The mode of action of turpentine on the body is not yet fully understood. When it is rapidly inhaled as a vapour it produces sleep, like chloroform, and it has been used in an emergency as a substitute for chloroform in order to bring on anæsthesia. A key to its action was given some years ago by Dr. L. C. Roche, who, in commenting upon the researches of Marchal de Calvi, relates an interesting fact told to him by the illustrious chemist Thenard. It is that Thenard analysed the atmospheric air of a cellar which had become poisonously charged with the vapour of turpentine, and found that all the oxygen had been removed, so that nitrogen alone remained. Hence Roche assumes that turpentine produces its bad effects by depriving the air of oxygen. I believe this theory to be sound, but it does not explain all the facts. A more recent research by Dr. Liernsh has proved, by direct experiment, that turpentine vapour causes paralysis of the vessels of the minute circulation, and congestion of the brain and of the other large vascular organs.

Constipation and *temporary congestion of the brain* are thus added to the industrial diseases by this agency.

Bi-sulphide of Carbon.

Of late years the volatile fluid, known originally as the alcohol of sulphur, then as sulphuret of carbon, and now as bi-sulphide of carbon, has come into great use in various industrial pursuits. It is employed for taking grease out of wool; for extraction and purification of paraffin; for extraction of oil from oil-cakes when pressure is of no further use; for draining the sawdust used in refining oil by filtration; for extracting grease from bones or kitchen refuse; and for extracting aromatic essence and perfumes from plants. But the most important use of this body, perhaps, is in the manufacture of inflated caoutchouc articles, balloons, and water proofings. In the first the bi-sulphide is largely used, temporarily to dissolve the caoutchouc, and bring it into such a state of softness as will allow it to yield to the blast of air from the bellows. In the second, it is used for varnishing with india-rubber. The peculiarity of the bi-sulphide of carbon is, that on its volatilisation the substance dissolved in it is deposited, while itself diffuses through the atmosphere.

The effects of this vapour on the workmen was first described by M. Delpech, to the Academy of Medicine, of Paris, on January 15th, 1856. The effects are peculiarly severe. They consist, first, of symptoms of anæsthesia, with intoxication. Afterwards they become more chronic, but the head is much affected at all times, and partial insanity is not infrequent. The taste is vitiated; the sight and hearing are troubled; the digestion is perverted so that the appetite is increased, even to gluttony, and there is persistent nausea. The breathing organs, the organs of the circulation, and all the secreting organs are deranged, and such enfeeblement results that the workers, so long as they continue at their work, are simply wretched.

No name can be found for this particular disease from the old classification of diseases; that which it induces is a malady, *sui generis*, from which the victim suffers so long as he labours. The symptoms include derangement of mind as well as body. The disease approaches most nearly the general paralysis of the insane, and we may classify it as *cerebral paralysis.*

Vapour of Nitric Acid.

The vapour of nitric acid is a source of injury in some occupations. It is experienced mostly in the process of fur-dyeing. The acid is used in this process for two purposes, for freeing the substance of the fur of greasy matter, and for giving a dark yellow or brown stain. The vapour of the acid rises very freely, and is of necessity inhaled by the workmen. The symptoms produced are, dryness and redness of the throat, constant constipation, and severe pain at the back of the head.

Now and then in the practice of the chemical laboratory the inhalation of the vapour of nitric acid produces very serious effects. A man who was engaged in my own laboratory once suffered severely from this cause, the symptoms of difficult breathing and cough lasting for several days. In March, 1863, Mr. Steward, a master in the school of the Edinburgh Royal Institution, and one of the janitors of the school, died from this cause. A bottle of acid was accidentally spilled, and the two men inhaled the vapour. Neither of them at the time felt pain; but both died, one ten, the other thirty hours after the accident.

Vapour of Hydrochloric Acid.

In some chemical factories the vapour of hydrochloric acid produces injurious effects, and, to a certain extent, the action of the vapour is felt by men who use this acid—for which the name of spirits of salts is still maintained—for soldering and other mechanical purposes. The symptoms produced are dryness of the mucous membrane of the nose, mouth, and throat, with suffocative cough, and sometimes spasmodic difficulty of breathing. To remedy this evil in chemical work, M. Kuhlman, of Amiens, at his large manufactories of artificial soda, invented and completed a most efficient apparatus, by which the fumes of the acid were condensed into a salt of barium, by making them pass through a fine rain solution of carbonate of baryta.

Altogether these three last-named gases or vapours, although they are capable of destroying life accidentally, are not so serious a cause of chronic disease as some other agents with which we have become familiar. Such symptoms of a chronic kind as are induced by them may be classified under the heads of *constipation, bronchial irritation, nausea, and headache.*

Aniline Vapour.

Since the manufacture of the new aniline dyes has become such a great commercial pursuit, serious injuries have occurred to the workmen employed

in the manufacture. The first decisive case of injury from this substance which attracted marked attention occurred in a lad sixteen years of age, who was brought into the London Hospital, from some aniline works in which he was engaged, on the 9th of June, 1861. The lad had been found in a state of insensibility, in the interior of a vat used for the manufacture of aniline. He was pale and cold; but that which attracted most attention was the extreme blueness of his lips. The lad recovered, but on the following day he still remained blue, and his breath smelt strongly of aniline.

Three years later, Dr. Kreuser, of Stutthart, reported a set of new facts respecting the influence of aniline on the industrials employed in its manufacture. He showed that the vapour, when it does not act to the extent of producing insensibility, causes violent dry spasmodic cough. He also noticed for the first time, that the vapours produced ulceration of the skin in the lower extremities, with much pain and swelling. The ulcers rapidly healed when the workmen were removed from the influence of the vapours.

Later, Messrs. Knaggs and Mackenzie in this country, and M. Chevalier in France, discovered that a peculiar and extreme neuralgia, is induced by the vapour of aniline. The neuralgiac attacks begin with an intense nervous pain in the head, and a giddiness increasing almost to faintness.

Two French investigators, Tardieu and Roussi, have made some important researches on the physiological action of the red and yellow dyes, by which they have determined that, when animal bodies are subjected to these substances, a fatty change takes place in the minute structure of the vascular organs. The liver is made specially to undergo fatty degeneration; the tissues are also dyed with the colour, and from the dye-stuff extracted from the animal organs, the experimentalists dyed a skein of silk.

We have no evidence, as yet, that these phenomena of fatty change have ever occurred in the human subject, although it is fairly to be inferred that a long exposure to the vapour would lead to this result. The mischiefs actually inflicted are sufficiently important. They include *insensibility, followed by blueness of the skin—cyanosis—ulceration of the skin*, and *acute neuralgia*, all new maladies to be entered on our catalogue of industrial disease.

Nitro-Benzole.

The employment of nitro-benzole in chemical works gives rise to another source of danger, which more than once has been fatal. In all cases long exposure to the vapour of this substance produces nervousness and stupor, but when the vapour is inhaled in the concentrate form, the drowsiness, after from three to four hours, passes into stupor and intoxication, and finally into complete coma, or apoplectic sleep. The mind remains clear until the stupor suddenly comes on, and then the insensibility is complete. The body falls precisely as in apoplexy, and death ensues in about five hours.

Dr. Letheby, who of all observers has most carefully inquired into the action of nitro-benzole, is of opinion that the poison is reduced in the body into aniline by giving up its oxygen, but that on the surface of the body the opposite condition is in progress, by which the salts of aniline are oxidised, and are converted into mauve or magenta purple. I have learned of another mischief incident to the manufacture of nitro-benzole. In making it, by acting on benzine with nitric acid, vapour of hypo-nitric acid is freely evolved. This vapour produces great bronchial irritation, nausea or vomiting, and colic. Chevalier has reported on the same facts, and has added others which in England have not been noticed so evidently. He says, that the process of washing the nitro-benzine is more painful than the making of it, and that the vapour of benzine itself induces intense headache, a fact I can fully confirm.

Thus *coma* and *apoplexy* are again added to our schedule of the industrial diseases.

Effects of Fumes.

Resinous Fumes.

Some very simple occupations are attended with bad results from trifling causes. For fixing the hair of brushes, such as shaving brushes, a compound is made by pouring melted resin into boiled linseed oil. The workman dips the tuft into this solution, and while leaning over it inhales the fumes of resin. Great distress of breathing and irritation are produced by this process. The cough is suffocative and becomes in time chronic, with persistent irritation. Many workmen have to leave the business from these causes.

Copper Fumes.

The first of the metallic fumes to which I have to direct attention is copper smoke. The action of this smoke is to produce asthmatic seizures in the older operatives, in addition to the bronchial irritation which it excites. The influence of the smoke is destructive to the surrounding vegetation; its influence on vegetation may, indeed, be summed up in one word—corrosive.

Although the fumes are called "copper" smoke, the amount of copper is exceedingly minute. One half per cent. only exists in the deposit in the interior of furnace chimneys, and so little is present diffused in the air, that none can be detected at the distance of a few yards from the works, except when the smoke is extremely dense.

The late Dr. T. Williams, F.R.S., of Swansea, from whose analyses we receive the above and the best facts, states that the products of the smelting operation are divisible into two parts, (*a*) the gaseous and non-condensible, (*b*) the solid and condensible—fumes.

The fumes which condense in the culverts contain oxide of iron, oxide of lime, with traces of antimony and other metals, in the proportion of about 44 per cent. pure copper; 5 per cent. arsenious acid; 10 to 15 per cent. sulphur, and sulphuric and sulphurous acids in combination, 15 to 20 per cent.; water from 14 to 19 per cent.

The smoke which escapes into the air from the chimneys contains coal smoke in abundance, traces of arsenic, and sulphurous and sulphuric acids. Williams reckoned that 829,790 cubic feet of sulphurous acid were sent into the Swansea district atmosphere every week from the copper smelting works on the Tawe. The acid can be detected in the atmosphere twenty miles from the works. Sulphuric acid is also diffused with sulphurous. According to Williams, for every fifteen parts of sulphurous acid in the smoke there exists one of sulphuric acid in combination. Upon these acids is chargeable the destruction of the vegetation of the district.

The cattle feeding in the locality are affected with a disease termed by the Welsh farmers *effydrdod.* This disease is an inflammation of the *periosteum* or membranous covering of bone. The bone becomes thickened in the neighbourhood of joints. There is inflammation of the joints with effusion of fluid into them. The bones are prone to fracture. The teeth sometimes fall out, and sometimes decay. Williams, whose description is here again followed, attributes the symptoms solely to the sulphurous and sulphuric acids. These acids, brought down by the rain, render the grass sour, and the eating of the grass causes the malady.

It is admitted that the copper smelters are subjected to bronchial affections from their occupation, but their families appear to be exceedingly healthy, and specially free from epidemic disease. Indeed, the accomplished author, to whom I have so many times referred, in treating on this subject of epidemic disease, has advanced a theory which is singularly interesting and curious. This theory is, that the copper smoke entirely destroys all the poisons of the spreading diseases, so that "if it were possible to obtain a permanent diffusion of copper smoke in the atmosphere of a given locality, the population of such locality would be permanently exempt from those epidemic diseases whose causative germs, whatever

they may be in essence, travel and multiply from place to place in the atmosphere."

I do not indorse this theory, because the germ theory of disease is to me incomprehensible ; but the speculation of Dr. Williams is worthy of remembrance.

Fumes of Mercury.

In the older manufactories the sublimation of mercury was conducted in such a manner as to lead to very serious symptoms of disease. The workers at mercurial mines are now most subject to the danger of mercurial fumes, especially when they are engaged in the outside works, preparing and subliming mercury.

The disease excited by the fumes varies according to the mode in which they are inhaled. The most frequent symptoms are salivation and ulceration of the mouth. In some instances the stomach is first affected; there is pain in the stomach, constriction, sleeplessness, and cough. These signs are followed by those of salivation, and in some rare examples, recorded by M. Ferrand, there was a red rash on the body like the rash of scarlet fever, which lasted for several days, and left rheumatic pains in the limbs.

In yet another class of cases, the symptoms are more purely nervous, and are those of neuralgia, accompanied or followed by muscular tremor called significantly mercurial tremor. The whole muscular system is in fact thrown into constant feeble contractions and relaxations, over which the patient can exert no control.

In the extremest forms of disease from mercurial inhalation, the teeth become carious, and even the bones are affected. Some idea of these varied forms of disease may be obtained from the facts that have been collected at Idria, in Austria. Here there are the second best mercurial mines in Europe, and over five hundred men are employed at them. The works for smelting and purifying are about a mile from the mines, but the men change about, so that all are equally engaged at the various parts of the works. In one year, Dr. Hermann found that of 516 men thus employed, 122 were attacked, with disease from the mercury, in the following forms :—27 had neuralgia ; 14 rheumatism ; 6 tremors ; 16 salivation ; and 2 caries. Hermann states that in the valley of Idria all the people and even the domestic animals are liable to be attacked with mercurial disease in one or other of its phases.

In England it is impossible to collect the facts respecting those who work in mercury with so much precision as is above recorded, but the symptoms, when they appear, are of the same order. They add three new diseases to the schedule, viz., *salivation*, *mercurial rheumatism*, and *mercurial tremors.*

Fumes of Zinc.

Men engaged in bronze founding are subject to serious symptoms from inhaling the fumes of oxide of zinc. The fumes rise to the mouth of the workman and settle on the lips, causing sometimes a whitish effloresence. After long exposure to these fumes there are induced choleraic attacks with shiverings, and severe cramps in the muscles of the legs. Sickness is also induced which may last many days, and the food that is taken seems to undergo a peculiar fermentative change, so that there is constant pyrosis or water-brash.

The specific action of zinc on the animal economy, for the description of which we are indebted to Dr. Leo Popoff, is amongst the most singular that the study of industrial pathology affords. It adds to our calendar *choleraic disease*, *cramps of the limbs*, and *pyrosis*.

Phosphorus.

The introduction of the manufacture of phosphorus or lucifer matches, which commenced about forty-three years ago, created a new form of disease caused by the inhalation of the fumes given off from the phosphorus. This disease, an extremely painful one, affected the jawbone of the worker, causing necrosis or death of the bone. It was not detected until the year 1845, when it became well defined in the public hospitals at Vienna. To Dr. Letheby we are indebted for the first light that was shed on the subject in this country. Soon after his report the whole matter came fully under investigation. The mischiefs, when they occurred, were all produced by the use of white phosphorus, the common phosphorus of commerce. In the match manufacture the fumes of the phosphorus were inhaled at every step in the process, from the stirring of the mixture, through the dipping, to the boxing of the matches. While the disease was present I made a very careful investigation of it in respect to its development and course, and reported the facts in one of my lectures on the " Medical History of Diseases of the Teeth " delivered in 1858, and afterwards published. The facts, briefly described from that lecture, are that the symptoms first complained of were pain, deep seated in the tooth, having, as it were, one tooth for a centre. It was not a toothache, nor was it strictly confined to one particular tooth, but it extended steadily and persistently along the jaw, and was much intensified whenever the jaw was gently percussed or struck. In time the disease became concentrated in the jaw, a slow inflammatory process occurred, and a thickening of the bone ending in death of the bony structure, with attempts, in parts, at regeneration. In fact, what is technically called a true necrosis was developed. In the worst cases, where the patient was not relieved by operative measures, hectic supervened, with copious night sweats, extreme pain, and even death from exhaustion. It was remarkable that no bones except those of the jaw were affected, even in the worst cases, so that the disease was purely local, and, indeed, was disconnected from the other symptoms of phosphorus poisoning. I inferred that the malady was due to a volatile acid of phosphorus, which was absorbed by the saliva, and affected the jawbone whenever the teeth became unsound and the alveolus or edge of the jawbone became exposed. This view accounted for many of the anomalies, namely, that the lower jawbone alone was affected, that the enamel of the teeth escaped injury, and that workers whose teeth generally were sound escaped the injury altogether.

When the phosphorus disease once commenced, it continued in progress over periods of one, two, or even three years. It was sometimes localised in its extent, so that the teeth only came out, sometimes it extended through the whole of the bone. I compared it in 1858 to a chemical destruction of the bone, with inflammation from the irritation produced by the foreign products of decomposition. I see no reason to modify that definition.

You will observe, that in speaking of the phosphorus disease, I have spoken of it in the past tense. I have done so because, fortunately, the affection is now all but extinct. The discovery made by Lundstrum, of Sweden, that red or amorphous phosphorus could be applied for the production of matches, led to a complete revolution in the match-making business, and to the introduction of what is called the safety match. By this plan the red amorphous and practically innocuous phosphorus was placed on the box, and the combustible substance put on the match was made of materials that were perfectly harmless to health. Two qualities of safety were secured by the improvement. The match was rendered safer for common use, and the operatives were freed from the invasion of one of the most severe of the industrial diseases.

The disease was classified under the title of *phosphorus necrosis* in the records of industrial pathology.

Fumes of Lead.

The fumes arising from the process of lead smelting are less often sources of injury then they were formerly. Some danger occurs from the inhaling of salts of lead in fine powder, but the greatest danger lies in the mani-

pulation of lead, when it is used as white lead or as a salt. To its action on the body and its importance as a source of disease I proceed, at once, in the next section of our subject.

Class II.—Injuries from Exposure of the Body to Chemical Agents, Soluble or in Solution.

From the study of the effects of substances inhaled, and productive of injury through their introduction into the body by the lungs and the blood, we pass to the second and succeeding classes printed on our table.

Disease from Absorption of Lead.

Lead is always introduced in the form of an oxide, or of a salt of the metal. It specially affects two of the industrial orders—painters and potters. The painters use lead, as we all know, in admixture with oil and turpentine, to make the common paints that are in daily use for ordinary paint-colouring. The potters use it for what is called glazing the pottery, that is to say, for giving the hard, smooth, shining surface to vessels of earthenware. The painters come in contact with the lead while manipulating with paint; the potters came in contact with it in solution, or rather in suspension, while dipping the earthenware. In these cases, and, as a rule, in all cases where lead is used, and becomes injurious from its use, it is first brought into contact with the hand of the workman. It has been usually assumed that in this way the substance is directly absorbed through the skin into the blood, and that the nervous centres are reached by this channel of absorption. I am inclined to question this hypothesis. There is no proof whatever, of an experimental kind, that lead is absorbed by the skin. Solutions of lead may be applied, I had almost said to any extent, over the external surface of the body without effect of a deleterious kind, and I have had the most convincing evidence of some men who have worked in lead for years, that they have never shown a sign of lead-poisoning. The evidence on the whole is to my mind conclusive that in all cases of lead-poisoning the poison is swallowed by the mouth. The workman or workwoman, becoming careless after a time, takes up bread or other article of food with hands soiled with lead. Thus a little lead is taken daily, and in time the mischief is done.

It is one of the peculiarities of this agent of disease amongst the industrial classes that it is a cumulative poison. Some injurious agents are so soluble they are readily carried out of the body when once they have been received into it. They accompany the excretions, and at a brief interval make their escape. Other foreign and injurious substances are of organic character; these are decomposed or broken up in the chemical processes that go on within the body, and so are eliminated. But lead, an inorganic and sparingly soluble substance, is thrown off with great difficulty. Its chief mode of exit is by the excretion from the kidney. For a time this mode of elimination is sufficient to prevent the general poisonous effects of the lead from becoming active; but at length the action of the poison upon the kidney is to cause chronic inflammation in it, *nephrosis*, as it is called, with destruction of the delicate mechanism of the organ and imperfect function. Then, the mode of escape cut off, the poison commences to accumulate in the system, and disease is established.

The disease induced by lead is of two kinds, acute and often transient, slow and entirely disabling, or fatal. The first or transient form consists of symptoms of intestinal spasm, *colic* as it is commonly called; the second of *paralysis*. I have seen, but this is of rare occurrence, an intermediate disease in which the internal spasm, succeeded by fever and by the extrication of an extreme fœtor with the breath has ended in a paralysis from which the sick man has recovered without other symptoms. Occasionally the spasm of the intestines terminates in death; but as a rule there is perfect and often rapid recovery from this symptom.

The paralysis from lead is never determinately serious from the first, and is so distinctive that the term "saturnine paralysis" has been applied to it. It is in some respects like that form of paralysis from alcohol, which I described last year in this place, and it has been compared with the general paralysis which affects the insane. It differs from these, and from all other paralytic affections in many respects, notably in the following particulars:—

(1.) It attacks most frequently the muscles of the upper limbs. This is so commonly the case that Tanquerel affirmed he had only seen the lower limbs involved in one case out of one hundred and two. His experience is exceptional. I should place the occurrence of general paralysis after the commencement of paralysis of the arms and hands at one in eleven. Still it is the broad fact that the muscles of the hands and arms are those in which the failure of power appears first, and that the failure in a large majority of instances is confined to these parts.

(2.) In this paralysis the extensor muscles, the muscles by which we extend the limbs, are first and most deleteriously affected, hence the origin of the condition known as "drop wrist;" the extensor muscles of the hand lose the power to lift the weight of the hand. Later in the course of the disease the same deficiency extends to the muscles that raise the limb altogether.

The loss of power which is induced is due, in the first instance, to failure of nervous stimulus from those nervous centres which direct and excite the muscles of the upper limbs of the body to motion. There is no doubt that all the muscles of the limbs are paralysed; but, relatively, the group of extensor muscles are less powerful as they are less massive than the flexors. In the extensors, therefore, the enfeeblement is first discovered and here it continues longest.

Many investigations have been made to determine the mode in which the lead poison acts in causing the paralytic state; but in this direction little that is definite has been revealed. In what form of chemical combination with the tissues the metal lead is fixed has not been determined; all that is known is that it is distributed largely throughout the body in the cases now under consideration. It has been found in the liver, the blood, the nervous substance, and in the muscles of those who have died from it, but how it is maintained in those parts is not ascertained. The nearest approach towards an explanation is that as a salt of lead it acts on the albuminous parts of the tissues, coagulating them, and becoming itself combined with the solidified structure. In this way the activity of nervous action would readily be cut off; but why particular parts of the nervous system should seem to be involved in preference to other parts is difficult to answer. I have thought, in studying the subject, that possibly the theory of selection of parts for action, which has been most entertained, is a mere fancy; and that all parts of the muscular system are deprived by the lead of nervous stimulus, those sets of muscles which are least powerful feeling the loss of stimulus most rapidly. After a period of inaction from lead paralysis the muscles waste, they become of fawn colour and shrunken. From this state they never recover, and when the heart, which as you know is a muscle, is involved, the sinking into death is slowly inevitable.

While the artisan is suffering from the influence of this simple but potent poison, other parts of his body, besides the muscles and nervous centres, undergo organic changes. Along his gums extends a deep dark blue line which specially indicates the action of the metal. His visceral organs, the liver, the kidneys, the lungs, show a reduced nutrition and shrinking of their tissues.

I have now given you a brief but fair idea of the ravages inflicted by lead on the animal body. Since the beginning of the days of firearms many a nodule of lead has been

the messenger of death, but I doubt whether the leaden bullet has inflicted a tithe of the suffering on mankind like that which has been inflicted by the metal in the stealthy and uncompromising manner of action above now described.

Happy were it for those who are engaged in those branches of industrial pursuits, in which poisoning by lead is so frequent an accident, if the influence of the poison were limited to those only who are first affected. Unhappily the mischief extends from the afflicted parent to the offspring. From the woman under the influence of lead poison, the disease extends to her unborn child. Still, more strangely, from the father under the influence of lead poison, the induced disease extends to his children born after its implantation in him. In a remarkable essay on this subject, published in the "Archives Général de Medecine," M. C. Paul, from observations made in the Hotel Dieu, shows, amongst other important facts, that out of thirty-two of the offsprings of seven men who were exposed to lead poisoning, eleven infants were prematurely born, and one still-born. That of the remaining twenty infants which were born alive, eight died in the first year, four in the second, and five in the third year, one only living beyond the third year. The death in all these instances was symptomatic of a general muscular paralysis. Thus, he adds, it is necessary to admit that there is a new variety of accident, hereditarily transmissible, which comprises disease produced by an inorganic body.

I am sorry to have to detain you so long on this subject of industrial pathology, but there is not a more serious subject in all our studies, and I have carefully kept to the salient points. The fact that those who work in lead die at a rate greatly above the mean of the mortality of all classes of the community is a sufficient apology for the devotion of an extra space of time upon them and theirs.

We add now to our list of diseases induced by industrial pursuits *colic* and *saturnine paralysis*.

SEVENTH ORDINARY MEETING.

Wednesday, January 19th, 1876; Dr. Letheby in the chair.

The following candidates were proposed for election as members of the Society:—

Burgess, Major Charles John, Naval and Military Club.
Cummins, Eaton T., 31, Lansdowne-crescent, W.
De Keyser, Polydore, Grosmont-house, Hampton-wick.
Duncan, Robert, Port Glasgow.
Fielden, Immer, 12, James Watt-street, Glasgow.
Hill, A. W., Heatherside, Cromthorne, Wokingham.
Hill, R. A., 2, Storeys-gate, Westminster, S.W.
Honey, Henry, 1, Westbourne-square, W.
MacIntosh, James, 38, Langham-street, W.
Mackenzie, William, C.B., C.S.I., M.D., 3, Talbot-square, Hyde-park, W.
McShare, J. F., 73, Great Tower-street, E.C.
Majoribanks, Edward, 134, Piccadilly, W.
Milward, R. H., 41, Waterloo-street, Birmingham.
Moore, James H., C.E., Town-hall, Basingstoke.
Nubar, Boghos, C.E., 1, Stafford-street, Derby.
Ohlson, J. L., West India Committee, 9, Billiter-square, E.C.
Probyn, Clifford, 55, Grosvenor-street, Grosvenor-square, W.
Sandwith, Humphrey, C.B., D.C.L., M.D., Athenæum Club, S.W.
Short, Rev. Ambrose, Bodicote Farm, Bodicote.
Stuart, Alexander, 8, Powis-square, Kensington, W.
Sugden, Henry Townley, 12, Buckingham-street, Strand, W.C.
Tayler, Christopher, Trowbridge.
Thurgood, Herbert John, 123, Chancery-lane, W.C.

The following candidates were balloted for and duly elected members of the Society:—

Angus, Robert, Lugar, Ayrshire, N.B.
Bartleet, Robert Smith, J.P., The Shrubbery, Redditch.
Eassie, W., C.E., F.G.S., Child's-hill, N.W.
Harding, Douglas Hamnet, 54, Wood-street, E.C., and 37, Burton-road, Brixton, S.W.
Harker, the Rev. William, the Vicarage, Milton, near Sittingbourne.
Knight, John Mackenzie, 2, Lansdowne-terrace, Bow-road, E.
Lawrence, W. F., New University Club, St. James's, S.W.
Mason, Thomas, 2, Westminster-chambers, S.W.
Salomons, Sir David, Bart., 46, Upper Berkeley-street, W., and 1, Oriental-place, Brighton.
Stewart, Charles, M.A., 50, Colebrooke-row, N.
Vallé, Burton H., Nether Swell Fields, Stow-on-the-Wold.
Woolnough, Charles Alfred, 22 Percy-circus, W.C.

The adjourned discussion on Mr. Alfred Smee's paper on "Proposed Heads of Legislation for the Regulation of Sewage Grounds," was resumed.

Capt. Monson said:—After reading the author's description I exclaimed, "What a mercy we have not all been poisoned!" Poisoned by cyanide of potassium and the refuse of all the photographic establishments; poisoned by disinfecting solutions and the waste from manufactories and electro-chemical works; poisoned by vegetable and animal food; poisoned by water, and for ought we know we may be imbibing typhoid fever poison, cholera poison, or erysipelas poison. As to cyanide of potassium, permit me to observe that the quantity from photographic establishments is so very small that it is hardly worth mention, and from the use of an iron developer it is decomposed before leaving the premises. The elements of cyanide of potassium are carbon, potash, and nitrogen, and all these elements are food for plants. The wash from electro-chemical works is also food for plants; it consists of chlorides, sulphates, nitrates, and occasionally acetates. Disinfecting solutions, such as chlorides and hydrocarbons, are also food for plants. As to the organic poisons:—if the solids be separated from the sewage and put under the ground, the state of things described by the author will not exist, and these poisons also will become food for plants. Then there will be no danger of poisoning the cows, or propagating disease. The organic remains will be removed from sight and decomposed, and the soil by this means will be rendered more fertile and capable of growing large crops of food for cattle, which in their turn will become food for man. The so-called poisons instead of being an evil will be a blessing, and instead of destroying life they will support it. Manure in the wrong place is injurious; it must be applied to the roots, not to the stalks and leaves. The question raised about fermentation is most important. Putrefaction, decomposition, oxidation, rotting, decay, call it by what name you will, lays at the very root of sewage purification. As soon as putrefaction is complete, the work of purification is ended. The fasting of plants is a novel idea, and if it would save the washing of turnips and celery, I have no doubt but it would rejoice the hearts of market gardeners. The plant takes its food in a liquid or gaseous state, and this forms the juices and substance of the plant. What has the plant to assimilate, and why should it be fasted, I ask? It has no mouth for taking in solid food, and it has no stomach like an animal to digest it. I for one do not think it wrong for a Local Board to sell the produce of a sewage farm. I should think it wrong if they did not utilise the sewage by growing suitable crops; and I consider it right for one part to irrigate on land lower down, although out of the district. It is wrong to grow watercresses upon raw sewage; it is wrong to feed cattle with grass smeared with excreta;

it is wrong to use raw sewage for irrigation. As to tramps drinking the effluent water from sewage, I pity the poor wretches, but the unfortunate people of London have water served out to them that is highly contaminated with sewage. "The water after it has passed over the sewage grounds must pass to the nearest river," says the author. Well, where else should it pass? Rivers are the natural main drains of countries, and ought to be available in England for removing purified sewage as well as the rainfall of the country, and it is for the present generation to restore and preserve them to their legitimate use. Let water companies get their supply elsewhere. Why should towns and districts be put to the expense of constructing large outfall sewers in order that water companies may take their water supply from rivers? Nay! rather let them be at the expense of constructing culverts for the conveyance of pure water to supply our towns from the springs—uncontaminated with sewage—or obtain it from the deep-seated springs. Local Boards were called into existence by the Sanitary Act to do that for a district which individuals cannot do for themselves, and it is part of their duty to sewer towns and dispose of the sewage. Local Boards, as a rule, are the cream of the place, men of high honour, gentlemanly bearing, and refined feeling; they are selected for their business habits and knowledge of the subject with which they have to deal, and they have a staff of skilled officers to assist them in their work. They are the representatives of the people, and retiring by rotation are elected every three years. So far as we at present know the only effectual way of disposing of sewage is to remove the solids by any convenient means, and pass the liquid through the soil. It is not for gentlemen with fanciful notions to settle down in the most eligible parts of the country and think everything is to give way to their special convenience; that no unpleasant smell shall offend their nostrils. If such persons are annoyed by the sewage let them remove further into the country—the few must give way to the many. Why should a whole town suffer for the gratification of one or two individuals? In conclusion I beg to thank Mr. Smee for his able and very interesting paper, which must have occasioned him much thought. But because one board has made a few mistakes, that is no reason why all the local boards in the kingdom should suffer. Until quite recently, you know it was thought that if sewage was passed over cultivated land it would be purified by the growing crops, and it is well to remember this. Speaking of Croydon, it deserves well of the country, for it was one of the first to adopt irrigation for the purpose of purifying sewage. All honour to Croydon, we can well afford to look over its defects. I will trouble you with no further observations, but I think the author has entirely failed to make out a case for applying legislative restrictions to sewage farms.

Mr. Charles Jones (Ealing) said that whatever objection might be made to the statements of Mr. Smee, there was no doubt he had raised a very important question bearing on local boards and sewage farms. He was glad to hear the principle of sewage clarification raised by the last speaker, but at Ealing they had solved it, and he hoped before long the Chairman would come down and see what they considered the proper mode of dealing with sewage. It was quite correct that nothing should be put on the land but what was absolutely clarified, and this raised the question of legislative measures concerning sewage farms. He held that it was not necessary to go to the enormous expense which had been incurred in some districts in purchasing large areas of ground, and laying long lines of sewers, in order to produce the maximum profit from the farm. It was his conviction that a sewage farm could be cultivated as highly as any other farm, and with as little nuisance. He hoped, therefore, that the recommendations of the Royal Commission would receive the attention of the Government, and that it would be seen that there were means of dealing with sewage without danger or nuisance, and at much less expense than was commonly supposed. If sewage were put on the land in a perfectly clean state, as he was now doing in Kent, and was about to do at Ealing, there could be no possibility of nuisance. They might grow watercresses, celery, or anything else without danger. The solid matter could be ploughed in like any other manure, and no nuisance need arise from the accumulation even of a thousand tons of deposit. He had had an experience of 12 or 13 years, and had never occasioned any nuisance, though his farm was placed by the side of the road and opposite a public park. If the principle of the clarification of sewage was made clear, it would be possible to deal with town sewage with a minimum of land, and the estimate made of an acre to a thousand persons would probably be found sufficient. This would prevent the great difficulty which now arose, and the enormous prices to which land in the neighbourhood of towns was raised when wanted for sewage purposes.

Mr. W. Hope, V.C., thought if Mr. Smee had revised his paper before printing it he would not have made the sweeping assertions he had against all irrigationists. Sufficient was stated in his letter, which had appeared in the *Journal*, to show that the present state of things was susceptible of great improvement by the intervention of Government supervision, for no doubt the ordinary sewage swamp was a nuisance which ought to be done away with, and if sanitary science were true, then the principle on which some sewage farms were conducted at present was entirely false. The sewage passed upon many farms could not be purified, in consequence of its being put on in excessive quantities at one time. Instead of the stream being so subdivided as to enable the crops or soil to extract from the sewage the manurial ingredients, it was turned over for days together, as used formerly to be done at Croydon. He was glad that Mr. Smee recognised the fact, that sewage could not be finally and entirely purified without being passed over or through the land. He had fought many battles against those who simply passed sewage over the land and then ran it off, and he thought that the nonsensical system of passing the same sewage over two or three successive acres of land, and then off the surface, ought to be prohibited, as it was not purified in any degree. On one occassion the Committee of the British Association found that some samples of the effluent water were positively fouler in albumenoid ammonia than the original sewage, which arose from the fact that the land was so saturated that there was a concentration of albuminous ammonia. On no properly laid out farm ought it to be possible for one drop of liquid to escape on any neighbouring land. He had never advocated such a course, and believed no one would who knew anything about enteric diseases. He entirely agreed with what had been said about watercresses, and nothing would induce him to eat any in London, because the bulk of those sold here were grown from effluent sewage water. Dr. Cobbold some years ago pointed out the possible danger where sewage was imperfectly applied, of causing parasitical diseases. Having had a bullock fed upon nothing but the rakings of sewage grass, which was most likely to contain the ova of intestinal worms, he invited Dr. Cobbold, Mr. Marshall, and Mr. Corfield to attend at the *post-mortem* examination of the animal, which they did, and Dr. Cobbold said he had never seen a healthier animal. He did not pretend that sewage farm produce was more wholesome than any other, but considered this result was due to the fact that the animal had only drunk pure water. It was a mistake to suppose that properly conducted sewage farms produced any kind of food which was unwholesome for cattle. Mr. Smee having quoted a petition presented to the National Assembly at Paris, he might mention that that petition was presented by a manufacturer of sulphuric acid and sulphate of alumina, who believed the sewage might be clarified by that substance, and that he might profitably supply it. Having gone over to Paris to investigate certain charges

made against his works there, he found that they had nothing to do with the sewage of Paris, but arose from the erection of weirs, which raised the level of the water. The declaration stated that M. Congé's furnace fires were put out, and that certain other disasters had happened to him; but an inspection of the place proved to him that the petition was nothing but a tissue of falsehoods.

Mr. A. Smee, jun., said his experiments were entirely opposed to the statement of Dr. Carpenter, that the milk from cows fed on sewage grass was up to the average, or above it. He kept cows himself, and had experimented very carefully on the sewage grass from the Croydon farm. Making more butter than his own family required, he had always been able to get the best price for it, but after feeding his cows on sewage grass he immediately heard complaints. On discontinuing it, his customers returned, but on again trying the sewage produce, this time in the shape of dry hay, the whole of his customers left him in ten days, and he had a quantity of butter left on his hands. He next took two cows of the same breed, and carefully stall-fed them, one on sewage grass, and the other on meadow grass. The result was that the butter made from the sewage grass fed cow required longer to make, and went rancid much more quickly than the other, whilst the milk itself would dialyse, unlike ordinary milk. Not only so, but the cow herself rapidly got out of condition. He next made an infusion from a definite quantity of sewage grass, and of ordinary grass, and analysed it for ammonia; the result was that in the latter the ammonia compounds were 9·1, whilst from the former they were 22·4. This seemed to show that at a certain period of their growth plants would take up sewage matter unconverted, and that it would pass unchanged into the juices. Professor Edward Solly informed him that if you watered a musk plant with Guinness's stout for some time, and then bruised the leaves, they would smell not of musk, but of beer. Therefore, if cows were fed on sewage grass, he thought it quite possible that the impurities might pass into the milk, although they might evade chemical analysis. He was informed by a friend that in some parts of the West Coast of Ireland the cows were occasionally fed with fish, which communicated its taste to the milk, and children who drank it were found to suffer from diarrhœa. If this were so, it was equally possible that the animal matter of typhoid poison might pass into the milk, though without being detected by analysis. He was quite certain that no chemist in England could detect an ounce of fæcal matter added to a gallon of milk, though that would be quite sufficient to cause the most disastrous results. He had also experimented on the produce from other sewage farms, and found that mangolds and such like crops from sewage farms did not produce so much feeding and fattening result on stock, as an equal weight from ordinary land. The roots did not differ so much at an early period of the year, but lost their feeding power at the close of the season. With regard to the statement of Dr. Carpenter that the effluent water at Croydon was perfectly pure and good, he had proved to his own satisfaction that his own cattle had on more than one occasion taken the foot and mouth disease from drinking this water, the disorder having disappeared when this supply of water was cut off, and re-appeared, when, by accident, they again got access to it, while those animals which were kept shut up did not suffer at all. He held a peculiar view in regard to this disease, in which he differed from most veterinary surgeons, but was supported by one of the medical officers in the midland counties, viz., that it held the same relation to scarlet fever in the human subject, as Trissot had shown existed between grease in the horse, scab in sheep, vaccine in cows, and small-pox in human beings. He thought if successive portions of grass, irrigated with sewage, were cut, an infusion made, and the albumenoid matter ascertained at different periods of growth, they might hope to find some scientific basis for determining how much sewage land was capable of absorbing.

Mr. Addy, being connected with the Beddington sewage farm, desired to say a few words on this subject. He felt that if the restrictions and penalties which Mr. Smee had recommended were carried out, it would not only stop all present sewage farms, but Government would stultify themselves in what they had already done. When the imperfect condition of ordinary farming was considered, it was no wonder that sewage farming had not yet been brought to the point which they hoped would be attained. Mr. Smee said that sewage ought to go to the ocean, and be there dispersed and oxidised, but he considered this would be a very wasteful process. As to the question of nuisance, he had been day by day for twelve months at the Beddington farm, and if there were any nuisance he must have discovered it; but he could only say he would much rather live in immediate contiguity to an irrigation farm than to any filtration or chemical works. But he thought Mr. Smee did not so much attack irrigation farms *per se* as their mismanagement; and no doubt there were many faults, especially in those which were laid out before so much experience had been gained as was now available. But even the sewage meadows at Edinburgh, which had been in existence 200 years, and were by no means well-managed, were reported on by Dr. Christison, in 1865, as producing no deleterious results. Then, with regard to an independent Government inspection, he believed that was the case at present, at any rate before any compulsory powers were granted, and any witness was entitled to be heard upon the inquiry. No one would object to a notice being put up stating the nature of the effluent water, but the very fact that persons made use of it showed that it was not so bad as had been represented. It would be impossible in many cases for sewage farms to be laid out within the district or parish. If the question were submitted to the inhabitants, he feared they would always be opposed to it, for very few sanitary improvements would have been carried out if they had depended on a vote of the ratepayers. He acknowledged that some of of the Beddington land was waterlogged at some periods of the year, but that could be overcome by pumping, and thus the ground might be dried, and due opportunity given for the proper effects of irrigation. Sometimes there might be offensive odours, but they might be avoided by better management, partly by the use of depositing tanks, and by the carriers being elevated above the surface, and flushed with pure water occasionally. He thought the true solution of the sewage difficulty would be the combination of the precipitation by lime or some similar process with irrigation. No one would advocate feeding cattle on sewage produce within a month after sewage had been applied to it, and then he considered rye-grass a most excellent crop. If the restrictive measures proposed were carried out it would be highly inconvenient, would prevent the working of the Public Health Act, and in his opinion would lead to retrogression in sanitary matters.

Mr. G. B. Galloway had paid a good deal of attention to this subject as an inventor, and thought it was one of the most important which could come before the Government, not only in its sanitary aspect, but on account of the value of sewage in producing more food for the community. The two main ideas he wished to suggest were, first, that large pumping engines and hydrants should be provided and arranged, so that farmers could have a supply of sewage as they wanted it; and secondly, that instead of sewage being turned out into tidal rivers, it should be conveyed in a canal or culvert to the sea shore, where the deposit it always occasioned might be utilised for growing crops upon, instead of stopping up the water way.

Mr. Baldwin Latham, as the engineer of the much maligned Croydon sewage farm, wished to point out that

Mr. Smee's paper set out with an erroneous statement, viz., that the water-closet system required an average consumption of water per head equal to thirty gallons per diem. He had taken the trouble to ascertain the consumption of water in several towns where water-closets were in use, and also in others using what was termed the "dry system," which gave the following results:—

Water-closet Towns.

	Quantity per head.
Alnwick and Canongate	30
Barnet	30
Croydon	56
Liverpool	26
London	29
Penzance	25
Plymouth	40
Uxbridge	20
Warwick	30
Watford	30
Average	31·6

Middenstead Towns.

Atherton	40
Ayr	38
Bradford	26
Bacup	33
Glasgow	50
Lincoln	30
Malton	40
Ormskirk	40
Perth	30
York	30
Average	35·7

This showed that it was not the water-closets which occasioned the use of the water, and in fact an allowance of two gallons per head per day would be ample for that purpose. He could not see the object of the attack which had been made on the Croydon farm; and with regard to the pecuniary results, though it was true it did not produce a profit, it cost much less than the various deodorising processes which had been tried before, and was more effectual. Besides, the land to which the sewage was applied produced tenfold the amount it did before, and thus indirectly the community gained by the increase of food production. The fact was, that after balancing accounts the expense was much less than it used to be for chemicals for the deodorising process. As to the statement about the sewage being too much diluted, plants required their food in solution, and it appeared to him that taking the ordinary rainfall, 20 tons of farmyard manure put upon a field would yield a much more dilute solution than that which was applied at Croydon. Then again, Mr. Smee spoke of poisons, but if they existed they were so infinitesimal that no chemist had ever thought it worth while to mention them. One of those mentioned as being highly dangerous was a disinfectant, and yet in a subsequent part of the paper Mr. Smee recommended disinfection of sewage, which it seemed must be dangerous also. In several other points he was inconsistent, saying for instance, that the sewage should flow through the land and not over it, and in another place, that there were cracks and fissures through which the water would run away and pass nobody knew where. Mr. Smee, junior, did not seem very well skilled in cow-keeping by his own account, but those who made their livelihood by it purchased the sewage produce by thousands of tons, and never complained of the dire effects which he had experienced. With regard to the question of deodorising, he held in his hand a table extracted from the reports of Royal Commissioners, and he found that the Croydon sewage before deodorisation contained a total quantity of impurities of 45·7 in 100,000 lbs.

	Croydon. Crude Sewage. (8th October, 1868.)	Croydon. Irrigation Effluent. (8th October, 1868.)	Weare's Filtration. Effluent. Stoke.	(1868.) Lime Process. Effluent. Leicester.	Chloride of Iron and Lime. Effluent. Nottingham.	Holden's Process. Effluent. Bradford.	Dr. Bird's Process. Sulphate of Alumina. Effluent. Stroud.	A. B. C. Effluent. Leamington.	Phosphate Process. Filtration. Dr. Voelcker.
Total Impurities	45·7	37·9	54·25	88 0	85.5	144·4	53·5	99·2	63·45
Organic Carbon	2·508	·605	2·45	2·870	1·815	5·858	2·203	3·379	...
Organic Nitrogen	1·576	·120	·67	·247	1·779	1·215	·692	1·652	·47
Ammonia	3·006	·005	4·90	2·125	5·000	1·279	2·275	5·815	3·34
Nitrates and Nitrites	·0	·382	6·93	·024	·000	·265	·033	·0	..
Total combined Nitrogen	3·527	·506	6·93	2·021	5·837	2·533	2·598	6·392	...
Chlorine	4·23	2·58	4·96	Not given.	Not given.	6·50	Not given.	11·00	...

Those results showed that each individually contained more polluted matter than the sewage of Croydon in its crude state. If they created a nuisance there was no law exempting Local Boards from the consequence of that nuisance, and if it could be established that there was a nuisance prejudicial to health, it would not be long before the law was put in force against them. The result of bringing the sewage to the outlying districts at Beddington had been to increase the value of land immensely and to lessen the rates. With regard to the question of the effluent waters escaping from the farm to other lands, he might say that the neighbouring owners were only too glad to cut a hole in order to let it run through to their land, and in one instance a market gardener had made arrangements with them in order to have the sewage on to his land. Those were facts against mere assertions. Mr. Smee had raised the point that no sewage farm ought to be established unless a sort of cordon were put round it to the extent of 200 yards; but it would be almost impossible to find a piece of land sufficiently large in a small place to allow of that being done; and if such a thing were done, a very large portion of the country would be robbed of the fertility necessary for the cultivation of crops. He entirely denied the statement that the produce of the Croydon sewage farm was sold only to the very poorest, and asserted that some of the most advanced agriculturists and largest capitalists in Surrey sent to the farm for the produce. For the last ten years he and his family had used the milk from cows fed on the farm without feeling any ill effects, and, therefore, it was absurd to say that such milk was highly dangerous, and that those who sold sewage produce ought to be fined for so doing. Mr. Smee said the only fit use for sewage was to cultivate weeds, but he would ask whether any man in his senses would dream of turning sewage into a pond in order to make a dismal swamp, as was the case in the Fen districts. Mr. Smee also

stated that sewage farms ought to be heavily fined, but he had miscalculated the amount, and instead of £350 a-day, it should have been £525. The statement that a £5 fine should be inflicted for every false statement of death was an innuendo that such misrepresentation had taken place, although in truth it appeared that the neighbourhood in the vicinity of the sewage farm was the most healthy. As Mr. Smee had not stated what he proposed to do with the fines when inflicted, he supposed he intended them to be distributed amongst the adjoining aristocracy, when he (Mr. Smee) would come in for his share of the plunder.

Mr. Saywell said Baron Liebig, in a pamphlet on the value of the sewage of the metropolis, stated it to be worth some millions annually, and gave statistics proving his statement. As a ratepayer he felt that the time had arrived when something ought to be done for the utilisation of the sewage of the metropolis. He felt there were great difficulties around the question, and one of the difficulties related to the report published by the Commissioners appointed to inquire into the pollution of rivers, for in that report they laid it down as an incontrovertible fact that the sewage could not be prevented from going into the rivers, and that the supply of water to the metropolis should be withdrawn. He considered that they had gone beyond their province in making that statement; for he believed if the sewage were diverted from the rivers they would form the best source of supply to towns. It was not a money question simply, but a question in which the public were concerned; and if it had not been productive of a great money gain to the Croydon Board of Health, still it had increased the value of the land in the neighbourhood, and been an advantage to the ratepayers. He trusted in any steps taken by the Government in reference to the question, that they would not throw any obstacle in the way of proper utilisation of the sewage, for he believed that nature wasted nothing, and that everything produced might be turned to some account.

The Chairman said the observations made by the last speaker explained to a great extent why it was there was the uncertainty and dissatisfaction, he might almost say the querulous spirit about the manner in which sewage could be disposed of. About 40 years ago, when Mr. Chadwick first started the sewage question, the public mind got impressed with the idea that sewage might be made to pay the rates and taxes, and it was in consequence of that false impression that nothing had really been done with the sewage question. It had been looked at rather as a money than a sanitary question, and therefore it was the subject was in its present uncertain and unsatisfactory condition. Baron Liebig, when he made his report, fell into the same mistake as Mr. Chadwick and his party did, by founding his estimate upon the condition in which it would be merchandisable, instead of upon the condition in which it would be when it came to the hands of the engineer who had to deal with it. They took the population of a large city or town, and found that taking 1,000 people they consisted of 302 men, 368 women, 164 boys, and 166 girls. They then made a large number of experiments to ascertain the quantity and quality of the excreta of that 1,000 persons, and found it to consist of 2,266 lbs. of urine and 178 lbs. of fæcal matter, or 2,444 lbs. in the aggregate. The question of the cost of drying the excreta was not considered as it ought to have been. After it had been dried, the urine was found to contain 96 lbs. and the fæcal matter 42 lbs. of solid matter, containing nitrogen 20·0 and 2·3, total 22·3; phosphoric acid 3·0 and 2·1, total 5·1; potash 3·4 and 0·8, total 4·2 The value of the excreta of those 1,000 people at the present price, was:—

lbs.				s.	d.
22·3 N = 27·1 ammonia, at	7d.	per lb.	....	15	9¾
3·0 soluble phosphoric acid	4d.	,,	..	1	0
2·0 insoluble do.	2d.	,,	..	0	4¼
4·2 potash	3d.	,,	..	1	10½
Total				18	2½

or £332 16 0½ per thousand people per annum, or 6s. 7¾d for each person. That had led to a great deal of conflict among chemists as to the value of excreta, but they all forgot what had been the cost of realising this. In this way it had been variously estimated as worth from 6s. 6d. to 20s. per head of population per annum. They had gone further, and said the dry soluble matter of urine was worth £18 14s. 1d. per ton, the excremental matter, when dried, £5 17s. 7d., and common cesspool matter £14 16s. 4d. per ton, and in the wet state the urine was worth £15 10s. per ton, fæcal matter £1 7s. 6d. per ton, and cesspool matter 15s. 8d. per ton, but who had ever realised anything like those amounts in commerce? During the time when London was a cesspool city, instead of 15s. 8d. per ton being got for cesspool matter it only realised 2s. a load when delivered into barges; and at the present time a cubic metre of the matters removed from cesspools in Paris only fetched one franc; so that there was just that difference betwixt what might be considered the laboratory value and the actual value of the materials. There was another mode in which it might be estimated; 1,000 people, consisting of the same proportions as before, furnished, upon an average, about 375,000 gallons of sewage daily. When submitted to a laboratory experiment that yielded in pounds avoirdupois:—

	Organic matter.		Mineral matter.		Total solid.
In solution	80·8	..	217·8	..	298·6
Suspended	86·3	..	118·1	..	204·4
Total ..	167·1		335·9		503·0
Containing—	Nitrogen.		Phosphoric acid.		Potash.
In solution	29·1	..	4·6	..	6·5
Suspended............	4·2	..	4·8	..	0·8
Total ..	33·3	..	9·4	..	7·3

Which, at the market price of the constituents, was worth

lbs.				£	s.	d.
33·3 N. = 40·4 ammonia, at	7d.	per lb.	....	1	3	7¼
4·6 soluble phosphoric acid	4d.	,,	....	0	1	6½
4·8 insoluble ditto	2d.	,,	....	0	0	9½
7·3 potash	3d.	,,	....	0	1	9¾
Total				1	7	9

By the other mode of calculation it was 18s. 2½d., and the difference of 9s. 6½d. was considered to arise out of street washings, slops, &c. When that was worked out it came to this, that the sewage of every 1,000 people, valued according to that mode of estimating the value, was worth £506 8s. 9d. per annum, which was just 10s. 1½d. per head of the population; and when it was worked into tons, a ton being about 220 gallons, it was worth 1½d. per ton. Upon such data as that men had before select committees of the House of Commons given evidence that the sewage of the metropolis was worth from ½d. up to as much as 9d. per ton; and he was sorry that Baron Liebig should have lent his name to what might be termed such a false notion. He did not describe it as a thing absolutely valueless, but he did say it was a false notion to imagine that sewage was of such value that, instead of costing the population something to get rid of it, it ought to realise something towards the payment of the rates. Whenever a question arose at the present time in any town upon the subject of the pollution of a river, or the creation of a nuisance by the misappropriation of the excreta of a town, it invariably arose from the indisposition of the local authorities to do anything, in consequence of their thinking they ought to get something for the sewage. That was

the whole secret of the disputes and differences arising out of the sewage question. The difficulty had arisen from the misunderstanding he had mentioned, and the sooner such misunderstanding was got rid of, and local authorities were made to understand it was their duty to regard the disposal of sewage entirely as a sanitary question, the sooner would they come to an end of the differences. He had long since come to the conclusion stated in the paper, that local authorities should be fined for not properly disposing of the sewage, although he did not go to the extent of the fines mentioned. In conclusion he begged to propose that the best thanks of the meeting be given to Mr. Smee.

Mr. Smee, in reply, said his paper was intended to be a belligerent one, in order to evoke discussion. He was not an enemy to sewage irrigation, and the whole point of his paper was to show that sewage farms must and ought to be properly and fairly conducted. Referring to the letter received from Mr. Hope, he said he considered it ought to be printed in letters of gold, for in that letter the greater part of the sewage questions were dealt with in a practical, philosophical, and almost perfect manner. Time was the very essence of the thing, because if animal matter were taken into the stalk of a plant it required a certain time before it was assimilated, and that point was now conceded by those who knew anything of the subject. Mr. Hope had not mentioned whether he would defecate it, but if he would, he should consider the labour bestowed upon the preparation of the paper had been well spent. Next, General Scott stated that all the evidence given before the Parliamentary Committee showed that sewage must be defecated before it was put upon the land, and if that principle were admitted, the sewage question was almost settled. That was why he thought there ought to be a penalty on its non-adoption. Of course there was the difficulty and expense, which often stood in the way, and he had no doubt that if Mr. Latham could have his own way, and were not hampered by the penny-wise and pound-foolish principle, which he had himself condemned, he would soon have things in proper shape. Dr. Carpenter came next, and it was hardly necessary to say anything about him, since he had adopted his own view, saying that if the evils which had been described, in fact existed, he should be in favour of imposing even heavier penalties than he had proposed. However, as he had controverted so many of his statements, it would be necessary to go through his remarks in detail. In the first place he said that he (Mr. Smee) had given no principles on which the question should be dealt with; but the fact was it depended on the principles of heat, cold, moisture, dryness, vegetable and animal physiology, in short on all the principles of nature. As to the fines of £350 a day being too heavy, that was but a small sum compared to the penalty of £10,000 to which they were liable for a breach of the injunction granted by the Court of Chancery against allowing any of the sewage to flow into the river Wandle to the injury of neighbouring owners, and three such injunctions were granted against the Croydon Local Board. There was a specimen on the table of a trout, one of a cartload which had been killed by the poisonous matter turned into the stream, and which he had assisted the Local Board authorities to trace to the gas works, and showed them how to get rid of it. This showed he had no ill-feeling against them when they were willing to act properly. Dr. Carpenter asked why they were not prosecuted. Perhaps he did not know how near they had been to prosecution several times. He was not a public prosecutor, or they would have been in his clutches long ago. With regard to his denial of the statement that there had been an epidemic of typhoid fever, he must say he never heard a more astounding statement. He held in his hand the printed report stating the mortality, and no reference, even in a note, to the fact of the epidemic, although it must have been known before it was issued. An eminent medical man wrote as follows:—"In February three cases of typhoid appeared in the district. Two of these cases were imported, and I was aware of their presence. By the end of April more than 200 cases were known to have occurred." That was signed "Alfred Carpenter, M.D." and by the end of June he reported 34 killed and 400 arrested. Then he said that for ten years up to that time Croydon had been perfectly free from typhoid fever, but this he could show not to be the case by reference to the returns. With regard to the penalty he suggested for not making proper returns of the cause of death, he considered that absolutely necessary for the security of the people. On one occasion, having reason to believe that cases of fever had occurred, he inquired of the undertaker where the deaths were registered, and found it was at Sutton; but on sending to obtain the information he was told he would have to pay a fee of 2s. 6d. for every certificate, and thus it would have cost him £40 to get the information he wanted. That showed that the system required alteration. A gentleman then present told him that a friend of his came from Australia, and looking upon Croydon as a healthy place took lodgings there, took the fever, and was now in his grave. With regard to the sewage being diluted, he referred to the enormous quantity of water involved, which no one but an engineer would have any idea of. One million gallons represented a height of 1,340 feet on an acre, or upwards of 4,000 feet for three millions, and dividing that over 400 acres it represented 120 inches per annum, which was so excessive that it must convert the land into a swamp. None of the Local Boards could see it in that light, but the birds soon found it out, as was proved by the quantity of snipe which visited it in the winter. If further proof were needed he might mention that on the previous Saturday some thirty or more boys and girls were skating and sliding on the piece of ground where it was said the water was drained away in the most satisfactory manner. Again, Dr. Carpenter said there was no putrid sewage at Croydon, but in avoiding Scylla he fell into Charybdis, because every medical man knew that the poison of typhoid fever was far more effective in its fresh state, and he stated that the sewage passed over the land within ten hours, so that in less than a day the fæcal matter was in full bloom on the water-cresses, tons and tons of which were grown and sent to London. On the table were two vessels filled, one with water-cresses, and the other with grass, over which filthy sewage had been poured, and it would be seen that the water which flowed through was tolerably clear, showing that the fæculent matter was arrested by the leaves and stalks of the vegetation, which was eaten, in one case by human beings, and in the other by animals. Then it was said that no one had suffered from the sewage farm, but the following extracts from the register would show the cause of death in the instances referred to:—

No. 1868.

73. Typhoid fever, 19 days; congestion of brain.
95. Typhoid fever, 16 days; congestion of brain.

1869.

243. Enteric fever; ulceration of bowels.
249. Enteric fever.
250. Fever.
286. Peritonitis; pleuropneumonia.
336. Scarlatina maligna, 14 days.
350. Gastritis, 4 days.
359. Scarlet fever, 9 days.
375. Scarlet fever; convulsions.

1870.

376. Scarlet fever; convulsions.
395. Diptheria; inflammation of chest, 1 week.
436. Malignant scarlet fever, 5 days.
485. Scarlet fever, 7 days; effusion of brain, 48 hours.
489. Scarlatina, 14 days; albuminuria, 5 days.
490. Scarlatina, 5 weeks; albuminuria, 14 days.
498. Scarlatina, 18 days; albuminuria.
22. Scarlatina, 19 days.
65. Scarlatina, 11 days; diphtheria, 5 days.

He had also obtained from Dr. Farre, at Somerset-house, the following figures as to the deaths at Carshalton, and it was there you must look for the effects, not in Croydon itself:—

Deaths at Carshalton.

	Deaths.	Scarlet Fever.	Fever.	Whooping Cough.
Sept. quarter, 1875	71	11	0	4
Dec. „ „	60	8	1	1

Croydon Sub-district.

		Zymotic.
June, 1875	369	60
September, 1875	359	69

Dr. Carpenter had reproduced statistics which he had shown to be fallacious on more than one occasion already, and in order that the matter might be properly understood he had obtained from an eminent actuary the following tables, the meaning of which would be explained by the correspondence:—

7, Finsbury-circus, London, E.C., January 3rd, 1876.

My Dear Sir,—It is a matter of public interest to know the rate of mortality which may be expected per thousand in the town of Croydon, where during the past year a great epidemic by typhoid fever has raged.

If adequate materials exist for the calculation of an authoritative statement of the numbers at each age and of both sexes, I should be greatly obliged if you would calculate the expected number for me. It appears to me that they should be calculated on the results of the mortality of Surrey, that is to say, of the population of Extra-Metropolitan Surrey, which from its large amount will give satisfactory results; and I further think that we should make the comparative calculations for the same year that the ages were determined, as the only method which can give reliable results.

Are there reliable data upon which similar calculations may be made with regard to Beddington parish, as it is of much public importance that a minute calculation should be made to compare the expected with the real results?—I have the honour to be, my dear Sir, yours very faithfully, Alfred Smee.

F. A. Curtis, Esq., F.I.A., Actuary to the Gresham Life Assurance Society.

The Gresham Life Assurance Society, 37, Old Jewry, E.C. London, January 14th, 1876.

My Dear Sir,—Adequate materials exist in the Census Report for 1871, and in the Registrar-General's Annual Report for the same year, to calculate the mortality which might be expected amongst the population of Croydon based on the mortality which occurred amongst the population of Extra-Metropolitan Surrey.

I have the pleasure to enclose the result of the calculations, made for every year up to five years of age, for every five years up to twenty-five years of age; and subsequently for every ten years of age; but as the population of Croydon is included in the population returns of the Census with reference to Extra Metropolitan Surrey, I have deemed it necessary for the purpose of a rigorous comparison to subtract from the population of Extra-Metropolitan Surrey the numbers of persons living and dying in the district of Croydon, by which it is shown that 56 more deaths at all ages occurred at Croydon in 1871 than might be expected from the mortality of Extra-Metropolitan Surrey. I have also calculated the mean mortality per thousand; the results will be seen in the accompanying tables.

It is to be remarked that the mortality of the first years of infancy is greatly in excess at Croydon over that in the Surrey district.

I am not aware that any materials exist for estimating the mortality in Beddington parish, as the census reports do not distinguish the population of that locality from the population of Extra-Metropolitan Surrey, and the deaths are not given separately by the Registrar-General.

It is proper to observe that as the deaths in Croydon town are conjoined with those of surrounding districts, it is probable that, if the returns of its suburban districts were subtracted from the returns under the head of "Croydon," so as to reduce the figures to those of the town proper, the deaths in Croydon would appear in still greater excess.

Comparative Mortality of Croydon and Extra-Metropolitan Surrey (with and without Croydon).

Males.

Ages.	Croydon Deaths. Actual.	Estimated on Surrey Mortality. With Croydon.	Estimated on Surrey Mortality. Without Croydon.	Actual Deaths per 1,000. Croydon	Surrey. With Croydon.	Surrey. Without Croydon.
0	231	195	184	188·0	158·6	149·7
1	52	44	42	48·2	40·9	38·7
2	14	20	22	11·9	17·3	19·1
3	15	13	13	14·0	12·4	11·9
4	15	13	12	14·0	12·0	11·4
5— 9	26	30	31	5·3	6·0	6·2
10—14	13	17	18	3·1	3·9	4·2
15—24	39	37	37	6·4	6·1	6·1
25—34	56	60	61	9·8	10·5	10·6
35—44	60	64	65	13·8	14·8	15·0
45—54	51	56	57	16·5	18·1	18·6
55—64	61	59	59	33·4	32·4	32·2
65—74	50	59	61	48·8	57·5	59·5
75—84	56	56	56	151·8	151·9	152·0
85—94	13	13	14	282·6	292·0	294·1
95	—	—	—	—	—	—
	752	736	732	20·2	19·6	19·5

Females.

Ages.	Croydon Deaths. Actual.	Estimated on Surrey Mortality. With Croydon.	Estimated on Surrey Mortality. Without Croydon.	Actual Deaths per 1,000. Croydon.	Surrey. With Croydon.	Surrey. Without Croydon.
0	202	148	131	163·3	119·3	105·5
1	45	38	36	40·8	34·3	32·3
2	22	20	20	18·9	17·4	16·9
3	21	13	11	18·7	11·6	9·4
4	20	13	11	18·9	12·1	10·1
5— 9	26	31	32	5·2	6·2	6·5
10—14	24	20	19	5·2	4·4	4·1
15—24	42	46	48	4·3	4·7	4·9
25—34	51	55	56	6·4	6·9	7·1
35—44	38	57	64	6·9	10·4	11·6
45—54	41	51	54	11·3	14·1	14·9
55—64	78	62	58	32·1	25·7	23·8
65—74	65	77	81	46·4	55·1	57·6
75—84	63	69	71	127·3	139·7	143·0
85—94	23	23	23	359·4	366·3	364·6
95	—	1	1	—	625·0	714·3
	761	724	716	16·3	16·4	16·4

MALES AND FEMALES.

Ages.	Croydon Deaths.			Actual Deaths per 1,000.		
	Actual.	Estimated on Surrey Mortality.		Croydon.	Surrey.	
		With Croydon.	Without Croydon.		With Croydon.	Without Croydon.
0	433	343	315	175·6	139·1	127·7
1	97	82	78	44·4	37·6	35·5
2	36	41	42	15·4	17·4	18·0
3	36	26	23	16·4	12·0	10·6
4	35	26	23	16·4	12·1	10·7
5—9	52	61	64	5·2	6·1	6·4
10—14	37	36	36	4·2	4·1	4·1
15—24	81	86	87	5·1	5·4	5·5
25—34	107	117	120	7·8	8·6	8·8
35—44	98	123	131	10·0	12·5	13·3
45—54	92	107	112	13·7	16·0	16·7
55—64	139	123	119	32·7	28·9	27·9
65—74	115	136	142	47·4	56·2	58·5
75—84	119	125	127	137·7	145·2	147·1
85—94	36	37	37	327·3	333·3	334·7
95	—	1	1	—	777·8	875·
	1,513	1,470	1,457	18·0	18·0	17·9

Comparison of Deaths from various causes in Croydon, and in Extra-Metropolitan Surrey (excluding Croydon).

Causes of Death.	Actual Deaths.			Estimated Deaths for Croydon based on Extra-Metropolitan Surrey, excluding Croydon.	Difference of Croydon Actual Deaths on Estimated Deaths.	
	Extra-Metropolitan Surrey.	Croydon.	Extra-Metropolitan Surrey, excluding Croydon.		+	—
Small-pox	184	81	103	31	50	..
Measles	83	27	56	17	10	..
Scarlet fever	220	41	179	53	..	12
Diptheria	37	5	32	10	..	5
Whooping cough	86	41	45	13	28	..
Typhus fever	13	..	13	4	..	4
Enteric or typhoid fever	119	30	89	27	3	..
Simple continued fever	33	5	28	8	..	3
Erysipelas	46	4	42	13	..	9
Metria or puerperal fever	18	5	13	4	1	..
Childbirth	34	12	22	7	5	..
Influenza	7	..	7	2	..	2
Dysentry	13	4	9	3	1	..
Diarrhœa	311	88	223	66	22	..
Cholera	4	1	3	1	..	..
Phthisis or consumption	757	159	598	178	..	19
Diseases of respiratory organs	956	219	737	220	..	1
Violence	186	36	150	45	..	9
Inquests	323	48	275	82	..	34

The population in the district of Croydon is very nearly three-tenths of the population of Extra-Metropolitan Surrey, exclusive of that of Croydon. Therefore, the deaths returned in Extra-Metropolitan Surrey, after deducting the deaths returned for the Croydon district, would be the basis for the estimate of deaths that should occur in the population of Croydon, upon the assumption of an equal rate of mortality. I subjoin a nosological table of mortality.—Believe me to be, my dear Sir, yours faithfully,

F. A. CURTIS.

Alfred Smee, Esq., F.R.S., 7, Finsbury circus, E.C.

With regard to the manner in which the farm was managed, he would quote the following letter, written by Dr. Carpenter himself:—

"At the same time will you allow me to raise a strong protest against the way in which the Beddington Sewage farm is managed by the Croydon Local Board of Health? At this time the money of the ratepayers of Croydon is being ruthlessly wasted to a very large amount, and the financial credit of sewage farming seriously endangered by a mismanagement, such as can only be done by a local board or an Irish squatter.

"It is well-known, that to farm 500 acres of land fairly well requires a capital of about £10,000; but the Croydon Local Board, in the interest of the penny-wise and pound-foolish ratepayers of the parish, are farming this land without placing a sixpence to the credit of the farming account. They have been turning rye-grass into hay, thus losing one-half of its value, and they are growing cereals upon land for which they pay £10 an acre rent, and by the same act seriously decreasing their power of purifying the sewage; whilst a most luxuriant crop of weeds is now filling the ground with seeds, which will give much trouble in future years. The grass when I saw it a month since, was rotting on the ground for want of labour to take care of it; and it fully matched in appearance the most disgraceful farms which occasionally appear on this side of the Irish Channel, and which indicate a want of capital as well as a want of knowledge in their management."—I am sir, your obedient servant,

ALFRED CARPENTER, M.D.

Newcastle, County Down,
August 19th.

When he spoke of the Female Orphan Asylum, he conveyed the idea that no injury had been caused to its inmates, but the fact was they had had 60 cases of fever and three deaths; and though he could not say these were caused by the milk, because he had not investigated the cases, it was a curious fact that the more milk the patients drank, the worse they became, and on one occasion a tadpole was found in it. A specimen of hay had been produced, but he had no hesitation in saying that it was not a fair sample, because on passing his fingers over it he found no sewage excreta adhering to it, as he had done when he had taken a sample from the stack himself. With regard to the roots, he acknowledged that if the ground were properly turned over, roots might be found fit for use, though not so good as those treated in the ordinary way. Then Dr. Carpenter said he took issue with Mr. Hope, General Scott, and the other great authorities who had spoken of the necessity of defecation, which he thought not very becoming, and had flatly contradicted him with regard to the sewage flowing over other people's land; but that was not the way to meet a positive statement of fact. He repeated that he had seen the sewage overflow into Beddington-park, even since he read the paper, and had got the park-keeper to measure the distance, 19 poles; in fact, a deep drain was now being made to prevent it. No one had really opposed his proposals except Mr. Addy, who said if they were adopted sewage farms could not be carried on, but if they could not, without encroaching on their neighbours' rights, the sooner they were stopped, in his opinion, the better. He said it would be very inconvenient; and in the same way some people though it inconvenient that they were not permitted to pick other persons' pockets. He had as much right to be protected against injury from sewage as against petty theft, which was of much less real im-

portance; and, no doubt, he could protect himself by Chancery proceedings, but they were difficult and expensive. Mr. Botly spoke of the violets grown at Aldershot; he could only say that if they were grown under sewage irrigation, the officers must have presented to their ladies much which they never bargained for, but the mystery was cleared up by a succeeding speaker, who said that the sewage went on the farm two days a-week, and the remaining five through a pipe direct into the watercourse. If that statement were confirmed, the sooner all such farms were put under stringent regulations and regular inspection the better. The following table would show the difference between the pure water from the Croydon wells and the effluent sewage from the farms:—

Croydon Well.

Common salt	2·00
Nitrogen oxide	0·018
Ammonia	0·003
Organic matter	0·004

Effluent Sewage every quarter of an hour.

Salt	3·400
Nitrogen	0·419
Ammonia	0·032
Organic matter	0·144

Sewage towns, Norwood and Beddington.

	Organic carbon and nitrogen.
Minimum	0·114 per gallon.
Maximum	1·786 ,,
Average	0·821 ,,

The Royal Commissioners said, "We unhesitatingly condemn the whole of them as dangerous and totally unfit for drinking." Average Thames water was much better than this, only containing an average of ·021 organic carbon and nitrogen, whilst rain water contained ·084. The effluent system at Croydon was an abomination; the effluents were very difficult to trace, but he had reason to believe that not being protected by notice boards persons might drink of the water unwittingly. In conclusion, he hoped the discussion, which had been taken up with such earnestness by so many leading engineers, and which would be read very widely, would not be wasted, but that before long the sewage question would be settled in a more satisfactory way than it was at present, especially at Croydon.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

January 26.—"Iceland, its Scenery and its Rocks," by W. L. Watts, Esq. Illustrated by numerous Photographic Transparencies.

February 2.—"Condensed Beer," by Dr. Bartlett.

February 9.—"The Cultivation of Hardy Fruits, with a view to improvement of quality and ensuring constant and abundant production," by Shirley Hibberd, Esq.

February 16.—"The Combustion of Gas, and its application to Heating Purposes," by John Wallace, Esq.

February 23.—"Contagious Diseases of Animals as affecting the Health and Wealth of the Country," by George Fleming, Esq., Royal Engineers.

March 1.—"Aquarium Construction and Management," by W. Saville-Kent, Esq., F.L.S., F.Z.S.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

Jan. 25.—"Opening Address," by Vice-Admiral Erasmus Ommanney, C.B., F.R.S. (Chairman of the African Committee.)

Feb. 15.—"Ostrich Farming and the Ostrich Feather Trade of South Africa." By P. L. Simmonds, Esq., F.S.S.

March 14.—"The Diamond Fields of South Africa, and their Influence on the Native Races of the Neighbourhood." By J. B. Currey, Esq.

March 28.—"The Industries of South Africa." By T. B. Granville, Esq.

April 18.—"The Commerce of the Gaboon; its History and Future Prospects. By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Tickets are sent with this *Journal*.

Cantor Lectures.

Monday evenings at 8 o'clock. The Second Course, "On Iron and Steel Manufacture," by W. Mattieu Williams, Esq.

Lecture II.—January 24th.

Pig Iron, Refined Iron, and Puddled Bar.

The theory of the blast furnace.—The hot blast.—The utilisation of the waste gases of the blast furnace.—The advantages and disadvantages of the modern blast furnace.—The impurities of pig iron, and how they affect its quality and market value.—Grey, mottled, and white pigs.—Spongy iron and its properties.—Is the blast furnace likely to be superseded?—The refinery and its action on pig iron.—Cort's invention and subsequent improvements.—The construction of puddling furnaces and the operations of the puddler.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Mattieu Williams, "Pig Iron, Refined Iron, and Puddled Bar." (Lecture II.)
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. C. G. Grey, "Fences used in Agriculture."
Royal Geographical, Burlington-gardens, W., 8½ p.m. 1. Major-General Sir F. J. Goldsmid, "Captain the Hon. G. Napier's recent Journeys on the Turcoman Frontier of Persia." 2. The President, "Remarks on the same."
Medical, 11, Chandos-street, W., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Lankester, "Blood-red and Leaf-green."

Tues. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (African Section.) Opening Address by Vice-Admiral Erasmus Ommanney.
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "Classification of Vertebrated Animals."
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion upon Mr. Morrison's Paper, "The Ventilation of Railway Tunnels;" and (time permitting) Mr. James Barton, "Carlingford Lough and Greenore."
Anthropological Institute, 4, St. Martin's-place, W.C. Annual Meeting.

Wed. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Watts, "Iceland, its Scenery and its Rocks."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. George Browning, "The Old Northern (Icelandic) Language and Literature, with Illustrations drawn from Icelandic MSS."

Thurs. ...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. W. Crookes, "Radiation of Light."
Royal Institution, Albemarle-street, W., 3 p.m. Dr. Gladstone, "Chemistry of the Non-metallic Elements."
Civil and Mechanical Engineers, 7, Westminster-chambers, 7 p.m. Mr. Bancroft, "Testing and Strength of Materials."
Philosophical Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri. ......SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Special Lectures.) Dr. Benjamin W. Richardson, "Industrial Pathology, or the Influence of certain Injurious Occupations on Health and Life." (Lecture V.)
Royal Institution, Albemarle-street, W. 8 p.m., Weekly Meeting. 9 p.m., Prof. Tyndall, "The Optical Deportment of the Atmosphere in Relation to the Phenomena of Putrefaction."
Quekett Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.

Sat. ......Royal Institution, Albemarle-street, W., 3 p.m. Mr. Pullan, "Excavations in Asia Minor."
Physical Science Schools, South Kensington, S.W., 3 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,210. VOL. XXIV.

FRIDAY, JANUARY 28, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

SUBSCRIPTION FOR THE FAMILY OF THE LATE S. T. DAVENPORT.

In consequence of the very straitened circumstances in which Mr. Davenport's family are left by his sudden death, it has been found necessary to appeal to the members of the Society on their behalf. The matter having been brought before the Council, it was decided that, while the long and valuable services rendered by Mr. Davenport formed an indisputable claim, it was advisable to appeal to the private liberality of the members before considering the propriety of recommending a grant from the general funds of the Society. A circular is, therefore, now being issued to the members asking for contributions, and the Council earnestly hope that a sufficient sum may be raised to provide at least for the more pressing necessities of the case.

The following donations have already been promised:—

	£	s.	d.
F. A. Abel, F.R.S.	10	0	0
G. C. T. Bartley	5	0	0
F. J. Bramwell, F.R.S.	21	0	0
Edward Brooke	25	0	0
Andrew Cassels	10	0	0
Edwin Chadwick, C.B.	5	0	0
Lord Alfred S. Churchill	10	0	0
Hyde Clarke	10	0	0
Sir Henry Cole, K.C.B.	10	0	0
Sir Daniel Cooper, Bart.	10	10	0
General F. Cotton, R.E., C.S.I.	5	0	0
Col. A. Angus Croll	21	0	0
C. Critchett	20	0	0
Major Donnelly, R.E.	5	0	0
General F. Eardley-Wilmot, R.A., F.R.S.	5	0	0
P. Le Neve Foster	5	0	0
C. J. Freake	20	0	0
"A Friend"	30	0	0
Capt. Douglas Galton, C.B., F.R.S.	5	0	0
Lord Hampton, F.R.S.	10	0	0
H. Reader Lack	5	5	0
Edwin Lawrence, LL.B.	10	10	0
Dr. Mann	5	5	0
Vice-Adm. Erasmus Ommanney, C.B., F.R.S.	5	0	0
Robert Rawlinson, C.B.	10	0	0
Samuel Redgrave	5	5	0
J. Russell Reeves, F.R.S.	10	0	0
Rev. A. Rigg	5	5	0
H. H. Room	5	0	0
Benjamin Shaw	10	10	0
John Spiller	2	2	0
Seymour Teulon	10	0	0
W. Trounce	5	0	0
E. Carleton Tufnell	10	10	0
T. R. Tufnell	10	0	0
T. R. Wagstaffe	3	3	0
H. Trueman Wood	5	0	0

Through the kind intervention of Mr. Chapman and Mr. Hamilton Crake, Mr. Davenport's second son has been appointed to a clerkship in the London and Westminster Bank.

COMPETITION FOR ADMISSION TO THE NATIONAL TRAINING SCHOOL FOR COOKERY.

The Society has established five Scholarships, entitling the holders to free instruction in this school. These will be competed for on Saturday, 12th February, at 10 a.m., at the School at South Kensington.

Qualified teachers are now urgently wanted for schools, and when they have obtained their diploma, they may earn from £1 to £2 weekly.

Candidates must not be under 18 or above 35 years of age. They must be sufficiently educated to perform the duties of an instructor in cookery after special training.

The examination questions are intended to test the candidates' knowledge of the first principles of cookery, and the reasons on which they are based; to prove their acquaintance with the essentials of good cookery; and to discover what the candidate can cook, and in what manner.

Every member of the Society of Arts is privileged to nominate one candidate, and members desirous of doing so are requested to fill up the form issued last week, and to send it to the Secretary of the Society of Arts on or before February 5th.

FORM OF NOMINATION.

SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE,

John-street, Adelphi, London, W.C.

NATIONAL TRAINING SCHOOL FOR COOKERY.

I, the undersigned Member of the Society of Arts, hereby nominate

Name ....

Age ....

Address ....

As a Candidate to compete for a Scholarship.

Member's Signature ....

Address ....

Date ....

INDIAN COMMITTEE.

A meeting of this Committee was held on the 25th January. Present:—Hyde Clarke (in the chair), Dr. Boycott, Sir George Campbell, C.S.I.,

Andrew Cassels, Major-General F. Eardley-Wilmot, R.A., F.R.S., W. F. Fitzwilliam, W. Maitland, J. T. Wood, with P. Le Neve Foster (Secretary), and Colonel Hardy (Secretary to the Committee).

AFRICAN SECTION.

The opening meeting of this section was held on Tuesday evening, the 25th inst., Vice-Admiral ERASMUS OMMANNEY, C.B., F.R.S. (Chairman of the African Committee) in the chair.

The CHAIRMAN delivered the following—

ADDRESS.

In referring to the very able inaugural address delivered here by Sir Bartle Frere two years ago, any one must be forcibly struck with the comprehensive views which he then took of Africa, socially, politically, and commercially, and with his forecast of progress which has been advancing in accordance with his predictions.

On the opening of another Session of the African Section of this Society, it is pleasing to reflect that in so brief a space of time we can perceive that the principles advocated in that address, concerning the vast continent of Africa, are taking a deeper hold of thinking men and the commercial world.

To what source then may we attribute this impulse in the direction of progress and research into the condition and resources of the vast continent? I should say it is largely due to those intrepid and persevering pioneers who have brought to light much of the unknown regions, and discovered new territories, new peoples and races. I allude to those travellers whose names and deeds in connection with African adventure stand unrivalled, who have triumphed over obstacles of the greatest magnitude in the pursuit of discovery, for the cause of science, and for the advancement of civilisation, especially Gordon, Schweinfurth, Nachtigal, Stanley, Cameron, Grundy, and Young. Thus in this brief period of two years, we have had a galaxy of heroes enlightening the world as to the hidden treasures stored in the heart of Africa, which seems to contain natural productions of high value, the necessaries of life in abundance, and climates not unsuited to the constitution of Europeans.

Only consider the significant instance of progress which the heroic Stanley affords us, who conveyed a portable boat from Zanzibar overland, amidst all the difficulties of swamp, forest, mountain, and hostile natives, a distance of 740 miles, and, launched on the Victoria Nyanza, he discovered and followed to the lake a new river, the Shimeseyer, which rises 200 miles south of the lake, proving it thus to be the most southerly known source of the Nile. He found this lake to be a great inland sea, and coasted around its shores for nearly 1,000 miles, and it turned out to accord very nearly with the description given of it by Captain Speke, to whose everlasting credit it was discovered. There are many islands on the lake; the deepest soundings taken by Stanley was 275 feet, and not in its centre, with a surface at an elevation 3,800 feet above the sea level. After nearly completing the circumnavigation of Victoria Nyanza, Stanley visited the King M'tessa, in his capital of Uganda, the same chieftain who not many years ago retained Speke and Grant in thraldom, whose ferocity, barbarism, and ignorance were instrumental in keeping our gallant countrymen in jeopardy for many months. Stanley now informs us that this potentate has embraced Mohammedanism, so that thus far he has learnt to worship the true God, and speaks of his evincing a taste for civilised habits, together with a desire to hold intercourse with Europeans; Stanley also claims the credit of converting him to the Christian faith, and states that he has become so tolerant of doctrine as to keep both the Mohammedan and the Christian Sabbaths, and has caused the Ten Commandments to be exposed to public view. With this advance in civilised ideas, we hear that the consequence has been a great reduction in the horrid practice of human sacrifices. The change thus effected in the mind of this potentate has opened a way to establish in this part of Africa a mission for the spread of the blessings of Christianity; for this special object large sums of money have been subscribed. Stanley describes Uganda as a dominion of vast fertility. This brave traveller means to follow up his success on the Victoria Nyanza, by pushing onwards with his boat to launch it on the Albert Nyanza, from whence we may next hear of him. Much honour is due to the noble munificence of the proprietors of the *Daily Telegraph* and *New York Herald* in promoting such an expedition in the cause of humanity and discovery.

As regards Colonel Gordon's proceedings, we have satisfactory accounts that he is consolidating the power of the Khedive of Egypt in the regions of the Nile bordering on the Equatorial Lakes, a work nobly commenced by Sir Samuel Baker. Of late he has had to contend with hostile races, and thus delayed his proceedings with reference to pushing his steam vessel on towards the Albert Nyanza to effect the much desired object of surveying that lake. He has suffered from the loss of many officers on his staff from death and sickness, so that it is more than probable that Stanley will be the first to navigate this lake.

By the last reports from Gordon, in September, he was subduing the hostile Baris, who had inflicted such serious loss on the detachment commanded by Colonel Linant, in which that gallant officer lost his life; four only out of thirty-six soldiers escaped. After this sanguinary encounter Gordon was engaged in enlisting the friendly alliance of other tribes, which he calculated would occupy him two months; he had at his command a Khedive's steamer which had ascended the Nile from Gondokoro. One formidable obstacle lies between him and the Albert Nyanza, in the form of a series of rapids, about 120 miles from the lake, but he felt confident that he would overcome this difficulty; and once past the rapids the access to the lake appears quite practicable, and so we may possibly receive joint reports from Colonel Gordon and from Stanley respecting the great achievement of exploring the Albert Nyanza.

Through the recent journey of a young naval officer, Lieutenant Cameron, we have had a large extent of the interior of Africa brought to our knowledge. He has travelled across from the Indian

Ocean to the Atlantic, from Zanzibar to Benguela, about 3,000 miles, a most wonderful feat to accomplish, which ranks him amongst the most renowned of our African travellers. He left this country with a view to relieve Livingstone, and to follow up his discoveries.

It was on his advance from the East Coast towards Ujiji that Cameron fell in with the mournful party carrying the remains of our great traveller, Livingstone, en route for Zanzibar; on this occasion he rendered good service by detaching an escort from his own party to protect those hallowed remains in a dangerous country in safety to the coast, which you know was accomplished, and you remember the universal sympathy manifested by the nation when the body reached England, and the national tribute of honour and respect paid to the memory of the great traveller who had toiled and died for Africa, by depositing his remains in a final resting place in Westminster Abbey.

After this service Cameron was left without a companion, having lost two by death, while the last declined to proceed further. He pushed on alone to Ujiji on the Lake Tanganyika, where he succeeded in recovering many valuable documents left there by Livingstone. He now did valuable service to geographical science by hiring a native boat and making an accurate survey of the southern half of Lake Tanganyika, discovering an erroneous bearing with which it was then placed on our maps. By various astronomical observations he fixed the position of Ujiji and determined by several methods, including the mercurial barometer, the height of Tanganyika from the sea, which proved to be 2,710 feet; added to this was the very important discovery of an outlet from this lake on the West Coast, reported to flow into the Lualaba; he was 88 days making this survey, and returned to Ujiji. This lake lies between 3° 20, S. and 8° 50, S. latitude, being 320 miles in length, but is comparatively narrow; the width of it varies from 10 to 25 miles. During this service our young solitary explorer underwent great sufferings and hardships, which were nobly endured; several times he was struck down by fever, and was even delirious; his eyesight affected, constantly in pain from boils and other ailments, with great discomfort, without any companions to sympathise with him or afford him relief, a more trying situation could scarcely be imagined.

Inspired by the love of discovery, nothing daunted by sickness or danger, this gallant young officer, in May, 1874, left the Tanganyika behind him, and plunged into the abyss of the unknown interior, fired with the ambition to launch on the Congo river and follow it into the Atlantic; onward he went, without a European companion, trusting to the tender mercies and good faith of the natives. Starting from the river-outlet from the Tanganyika, Cameron journeyed westward, following on the track of Livingstone to Nyangué, a town on the bank of the Lualaba; he found it to be 1,400 feet above the level of the sea, and 500 feet below that of the Nile at Gondokoro, a fact of vast importance for geographers and science. At Nyangué he tried hard to hire canoes to follow the Lualaba waters to the westward, but without avail. Here it should be stated that from this point, to the West and South, was all new ground for the explorer. From thence he pushed on for a lake named Sonkurra, into which the Lualaba is said to fall, and to which "trouser wearing traders" come up from the West in large sailing canoes for palm oil and dust—probably gold dust—under the guidance of a chief called Tipo-tipo. He advanced to the banks of the Lomani, an effluent to the Lualaba, in the hopes of getting on to Sonkurra. Here he came upon the dominions of a chieftain who was deadly hostile to Tipo-tipo, who positively refused Cameron a passage through his dominions, whereon he had no alternative but to journey for the country of Kosongo, a big chief of all Urua. Here he fell in with a black trader, José Antonio Alviz, from the Portuguese colony of Benguela, with whom he entered into an agreement to conduct him to the shores of the Atlantic, whom he describes "as the most persistent and ceaseless teller of lies he had ever met with." This Alviz proved to be on a slaving expedition, and, like all those diabolical dealers in human beings, he was a scoundrel of the blackest dye. He subjected our brave young explorer to many painful delays and annoyances whilst purchasing and procuring slaves.

From Kilema, the capital of Kosongo, Cameron was enabled to make further discoveries, especially of the Lake Kassali, and a very extensive system of water communication throughout the country, embracing the sources of the head waters tributary to the river Lualaba.

From Kilema by dawdling journeys he was brought on to Podela, the centre of a district, where Cameron was delayed by Alviz making his slave expeditions about the country, and he succeeded in tracing out the parting shed between the basins of the Lualaba and the Zambesi

Having pointed out these leading features of his discoveries it only remains to say that after a very wearisome and trying time of it, Cameron at length reached the Atlantic at Fish Bay, near Benguela, suffering severely from scurvy and debility; he was conveyed by sea to the Portuguese settlement of Loando, where he now stays to recruit his health, and to provide a passage for his men to Zanzibar.

In making this wonderful journey across tropical Africa, Cameron has gone over 600 miles of ground, never before trodden by a European, viz., the country lying between Nyangué and the point where he struck into the former track of Livingstone on his celebrated journey to the Zambesi. He has sent home the most authentic records in the shape of astronomical observations of all his positions, together with hypsometrical observations of inestimable value, by which we shall obtain the various elevations of land and water across the continent. He has solved the problem regarding the basin of the Lualaba, as being entirely separated from the Nile basin, and looking at the natural confluence of the streams which contribute to form our great river flowing towards the Atlantic, we may confidently assume this to be no other than the Congo.

Cameron could only forward but a brief report of his services and of the countries he had seen, which appear to contain valuable natural productions, a very rich vegetation, a healthy climate, and a vast extent of water communication; but judging from his copious notes, made at the commence-

ment of his journey, we may expect a vivid description of all the countries passed through, and the various people which he has met. Above all the highest credit is due to this young sailor for having completed this wonderful journey, occupying a period of more than three long years of toil, suffering, and hardship; his work has been performed without causing one drop of bloodshed, and like Livingstone he leaves no blood track behind him on the soil of Africa.

Let us now take a glance at another part of Africa nearer home, the dominion of Morocco, within a week's voyage of these shores, a country abounding in nature's best gifts, with a fine climate and a rich soil, with its resources still remaining undeveloped. The population consist chiefly of the most fanatical Mohammedans in the world, ruled over by a race of Sultans held in great sanctity as the lineal descendants from the Prophet, who are so bigoted and intolerant that no progress or change is ever encouraged. If you cross the Straits from Gibraltar you find everything as oriental, barbarous, and primitive as in the heart of Syria, and yet the country is now within daily intercourse with Europe. I have seen much of the coast of Morocco, and it is deplorable to see fine tracts of land capable of yielding grain crops and breeding cattle for Europe, all uncultivated; here there is, I am sure, a field for the capitalist. Were Morocco ruled over by a man of enterprise, and with a keen eye to develop the resources of his country, like the Khedive of Egypt, it would become rich and prosperous; our plethora of gold would soon find its way there for commercial pursuits. Our posession of Gibraltar has been the means of giving us a preponderating influence in Morocco, but our policy has been chiefly directed to maintain its integrity and not to encourage reforms. The Spaniards hold Ceuta and a few other forts on the north shore of Barbary; they have never encouraged friendship or commerce with the Moors, who are not allowed within range of a cannon shot of these places.

The African Continent is, at this moment, well provided with explorers from other nations as well as from ourselves; the French are prosecuting another expedition from the river Ogowé, near the Equator, in the Gaboon, with the object of ascending the Ogowé, and then crossing the entire continent of Central Africa to the Valley of the White Nile. On the East Coast we have a mission, under Bishop Steere, on its way to the North-East shores of the Lake Nyassa, in hopes of establishing a missionary station. Another party, got up by the friends of the late Dr. Livingstone, has gone to plant a mission on the shores of the same lake. This party has with them a small screw steamer, commanded by Mr. E. D. Young, R.N. This will be named Livingstonia, and by its aid they hope to civilise and Christianise in the valleys of the Zambezi. The Italians have sent forth an expedition of a scientific character to advance from the Somali country, through Abyssinia, into the Valley of the Nile. Then we have, as I have already related, Colonel Gordon and Stanley bent on exploring the Albert Nyanza and the surrounding region. The German expedition to West Africa, intended to penetrate the interior in the vicinity of the Congo, has failed, having met with the same hostile opposition from the natives which debarred Lieut. Grundy, R.N., from ascending the Congo. When all these travellers return successfully, we may then say that we know the length and breadth of Africa, together with its productions.

Now a word with regard to missions, which, in my humble opinion, if they are to be successful, should not merely be confined to the spread of the Gospel, for the work of civilisation should be combined with instruction in the arts of industry; all missions should be accompanied by artificers capable of instructing the natives in handicraft and mechanical ingenuity, especially in improving the cultivation of the soil which Providence has placed beneath their feet.

Concerning commerce, with the exception of Egypt and South Africa, the great continent appears to be in a state of stagnation, but with openings by which this great lever of civilisation may be introduced. In the Sultan of Zanzibar we have an ally who appreciates the advantages arising from industry and commerce, whose dominions constitute a basis for intercourse with the interior. The princes of Morocco are desirous of European education, which it is to be hoped may induce them to follow the liberal policy which in Egypt has produced such flourishing results. And if they can establish missions which combine Christianity with industry, we may anticipate a better state of things in Africa.

As to the subject of slavery, which this nation has been the foremost in the world to abolish, we must not relax our efforts if we desire to effect a complete suppression; though from what has reached us from the last great traveller, Cameron, it appears he finds the horrid trade in full activity in the interior, and that it continues the chief cause of war and misery between chiefs and races.

In conclusion, I am glad to inform you, that the Council of this Society in carrying out its work of usefulness has provided for a series of interesting papers on African questions being read and discussed during the Session, which all aim at encouraging commerce between this country and Africa.

The Chairman, at the close of his address, alluded to the several subjects which are to come under the consideration of the Section during the Session.

Mr. Trelawney Saunders and **Mr. P. L. Simmonds** then urged the desirability of merchants connected with African trade taking an active part in the business of the African meetings.

Dr. Leared, in alluding to the condition of Morocco, stated that the Sharif of Wazan, who is only second to the Emperor in influence, is on his way to England, and expressed a strong hope that in the interests of commerce and social progress some kind of public reception and attention may be accorded to him.

Mr. Alfred Bellville remarked that the operations of the mission to Lake Nyassa, under Bishop Steere, were unavoidably suspended for a time, on account of difficulties that could not be at once removed.

The Chairman then asked Dr. Mann to give some account of the origin and character of the Dutch South African Republics, remarking that these were matters immediately concerned in the questions of social rearrangement and organisation which are pending in South Africa, and, it is understood, are on the point of coming under the consideration of Parliament.

SOME NOTES ON THE ORIGIN AND CHARACTER OF THE DUTCH REPUBLICS OF SOUTH AFRICA.

By Dr. Mann.

As the several distinct communities of South Africa are likely to have some considerable share of public attention during the next few months, in consequence of the question of Confederation between them for mutual aid and support which has been suggested by Her Majesty's Secretary of State for the Colonies, it seems to be a convenient and suitable time to sketch out briefly the leading facts of their position, character, and history, in order that a more exact knowledge may be entertained of the social elements that have to be dealt with in establishing any plan of co-operation and alliance.

The Cape of Good Hope itself, as must be remembered, was unknown to Europe four centuries ago. It was discovered by the renowed Portuguese navigator, Bartholomew Diaz, in 1468. A small band of Englishmen, under Captains Shillinge and Fitzherbert, planted the English flag on the shores of Table Bay in 1620. That was during the reign of James I. A Dutch colony was formed under Jan Van Riebeek in 1652, and the first stones of the Castle of Cape Town were then laid. There is an extant record which states that on the night of January 23rd, 1653, "it seemed very likely that the lions would have taken this fortification by storm." Between 1685 and 1688 a considerable party of French Huguenots, driven out by the revocation of the Edict of Nantes, was added to the Dutch community. These settled down at Paarl and Stellenbosch, and it is worthy of memory that they brought with them the vine from France. The vineyards of Constantia were planted in 1688, and had become famous for their luscious wine in 1714. The frontier of the Dutch settlements towards the East was first fixed at the Gamtoos River, which runs down into St. Francis Bay, and which was the natural division between the Hottentot and Kaffir tribes. But in 1780, the frontier was pushed on beyond Algoa Bay to the Great Fish River. In 1795 an insurrection broke out against the Dutch authority in Graaf Reinet and Swellendam, and an attempt was made to establish a Republic there. This, however, was met by the intervention of the British Fleet in the interests of the Prince of Orange. The territory thus occupied by the British was held as a kind of Protectorate until the Peace of Amiens in 1801, when it was restored to the Batavian Republic. On the breaking out of the great European war shortly afterwards it was, however, again occupied by the British troops, and General Janssens capitulated to Sir David Baird, on January 10th, 1806. The British flag has never ceased to float over the castle since that time; but the Cape was not formally ceded to the British until 1815, when it was passed over to them in the Treaty of Paris by the King of the Netherlands. The Dutch language was superseded by the English for all public purposes in 1822.

At the time of the first restoration of the Cape territory to the Batavian Republic it consisted of 120,000 square miles of land, occupied by a population of 62,000. At the present time it consists of 200,000 square miles of land, and has a population estimated at nearly 700,000. This population is made up of the descendants of the first Dutch and French settlers; of the English who have since been drawn to the place by the attractions of commerce and agriculture; of a sprinkling of other nationalities who have been influenced by similar inducements; and of the remnants of the aboriginal population, who are chiefly Hottentots.

About the year 1834, a strong feeling of political disaffection arose amongst the Dutch farmers, who had by this time become a large and influential section of the community, on account mainly of the tendency of the British Government to restrict their relations with the native population. An exploring party having recently been examining the land on the seaward side of the great mountain barrier of the high table land, some distance beyond the eastern frontier, a portion of the disaffected Boers, or farmers, led by Piet and Jacobus Uys, Hans de Lange, Stephanus Maritz, and Gert Rudolph, proceeded with 14 waggons along the same route, and ultimately reached a small party of English travellers, who at that time had a settlement at the natural harbour which now constitutes the port of the colony of Natal. They spent some considerable time exploring the land and shooting game, but finally returned the same way they had come, in consequence of the breaking out of a Kaffir war on the frontier of the eastern province of the Cape colony. The attractive report which they gave of their expedition was not lost. At the close of the war, 200 of the Boers, under Hendrick Potgeiter, crossed the Orange River towards the north, but others of them, led by Jacobus Uys, a patriarch of 70 years of age, and by the families of Moolman and Retief, broke away from these and found a practicable path through the mountains, down into the seaward slopes of the Natal territory. Dingaan, the brother and successor of Chaka—whose early history was given by Mr. Shepstone in a paper contributed to the Section last year—at this time claimed supremacy over the whole land, which had been devastated by the invasion of his hordes, as paramount chief of the Zulus; but he was residing near the White Umvolosi River, some 150 miles or so further to the north-east than the spot marked by the descent of the Dutch emigrants. Pieter Retief, who had assumed the leadership of these adventurers, decided to go at once to Dingaan and endeavour to make some terms with him for the acquisition of land. He accordingly went up to the chief's great kraal, near the White Umvolosi River, which was known as Umgungundhlovu, or the "place of the trumpeting of elephants," and was there well received, and it was arranged that he was to have land upon the condition of first recovering for Dingaan a number of oxen which had been taken from him by a Mantatee chief, named Sikonyella, at the sources of the Caledon. Retief went up to Sikonyella, procured the restitution of 700 cattle and 60 horses, and returned with these to Dingaan, taking with him 70 picked men and 30 Hottentot servants, with led horses. A formal deed was then drawn up by an English missionary, who chanced to be at Dingaan's place, which professed to cede the entire district desired by the Dutch.

The deed was executed by the marks of Dingaan and his chief councillors, on February 4, 1838, and is a notable document on account of being the first formal "conveyance" of Natal territory. The Dutch farmers were invited to "kiss hands" on taking leave the following morning, and in doing this they left all their arms piled outside of the kraal, as a mark of friendly confidence in the chief, a mark, however, which was sadly misplaced, for whilst Kaffir beer was being hospitably served round, Dingaan suddenly exclaimed, "bulala amatagati"—"kill the wizards," and the entire party were clubbed by 4,000 Kaffirs, who had been held in ambush for a sudden attack. The Dutchmen fought bravely with their clasp knives, but they were all slain. Ten regiments of the Zulus were then immediately sent down into Natal to complete the work of extermination. They there found isolated parties of the Dutch encamped, in most instances with the men away from the camps upon hunting excursions. The Zulus first burst upon a camp on the Blue Kranz River, near Weenên, and destroyed nearly all who were in it. They simultaneously attacked other camps in the Klip River district with similar results, and then marched southwards to complete their work in that direction. Two or three of the young Boers, however, had made good their escape, and had spread the alarm, so that the Zulus found a strong party assembled at the Bushman's River in a laager, or fortification, constructed of waggons. After a severe fight the Zulus were signally repulsed, and the Boers then followed their retreat to ascertain the loss that had been inflicted upon their kindred and friends. They found at the Blue Kranz a heap of mangled corpses, amongst them two young girls of 12 and 14 years of age, who had received respectively 19 and 21 stabs from the Kaffir spear, or assegai. These girls, whose names were Johanna Van der Merwe and Catharina Margaretha Prinslo, ultimately recovered in some marvellous way. Six hundred victims had, however, been added to the loss incurred by the act of treachery at the royal kraal. Strong reinforcements of Dutch now came in from beyond the mountains. A diversion was made in favour of the Boers by the English traders at the port, who sent 700 of their own Kaffirs, under one of their party named Biggar, across the Tugela River. These were caught in a trap by Dingaan and destroyed. The Boers had in the meantime again advanced from the Klip River district. Four hundred mounted men, under Piet Uys and Hendrick Potgeiter, crossed the river in April, 1838, and moved straight upon Umgungundhlovu. They were, however, led by a spy into the savage gorge of the Ipati River—a spot which is interestingly described by Mr. Shepstone in his official account of his visit to Zululand to instal Cetywayo—and were there caught in an ambuscade which had been prepared for them by the wily savage. The Boers gallantly broke through the surrounding horde, and fought their way out, but with the loss of their leader, Piet Uys, and made good their retreat to Natal. Dingaan once again attacked them there in the following August, but he found them entrenched in their formidable laagers, and was repulsed with great loss. In the month of December, 460 well-mounted Boers, under Andries Pretorius and Carl Landman, once more advanced into the heart of the Zulu territory. When near to the royal kraal, they were attacked in the early morning, in their camp, by 12,000 Zulus under Dingaan's command, and, after a fierce and prolonged defence, sallied suddenly upon their assailants in the rear, as these were attacking in front. Upon this the Zulus fled with the utmost precipitation, and Dingaan set fire to his kraal. The Boers, however, found there the bodies of Retief's party, thrown out from the kraal upon a neighbouring hillock. The remains of Retief himself were recognised by a Bandoleer attached to the body, which contained the deed of conveyance of Natal to the Dutch, and it was found to be an agreement on the part of Dingaan "to resign to Retief and his countrymen the place called Port Natal, together with all the land annexed; that is to say, from the Tugela to the Umzimvubu River, and from the sea to the north, as far as the land may be useful, and in my possession." The Boers completed the destruction of the kraal, and drove away with them back to Natal 5,000 head of oxen. They then proceeded to trace out the plans of the capital city of Pietermaritzburg, and of the Port, at Durban. Umpanda, a brother of Dingaan, was at the time residing on the Natal side of the Tugela River, and was an object of jealousy and suspicion to Dingaan, who had good reason to know that brethren are not always the most reliable friends in barbarian life, having himself managed to get his own powerful brother Chaka put out of his way. Umpanda accordingly made overtures of alliance and assistance to the Boers, which were at first viewed with suspicion, but at last accepted, and a combined force of Dutchmen and friendly Kaffirs was once more sent over the Tugela to try their hand upon Dingaan. They found him at last with a concentrated army, which was in the first instance attacked by the Umpanda's Kaffirs, and then utterly routed by the Boers. Dingaan fled to Delagoa Bay, and there shortly afterwards fell into the hands of a hostile tribe and was slain. The Dutch farmers then proclaimed Umpanda King of the Zulus, and charged him for the act a fee of 36,000 head of cattle, which were immediately paid. They at the same time reserved for themselves the entire stretch of land lying between Delagoa Bay and the St. John's River, and claimed for it the position of an independent South African Republic, under the designation of Natalia.

It is impossible to pass in review, after this length of time, this passage in the early history of the Dutch emigrant farmers of South Africa, without feeling strongly impressed with a sense of the sturdy and heroic character of the small handful of men who thus, single handed, broke the power of the barbarous Zulu despotism. It was simply a life-and-death-fight which the 460 Boers, under Andries Pretorius, waged, when they marched for the third time into the heart of savage Zuludom, and, with the unaided strength of their own right arms, scattered the 12,000 barbarians, strengthened by all the traditions of Chaka's glory and success. This remarkable feat of Andries Pretorius and his companions, performed on Sunday, December 16th, 1838, will always remain a distinguished page in the history of the early days of South Africa.

About the time of this first decided success of the Dutch, Sir George Napier, the Governor of the Cape, sent a small company of soldiers to the

seaport of Natal, with an intimation that, as the Boers were properly British subjects, notwithstanding their emigration, they could not be allowed to acquire independent territory of the natives. When Pretorius returned from burning the kraal of Dingaan, he was somewhat surprised to find these English soldiers, and this message, at the port. Friendly relations were, nevertheless, for the time maintained, and in 1839, the small company of soldiers was withdrawn by the mere accident of the regiment to which it belonged being recalled from foreign service to England. On the departure of the English soldiers, Pretorius hoisted the flag of the "Dutch Republic of Natalia," which consisted of the usual insignia of the Dutch flag, placed transversely instead of vertically at the ports.

At various times intimation was sent to the Dutch farmers that they had not been released from their fealty to the British Crown, and that their Republic could neither be recognised nor allowed. The Boers remained deaf to these intimations, and, in consequence, in the month of May, 1842, Captain Smith, with 200 Infantry and two guns marched into Natal from the nearest frontier post of Umgazi, to renew the military occupation, and to enforce the obedience of the Dutch emigrants. Captain Smith made his way to Natal along the coast by a road which can still be traced by its trail through the bush. He proceeded at once to the port, hauled down the flag of Natalia, spiked two big guns standing ominously near, and then proceeded to entrench himself in a camp on the Bay, where the camp of Durban still remains. The Dutch farmers assembled at Congella, three miles off, and formed their own camp there. In a short time it was reported that 200 farmers, under the command of Andries Pretorius were assembled. Capt. Smith, after some parleying, summoned them to disperse. They anwered by seizing 60 oxen provided for the supply of the troops. This first open act of hostility was performed eleven days after the hauling down of the republican flag. Captain Smith then made a night attack upon Congella, but was received by a heavy fire, at long range, in the bush, which threw the oxen dragging the guns into confusion, and the English had to make their way back to their camp with the loss of 47 killed and wounded. The Dutch farmers now closed up round the camp and formed a regular siege. They, however, received some women and children from the camp, and placed them on board a vessel in the harbour.

It is believed that there were at this time about 330 Dutchmen in arms, and a very interesting account of them, as they existed at this time, has been preserved in a letter of one of the English officers under Captain Smith. This account describes the farmers as being armed with guns of the very best character, carrying from 8 to 17 balls to the pound. They had excellent horses, and rode them admirably, and always fought in skirmishing order, riding up within range, dismounting, firing, and then jumping on their horses and riding away out of range. They were practised marksmen, and took unerring aim.

The English in their beleagured camp were speedily reduced to short commons, but they maintained a resolute resistance; for the contingency which had occurred had been provided against by the English commander. The instant after his repulse from Congella, he had, with the aid of Mr. G. C. Cato, sent off a messenger to notify his reverse and the difficulty of his position to the frontier of the old colony. Two horses were swum across the land-locked harbour at night, and Mr. Richard King started with them for a lonely ride of 600 miles through wild country, during which he had to cross some 200 rivers. He was ten days performing this distance, during two of which he was arrested by illness. But the result was that on the night of the 24th of June, thirty days after the final closure of the English lines, rocket signals at sea were seen from the camp. A small schooner, with a company of soldiers from Delagoa Bay, and immediately after the Admiral's flag-ship from the Cape, with a still larger contingent of troops, had arrived for the relief of the beleaguered garrison. The troops were landed on the 26th of June; the Boers discreetly retired before them, and on the 5th of July, Colonel Cloete received their submission at Pietermaritzburg. In the month of May in the following year, namely, 1843, 24 Dutch farmers, acting together as an assembly, or Volksraad, formally accepted the annexation of Natal by the British Government, and agreed that thenceforth "within its limits there was to be no distinction of language, colour, origin, or creed, and that no slavery should be allowed." At this time a large party of armed Boers from beyond the mountains had assembled to insist that the territory beyond the mountains—that is the Orange River district—should not be included in these conditions. As this was at once agreed to by the British commander, the protesting Boers withdrew beyond the mountain fastness. But they, of course, carried with them their rooted antipathy to British rule.

The Dutch emigrants, who thus took up their position on the inland side of the Natal frontier in the higher interior regions, now turned aside all further accession of recruits, from the disaffected in the old colony, to themselves. With their guns in their hands they made short work of any native claims to the territory. But, about this time, to their intense annoyance and disgust, an Act of Parliament was passed in England, providing for "The punishment of offences north of the Orange River of South Africa up to the 25th parallel of south latitude." In 1845, Sir Peregrine Maitland, the then Governor of the Cape, instructed the native chiefs of the district to mark off any land to which their were prepared to establish a claim; and, at the same time, suggested that the Boers should "lease" land of these native proprietors. A British Resident, with a small body of troops and a native contingent, was established in the district, to carry out these arrangements. On the 3rd of February, 1848, Sir Harry Smith formally proclaimed the whole territory, up to the 25th parallel of latitude, a British Dependency, under the distinctive title of the Orange River Sovereignty. The Boers resisted this in arms again under the leadership of the hero of Umgungundhlovu. But they were beaten in a pitched battle at Boom Plaatz by Sir Harry Smith, and a reward of £2,000 was put upon the head of Andries Pretorius. After this, two commissioners, Mr. Owen and Major Hogg, were sent from England to report upon the position

of affairs. They recommended that the insurgent Boers should be allowed to withdraw their allegiance from the English Crown, and to establish an independent repuplic beyond the Vaal River. This, it will be observed, was substantially the first distinct expression of the idea of a Transvaal Free State. On the 25th of March, 1851, Earl Grey issued letters patent, establishing "The Orange River Sovereignty" as an apanage of the British Crown. But two years subsequently, that was in 1853, Sir George Clerk was sent as a commissioner to examine and report, and he reported to the effect:—

"The more I consider the position, the more I feel assured of the inutility of the Sovereignty as an acquisition. * * * It is a vast territory, possessing nothing that can sanction its being permanently added to a frontier already inconveniently extended. It secures no genuine interests; it is recommended by no prudent or justifiable motive; it answers no really beneficial purpose; it imparts no strength to the British Government, no credit to its character, no lustre to the Crown."

Sir George Cathcart at the Cape, and the Home Government acquiesced in the recommendations of this report. A debate upon it was raised in Parliament by Mr. Adderley, on the 9th of May, 1854; but the general feeling seemed to be that which was expressed by Sir John Pakington, that Great Britain was really in no sense bound "to follow up the flying Dutchmen wherever they might go." Accordingly the abandonment of the Sovereignty was ultimately decided upon, and formally carried out. As a last legacy, the British Government made the Dutch occupants of the territory a present of three big guns, and all the public offices and furniture, and the Dutch then formed their own Legislative Assembly, or Volksraad, and elected a President for a term of five years. In February, 1859, the British Government made over a further tract or territory, which they had themselves received from Moshesh, to the Orange River State. The Republic, which has been thus constituted, consists of 70,000 square miles of undulating plains and hills, between the Vaal River and the upper stretch of the Orange River, with a population of about 80,000 white, and 15,000 black, inhabitants.

Before 1842, and the first migration of the Dutch, the Orange River territory was principally occupied by a tribe known as the Griquas, who were of a mixed race, being descended from the Dutch settlers on one side, and from their Hottentot slaves on the other. These Griquas were concentrated on the confluence of the two streams, the Vaal and the Orange rivers. But they were divided into two sections, of which one, under the chief Waterboer, clung to the Vaal River, whilst the other, under Adam Kok, had taken the Orange River. The Adam Kok's branch has since been removed to make way for the Boers, to Nomansland, on the seaboard side of the great mountain range. The diamond fields of South Africa lie in the district which fell to Waterboer, and they were ceded by him to the British in 1871. This cession, however, is objected to by the Boers of the Orange Free State, who conceive that they have themselves a better claim to the territory. This will probably be one of the entanglements which will have to be set straight by the labours of the first deliberations on Confederation, and, in the mean time, the British Government charges itself with the good order of the district.

The territory known as Basuto land, is a rugged mountain region, lying between the south-west angle of Natal and the southern half of the Orange River Free State. Its people are a branch of the Betchuana tribe of Kaffirs, and were for many years under the rule of an astute and able chief, familiarly known as Moshesh. This chief, when at war, and somewhat hardly pressed by the Dutch Boers of the Free State, in 1868, placed himself under British protection. Basuto land, Adam Kok's land, and Griqua land west, therefore, all now take rank as British territory.

The Transvaal Republic, which is socially of an exactly similar character to the Orange River Free State, has a stretch of territory nearly as large again. It is to the north of the Orange Free State, beyond the Vaal River, as its name imports, and is pushed up quite within the tropic, into a vast loop of the Limpopo river. It has probably a population of about 30,000. It was first occupied by the Boers retreating, in 1848, before the British power. When the Orange River Sovereignty was annexed by Sir Harry Smith, Andries Pretorius, of Umgungundhlovu, Congella, and Boom Plaatz, was its first Commandant-General, and died there, with his head upon his shoulders, an idol amongst his people and friends, on the 23rd of July, 1853. The Transvaal has exactly the same form of Government as the Orange River Free State, but it is entirely independent of it, and has its own "People's Parliament," or "Volksraad," and President. It is very rich in mineral wealth, and has gold upon its eastern confines. It is also, in consequence of some peculiarity of physical position and climate, a fine agricultural as well as pastoral district. It is said that it entirely supplies the Free State with corn, besides going very far to furnish the old Cape Colony with beef.

Thus, British South Africa is the vast temperate tract of the great continent lying south of the Orange River, which crosses from East to West approximately, in the parallel of 28° south latitude. It is continued from the sources of the Orange River to the Indian Ocean, with only one small unoccupied gap, that, namely, of independent Kaffraria. Nearly an equal extent of land is pushed up on the eastern side, beyond the Orange River, quite within the tropic, as a sort of Dutch supplement to the Britsh dependencies. Throughout the greater part of the older district, towards the West, there is but a thin and scattered black population, but within and about Natal there is a very remarkable and important concentration of the black tribes. Immediately to the north-east of Natal is the energetic and warlike race, under its ambitious and able chieftain, Cetywayo, the nephew of Chaka, and the son of Umpanda. Within Natal there are close upon 300,000 Kaffirs, who have flocked into the settled territory for the safeguard to life which its civilised rule affords; and immediately to the north-west of Natal there are the half-tamed and half-annexed Griquas and Basutos. Such are the social conditions and elements that will have to be dealt with in any consideration of the question of a Confederation for South Africa. The view that is taken in the Cape Colony itself of the present position of the Dutch Independent Republics in the matter is very

fairly and interestingly expressed in the following extract from a letter which was printed in the *Times* as recently as Friday last. The letter is from "An Occasional Correspondent," and is dated Cape Town, December 25th, 1875. The extract runs :—

Some present difficulties stand in the way of getting the free Republics who are our neighbours to unite; but if a Confederation is once formed, with a door left open for them to come in, a national fellow-feeling will very likely soon induce them to join. The bucolic inhabitants of these States are usually represented as holding the English rule as hateful as the English tongue; and it has been said that any attempt to press forward Lord Carnarvon's proposals would goad them to leave their farms and move off into the wilds of the interior, as their fathers did before them. But the "Boer" element as it is termed, is not now what it was a few years ago. The European population which flocked to the Diamond Fields, and from there spread into the neighbouring Republics, has revolutionised the character, feelings, and ideas of these South Africans; at the present moment, both in Bloemfontein, the capital of the Orange Free State, and in Pretoria, the capital of the Transvaal, the English language is more commonly heard than Cape Dutch; and trade and business, and even pastoral and agricultural pursuits, are in the hand of British subjects. Then it must be remembered that in the Cape Colony itself, as well as in Natal, three-fourths of the white inhabitants are of Colonial-Dutch extraction, and there are no more loyal and attached subjects to Her Majesty the Queen under the sun. There is, however, no insuperable impediment in the way of our brethren across the Orange or the Vaal accepting the flag of Great Britain if overtures are made to them in an amiable and attractive manner. The intimation Lord Carnarvon has given of his willingness to settle the long-standing grievance of the Free State with regard to Griqua land West is a step in the right direction, and, if judiciously effected, will tend to secure perfectly cordial relations and ultimate union. Such a policy at present is most desirable, for any attempt at Confederation, to be successful, must be supported by the popular sympathy and approval of the various communities of this country.

EIGHTH ORDINARY MEETING.

Wednesday, January 26th, 1876; E. J. Reed, C.B., M.P., Member of Council, in the chair.

The following candidates were proposed for election as members of the Society :—

Bird, Robert, Belmont-villa, Roath, Cardiff.
Lockwood, Philip Embury, 19, Cromwell-place, S.W.
Montagu, John Montagu Pulteney, J.P., Downe-hall, Bradpole, Bridport; and 51, St. George's-road, Eccleston-square, S.W.

The following candidates were balloted for and duly elected members of the Society :—

Benjamin, Horace Berton, 22, King-street, St. James s, S.W.
Clarke, Alderman Edward, Park-cottage, Macclesfield.
Denny, P., Leven Ship-yard, Dumbarton.
Denny, William, Leven Ship-yard, Dumbarton.
Haddon, John, 3, Bouverie-street, E.C.
Hone, George John, 11, Strand. W.C.
White, James Sewell, 34, Cornwall-gardens, South Kensington, S.W.

The paper read was—

ICELAND: ITS SCENERY AND VOLCANIC ROCKS.

By W. L. Watts.

The country we are to visit this evening is Iceland. This little island, little I call it (for somehow it seems natural to speak of it in the diminutive), is nevertheless about one-third larger than Ireland; it is, as you all know, situated upon the borders of the Arctic circle. Apart from its historical and literary fame, which a short time ago was so ably described by my friend Mr. Browning, it is of especial interest to the geologist and physical geographer, for its equal as a centre of volcanic activity can alone be found amongst the islands of the Pacific Ocean; and the peculiar manner in which we here find ice and snow mixed up with the igneous productions of volcanoes, imparts a peculiar grim beauty to its scenery that I can well imagine we might travel the whole world over without seeing surpassed. A very short sojourn amongst the weird rocks of Iceland arouses that latent superstition that will lurk in the minds of even the most materialistic, and while we laugh at the mythological credulity of the ancient Icelanders, we cannot help acknowledging that a more fitting place to create an implicit belief in wraiths and demons could not possibly be found, from the elf and pixy dancing amongst the timid flowers, whose bright eyes peep from sheltered nooks in ancient lava streams, to the hobgoblin and ghoul moaning and shrieking and performing their nameless deeds amongst blasted peaks and barren mountains, where fire strives with frost. This remarkable little island was colonised 1002 years ago by Norwegians, though its earliest settlement is involved in some obscurity. It afterwards became subject to Norway, and subsequently to Denmark, until the year before last, when it received its legislative freedom.

The picture now before us was especially drawn to commemorate the 1,000th year since the landing of the Norwegians, and the commencement of Icelandic legislative freedom upon the landing of the King of Denmark in 1874. At the top of the picture we have the Queen of the mountains sitting upon a huge "johull" or snow-covered mountain, which towers above the ocean. In the centre is Iceland guarded at its four corners by tutelar genii. In the topmost corners are the portions of Greenland and America which were visited by hardy Icelandic pirates long before the birth of Columbus. At the bottom of the picture we have some of the physical wonders of the country, the Geysirs, Mount Hecla, and the waterfall of Detta-fop. Upon each leaf of the oak which encircles the picture is the name of an Icelandic poet, while around the map of Iceland is the first stanza of the Icelandic national song :—

World-old Iceland, beloved foster land,
As long as the ocean girds our shores,
As long as lovers for their sweethearts sigh,
As long as the sun shines upon our mountains,
Thy sons shall love thee.

We will now glance at a larger map of Iceland, and see whereabouts we are to travel this evening. We will first land at Reghjavick, the capital of Iceland, we will go to Thingvallir and stand upon the rock which for centuries served as a forum to the Althing or parliament of Iceland. We will examine the wonderful sights upon either side of the valley of Thingvallir; we will visit the renowned Geysirs and climb to the summit of Mount Hecla; we will journey on the South Coast of Iceland, and cross that vast accumulation of volcanoes, and ice, and snow, the native jöhull, and reach the "Northerland," by a route that has never before been trodden by the foot of man; we will visit the

volcanoes which erupted so violently last year, and finally, by the aid of the oxy-hydrogen microscope, examine some of the volcanic rocks over which we have been travelling.

As we are now to start upon a trip to Iceland we must avail ourselves of the only regular mode of communication, namely, the steam-ship *Diana*, which during the summer months makes monthly excursions to and from Copenhagen, Scotland, the Feroe Isles, and Iceland.

We are steaming out of the mouth of the Firth-of-Forth, leaving the fine old and new cities of Edinburgh behind us. Let us for a moment pause and look at that old saddle-backed volcano, Arthur's seat, and the contour of the neighbouring mountains; the rude peculiarity of their outline will be very familiar to us ere we return from the fire-wrought island we are about to visit, for the aspect of a country, like the countenance of a man, generally gives some indication of its character.

We have endured the unstable liveliness of the *Diana* for a week or more, and at last the snow-capped mountains are within sight. We are entering the bay of Reghjavick; the bright rays of the evening sun are illuminating the beautiful Mount Esjia, which is still clad in its winter clothing, a few fleecy clouds are creeping down its steep black sides and clinging like masses of wool to the sunlit summit, and the western face of the mountain, far in the north-west horizon, is the snowy pointed mass of Suafells Johull. Upon the opposite side of the bay is the straggling capital of Iceland, Reghjavick. The town is gay with flags, and crowds are clustering upon the wooden landing stages to welcome the post ship and her passengers.

Upon landing at Reghjavick one finds oneself surrounded by perhaps the most important branch of industry in Iceland, namely, its fisheries. Men in numerous small boats are both going out to fish and returning laden with their finny spoils. Stretched upon the black pebbles of the beach, and piled in stacks upon the borders of the principal street, is the staple article of the Icelander, namely, the stock fish. This is the ling split open and dried to the consistency of a fibrous board. What the date is to the Arab, or beef-steak to the Englishman, the stock fish is to the Icelander; he eats it at all times, and prefers it to everything else. The only preparation given this delicacy is a severe pounding with a hammer, which enables those desirous of eating it to strip off filaments of fibrous fishy flesh; these are eaten either with butter or with tallow; and perhaps, as a friend of mine once said, its best quality is that, having eaten a good dinner, one could amuse oneself by masticating it until one had an appetite for supper.

Upon taking a survey of the town of Reghjavick, we find it to consist of the usual wooden frame houses, which spring up with such mushroom-like growth upon the plains of North-West America, the only difference being that their growth in Iceland is as slow as it is rapid upon the other side of the Atlantic. The architecture of Reghjavick is decidedly of the lath and plaster order, but there has been a great improvement in the town during the last twelve months. The principal buildings are the cathedral, the governor's house, and the hospital.

The stores, which are for the most part kept by Danes, are situated in the principal street, and supply the usual miscellaneous assortment of necessaries from a crochet hook to a pound of treacle or a chain cable.

Lounging about the stores and attending to their ponies, which are patiently waiting for the heavy loads of necessaries which they are to convey to the homes of their masters in the interior of the country, are numerous specimens of the pure and unsophisticated Icelander. He is short, sturdy, very often dirty, is clad in a suit of home spun cloth, or "wadmal," and wears moccasins of untanned skin upon his feet; he is honest and trustworthy, but like most other people has a decidedly good eye to the main chance.

The women of Iceland, upon whom I am sorry to say devolves perhaps the greater part of the hard work of the country, are, like the men, sturdy and hardy, but hard work and exposure are never very favourable to good looks, and considering the constant struggle that the Icelander's life is against all kinds of hardship and exposure, the only wonder is that there are so many comely Icelandic maidens who can decidedly lay claim to their full share of good looks. Their dress is a tight bodice, with a jacket and skirt of homespun cloth; they wear a little black cap upon their heads, with a large silk tassel hanging upon one side, the effect of which is rather pretty and decidedly unique. Upon grand occasions they wear a grander costume, often enriched with gold and silver braiding, and a tall helmet-shaped cap called a "faldi," from which depends a veil. The employment of the Icelanders in summer is fishing, tending their flocks and cattle, gathering in their hay, which is the only harvest the Icelander knows, digging turf, and collecting fuel. In the winter he prepares his home-spun cloths, and exercises his skill in the rougher kinds of jewellery, carpentering, and smith's work, and spends by no means an inconsiderable portion of his time in the study of literature.

The food of the Icelander is mutton, fish, butter, rye cakes, and many European luxuries, which of late years have found their way into the country. He drinks milk, coffee (the Icelander's speciality, a good cup of which can be procured at the poorest farm), and brandy (or schnaps); to the latter he is as much attached as the Englishman is to his beer, and even Englishmen themselves can ill afford to despise it after a long ride on a wet cold day.

The religion of Iceland is Lutheran; it was introduced by King Christian, of Norway, in the year 1545 A.D. The cathedral is built of stone, and is by far the handsomest building in the town, and the service in it would do credit to many places of greater importance.

But our horses are ready and waiting; there are our pack horses with their heavy pack boxes hung upon either side of them, and here are the Icelanders who are to accompany us. All are impatiently waiting for us to start and examine the marvellous curiosities and admire the grand scenery that their island contains.

We are soon leaving the town of Reghjavick behind us, with its beautiful bay, and the numerous small craft lying so peacefully upon its tranquil waters. The road does not extend far, and we are soon upon one of the usual bridle tracks which constitute the only roads of Iceland, except in the

immediate neighbourhood of Reghjavick. It was evening when we left the town of Reghjavick, but as it is the month of June there is no darkness. The sun has just risen after its brief sojourn beneath the horizon as the valley of Thingvallir opens before us, with its beautiful lake, its little church and parsonage, and the Logsberg, or Rock of Laws, so famed in Norse history and Icelandic legend. Behind us is a dreary lava field, and the Western horizon still glowing with the sunset of yesterday. To the north, all the crags of Ammenan's-fell, upon which the unmelted winter's snows are glistening in the light of the newly-risen sun, while a few soft clouds that have rested for the night upon them, rising, resume their journey, soaring into the fair beauty of the morning sky. Crossing the river Oxerä, we camp hard by the little church and parsonage of Thingvallir, and a very characteristic representation it is of the usual country church and manse in Iceland. This church is built entirely of wood, and the pastor's house of lava blocks and turf.

Upon awaking, the eye first rests upon the crags of Almanaigja; this is a huge rift some seven miles in length, and in some parts 300 feet in depth; there is a corresponding fissure on the opposite side of the valley of Thingvallir. These fissures occur in a vast lava stream, which, at some remote period of the geological history of Iceland, flowed from Skjaldbreith into the valley; a crust, of course, soon formed upon the surface of the cooling lava, and, on the cessation of the eruption, the still liquid lava at the bottom of the stream continued to flow into the deeper parts of the lake which occupies the south-east end of the valley of Thingvallir, leaving the unsupported crust, which had become of great thickness, to sink down in the middle to the present level of the valley, leaving two lateral fissures on the side of the lava stream—the Almanaigja on the one side, and the Ravensrift on the other. The valley of Thingvallir is traversed with many smaller fissures and crevasses, which in many instances almost completely enclose large masses of lava. The Logsberg, or Hill of Laws, is such an island of rock, and is rendered inaccessible, except at one point, by deep yawning crevasses. It was on account of these natural fortifications that it was chosen as a forum for the ancient court, or Althing. Such are the rude monuments of Iceland, which take the place of ruined castles and abbeys of other countries; simply the rude rocks of nature, ennobled by brave deeds of history or some touching romance of love. Centuries have rolled on, and the moss grows thick upon this rocky forum; the last speech has long since died away from that natural senate-house, and the orators have mingled with the dust.

It is the summer of 1871. Gazing towards the beautiful lake of Thingvallir, and along the tortuous course of the river Oxerä, one is surprised to find that the lonely valley has become a populous encampment. What means this unusual stir? The King of Denmark has come to visit the wonders of this remote corner of his kingdom, and to give to the people of Iceland their legislative freedom. Close beneath the cliffs of the Almanaigja, and upon every available piece of turf, are the tents of those who have come from all parts of the island in honour of the great occasion. As the king advances, the assemblage breaks forth into the anthem especially composed to commemorate the thousandth year of their nation's existence, and the new era of their country's freedom; their voices mingle with the roar of the waterfall, and echo amongst the dark crags around them, while for the first time in history's record, the rocks of Thingvallir are trodden by royal footsteps; but we must hasten onward, for one evening is but a short time in which to pay a visit to Iceland. Leaving Thingvallir, we pursue our way towards the Geysirs over the north-east margin of the lava stream in which the wonderful rifts of Thingvallir occur. As we proceed, the burnt and scoriaceous aspect of the lava increases, until we descend to the little lakes of Apvatn and Laagervatn, upon the shores of which several hot springs are spouting and bubbling away, affording a good supply of hot water to the neighbouring farms, and reminding us by an occasional whiff of sulphuretted hydrogen, that we are approaching one of the greatest curiosities in the world—the Geysirs.

We are still upon the king's highway, and if the track were always discernible, had a few more of the loose masses of rock cleared away from it, and were it not occasionally tangled up by bogs and quagmires, it would be by no means a bad bridle path. The Icelandic roads (so called) are very long and very crooked.

At length we reach the River Bruarà, and now we are not very far from the Geysirs. This river finds its way over an ancient lava stream, grown thickly over with dwarf birch and herbage. A large fissure in the centre of the river here draws off the greater portion of the water, leaving the residue very shallow, though rapid; this chasm is spanned by a wooden bridge, which renders this otherwise impracticable ford a matter of comparative ease and safety. A short ride brings us to the plain of Geysir, where columns of steam arising from the principal springs inform us that we have reached one object of our journey. A wide plain opens before us, beyond which the Blàfjalldr, or Blue hills, stand out boldly and clearly in the evening light. The cluster of boiling springs, which constitute the springs of Great Geysir, are situated upon the south-west side of the plain, immediately at the base of some low mountains, whose rude outline proclaims their igneous origin; the springs have surrounded themselves with white patches of silicious rock deposited by their waters, which, crumbling under the action of the atmosphere, is scattered for some distance around them in the form of a whitish sand. There is a party of friends already encamped at Geysir. The two principal springs are spouting slightly, but by the time we have reached them all are tranquilly steaming. Having saluted our friends, we pitch our camp, and partaking of a hasty meal, we proceed to photograph our encampment and our friends, who little suspect that the penalty they will have to pay for it is to be published and exhibited to our friends at home, both in public and in private, in the rude costumes they had adopted for their Iceland travel.

We will now start on a little tour of inspection, first of all to Great Geysir. We find it to consist of a large mound, shaped like an inverted saucer, and composed of a white silicious rock, formed by the deposition of its water. At the top of this

mound is a large basin, which, immediately after an eruption, becomes perfectly empty, the water disappearing down a deep shaft in the centre, at other times it is simply a circular pool of limpid scalding water, which is a great deal too hot to bear the hand in. Directing our steps to the south west, we inspect the springs of secondary renown—Ströker. This is a circular shaft about 20 feet in circumference. Down this well, at a depth of some 16 feet, the water is boiling violently; not only does Ströker erupt of its own accord, but it can also be made to erupt at the pleasure of the visitor. We therefore proceed to provoke him in the usual way, by throwing down a quantity of stones and turf; this causes the muddy water in the bottom of the tube to boil with increased violence, but there is no perceptible difference in the spring for about 30 minutes. Suddenly a column of water, stones, and mud, rises with great violence to the height perhaps of 120 feet; it continues to play for about half-an-hour. The beauty of this display is greatly marred by the colour of the water, which as may be expected, is filthily dirty. Turning from this hydraulic pop-gun towards the hills which overhang the Geysirs, immediately at their base, are two large pools of the clearest boiling water, in which visitors generally cook their food. These springs are of great beauty; when their surface is unruffled by the wind, they reflect from their more shallow parts a lovely azure which deepens in tint until it passes away into the black depths which lead down into the bowels of the earth. The walls and sloping bottom of these springs are of pure white fiorite, which in many places forms fanciful incrustations clothed in ethereal blue, sometimes passing into pink, but the depth and character of the colour reflected seems greatly to depend upon the state of the weather. Leaving a lamb dangling by the neck to cook in this elfin grotto, we proceed to mix a plum pudding, put it in Great Geysir to boil, and mix our toddy with some of the Great Geysir water; for although it contains a great deal of mineral matter in solution, it is not bad to drink. The other small springs in the neighbourhood are scarcely worth describing, but there are many pools of variously-coloured mud, which are rather peculiar when we consider their diversity of colour and their proximity to one another. It is good fun cooking in the Geysir springs, but one can get tired of it. After waiting three days, we are not at all sorry to hear a hammering, thumping noise under our feet, which makes one think a small earthquake is inevitable, and to see a column of water rise from the top of the mound of Great Geysir, through which huge columns of heated water are forcing their way, column rising above column, tearing through the dense volumes of steam and leaping high into the air, full 200 feet above the basin. A near approach gives us a still better appreciation of this wonder of the world, and the violence of the force exerted.

We have been indeed favoured in seeing such an eruption, for it is not often that one of such magnitude occurs. After a few minutes all is over, and the water sinks to rest, leaving the empty basin and pipe, from which clouds of steam still continue to ascend. We must hurry on to Hecla, leaving the Geysirs behind us.

Mount Hecla rises direct from a large plain, a great portion of which has been rendered desolate by the repeated eruptions which from time to time have strewn the plain with lava sand and volcanic *debris*. We travel over alternate beds of lava and sand, occasionally emerging upon portions of the grassy plain which have not yet succumbed to the devastation which Hecla has spread upon the surrounding country. We pause at one of the little farms situated at the base of the volcano, seeming to defy its terrors and destruction.

Mount Hecla, which has been in eruption no less than fourteen times since the year 1004, belongs to the class of volcanoes known as paroxysmal, erupting only after periods of inactivity. This class of volcano is by far the most dangerous, as by long periods of tranquillity, continued sometimes for centuries, the surrounding inhabitants are lured into a false idea of security, until the character of their terrible neighbour is proclaimed to them by the sudden outburst, which perhaps destroys their homes and their lives.

As Mount Hecla is approached from the northwest, its form appears to be that of an oblong cone; it is about twenty miles in circumference, and 500 feet in height, and is capped by three smaller ones, the product of more recent eruptions.

Procuring a guide, we ascend by the side of a lava stream over an undulating sandy slope. This lava has flowed in a very compact stream, sometimes in the distance resembling a large black caterpillar, though it spreads out in many places, to fill up a valley and declivities in the side of the mountain, where it is tossed about in huge black cindery waves, assuming all conceivable shapes and fantastic forms. We reach the first crater after a smart climb over snow and lava, which are mingled in such a ghastly and forbidding manner that one could almost imagine oneself wandering with Dante through some of the baleful realms wherein lost souls are tortured alternately by frost and fire, and we can almost expect some Stygian imp to start from the shelter of the lava crags to bar our progress. This crater, upon the edge of which we are now standing, is (erroneously I believe) called the crater of 1846; for I believe it merely tapped a larger and more distant crater of its lava, from which in reality the eruption proceeded. This smaller collateral orifice is perfectly cold, but from the larger one steaming exhalations are emitted.

The larger crater is an elliptical depression, 300 yards across and 250 feet deep. Its side consists of a series of terraced banks, of many coloured cinders and sulphurous clay; at the bottom is a patch of indurated snow. Descending, we perceive in some places that the ashes and clay are too hot for the hand to bear, and wreaths of vapour are rising from them, depositing a variety of sublimates upon their surface. Re-ascending and proceeding along a narrow saddle of the mountain, its two principal cones come into view. Crossing a snow slope, which contains many miniature ice caverns, we ascend to the apex, which surrounds a long deep crater, breached towards the west, and nearly choked with snow. From one part of it a small body of vapour is rising. The summit, in clear weather, commands a most extensive view. To the south is the plain of Hecla, with its devastation of sand and lava, which bear record of the various eruptions of the mountain; upon the east

and north are the snowy Johulls, or ice mountains, especially the huge mass of the Vatna Johull, whose unsullied dazzling snow-slopes have hitherto resisted all attempts that have been made to cross them; but as we are to journey right across this abode of Arctic frost and volcanic fire, we will not say much about it at the present moment. Leaving Hecla behind us, and travelling eastward over immense lava streams and tracts of volcanic sand, which have been ejected from neighbouring volcanoes, we continue our way towards the Vatna Johull. We cross the roaring torrents formed by the melting Johulls, and crawl like ants beneath the towering cliffs of the bulging headlands of the principal mountain sections. We must pause for a moment at the waterfall of Scogarfoss. This grand waterfall is about 200 ft. in height; the body of water is very considerable, and it displaces a vast amount of air in its descent; the spray rising from it makes a near approach a matter of a wet skin, unless one is provided with a complete casing of mackintosh.

In connection with this waterfall, there is a legend of a coffin of gold supposed to be sunk in the pool into which the Scogarfoss falls, but like many other legends it has made itself perfectly safe from verification, by locating the treasure where it is quite certain no one will ever search for it. We are soon riding beneath the fine basaltic cliffs which skirt the outlying hill of the Vatna and Shaptar Johulls, sweeping in grateful curves, and terrace after terrace displaying the most beautiful basaltic columnous structure. Numerous caves, some of which have their weird Norse legends, indicate perhaps the wash of oceans long before the eye of man rested on the dark crags they penetrate; mountain streams, now swollen by the previous rain, leap from the summit and disperse themselves in spray long ere they reach the bottom of the dark cliffs, collecting again as if by magic underneath, rippling along between the lava blocks, and spreading out upon the broad black sandy plain, it is difficult to believe it is the same band of foam we last saw losing itself over a precipice 200 feet in height.

But we are fast approaching the Vatna, and it is our intention to cross this vast accumulation of ice and snow, to journey over untrodden snow slopes, and reach the northerland by a route which has never been travelled since the island of Iceland rose above the waters of the north Atlantic.

The Vatna Johull is a mass of ice and snow resting upon a nest of volcanoes. Concerning this district and the country immediately to the north of it, the wildest stories have been current; tradition has handed down the supposed existence of fertile valleys in the heart of the Vatna Johull, and of outlaws lurking amongst the crags of the Odatheraun.

To this district the volcanic forces of Iceland appear of late years to have retreated, and although the most terrible volcanic eruptions have been witnessed in the Vatna Johull and its immediate neighbourhood, the seat of this occurrence until this year had never been visited.

Well! here we are upon the south side of the Johull, we have hired eleven sturdy young Icelanders, and with a good equipment are now arrived at the point where the rocks terminate, and the eternal snows of the Vatna commence, We send back the horses under the care of two Icelanders, directing them to proceed to Northerland and await us there, and we commence the ascent of the frozen mass before us. Perhaps it will not be out of place to give you a brief description of the necessary outfit for an expedition of this kind. In the first place, everything has to be carried upon hand sleighs, you may therefore imagine that nothing superfluous is taken.

Our most important article is our bed; it is a bag 8 ft. by 5 on one side; made of india-rubber, felt, and cork, and the other side of thick blanketing, covered with mackintosh. This is open at both ends, so that three can sleep with their heads one way and three with their heads the other way; a hood which covers both ends completes our arrangements, and thus we have sleeping accommodation for six men, with a weight of only 50 lbs.

This bag, however, has its little disadvantages; for instance, should any one be taken with the cramp, or dream of engaging in any violent exercise, the limited dimensions of our bed become painfully apparent.

Our provisions consist of pemmican in skin bags, biscuit, butter, condensed soups, chocolate, and whisky, which, with a low tent, a good supply of clothes and moccasins, and the necessary implements and instruments, complete our equipment.

Last year the Johull at this point was a crevassed glacier, the surface of which was covered with black sand and ice; now all traces of the glacier are buried beneath a vast accumulation of snow. From the first we are able to use our sleighs, and we are fast leaving the habitable world behind us, and approaching a solitary wilderness of Arctic frost and volcanic fire, wholly destitute of animal, insect, or floral life; the home of the fog and the storm, and the more terrible forces of nature. Passing some conical volcanic eminences which here penetrate the snow. which during some ancient eruption poured forth a lava stream of several miles in length, we find the snow lies heavy and deep, and as it is snowing heavily we decide to halt. The plan I usually adopt, and one of the warmest methods for camping in the snow, is to dig a square hole, three or four feet deep; over this I pitch a low tent; in the bottom of the hole the sleeping bag is placed. Here is a view of our encampment; here is our tent, here are our sleighs, our snow shoes, our Alpenstocks, and our party, all employed in making our resting-place as comfortable as it is possible to do under the circumstances. We thus pass our first night in comparative comfort. Six of us occupy the bag before described, and sleep much after the manner of sardines in a sardine-box, and the remaining four, who are to accompany us only a short way, make themselves as comfortable as they can with mackintosh coats and rugs in the front part of the tent. The morning light brings us only fog and gloom, but as I have been here before, I decide to advance. After struggling for some time through the deep snow, we are obliged again to halt, for the storm has increased in violence and the fog in thickness. It is not until the following morning that we are able to make satisfactory progress, for when the snow is loose and deep we have to wait for the ice to form a firm crust upon the surface before the sleighs will travel. By 3 a.m. the surface of the snow is frozen hard, and as the sun illumines

the magnificent snow slopes around us, everything seems to promise fair weather and success. The sleighs travel merrily over the frozen snow until we reach the mountain I last year named Mount Paul, after my head man, who accompanied me both then and on the present occasion.

Mount Paul is a cluster of volcanic eminences, which penetrate the snow, and the radiating heat from it has thawed out a semi-circular gulf upon the south, in the bottom of which we find a good supply of water.

We here send back four of our men, but we ourselves are detained by bad weather. Our compass, owing to the magnetic iron contained in the rocks which lie beneath the snow, is of little use, and in thick weather we have to steer principally by the wind. When it is practicable we again push on, despite the deepening snow, but, after going a short distance, a fresh storm bursts upon us, and we are so surrounded by whirling clouds of snow, that it is utterly impossible to tell from what quarter the wind is blowing. This compels us to halt again, to seek the shelter of our tent; for two days the storm continues, and we are obliged to submit to short rations. The next night we make little progress owing to the indisposition of two of my men, but on the ensuing evening we are favoured by 20 degrees, a firm crust has formed over the snow, and when we again start we make good progress northward. Towards morning a fog shoots down upon us, but the rim of the sun is just discernible through it, giving us a good line to steer by, and bright fog-bows bring up our rear to windward. We camp at the height of 615 feet, just in time to escape a storm, such as I have never before been exposed to. For three days and nights the storm beats pitilessly upon our small encampment. We are again obliged to submit to half rations. It is a trying time, lying weather bound in this bleak mountain region with provisions growing less and less. On the morning of the fourth day our hopes revive, the fury of the storm has beaten the snow hard, we pack up our traps with the utmost expedition, and push on northward. After ascending a short distance we commence to descend, and presently at so rapid a rate that I order three men to put spiked iron clamps upon their feet to steady the sleigh in its descent; without this precaution we shall doubtless end our career, sleigh and all, by an abrupt descent into the valley beneath, unless we are stopped by some very ugly crevasses about half-way down the snowy steep, upon the precipitous and slippery sides of which we are descending. Our work is now comparatively easy, and the next morning sees us at the south base of the Vatna Johull, leaving behind us its mysterious recesses and volcanoes, so carefully guarded from intrusion by gloom and storm.

Before us is our first view of Northerland; to our immediate north is a cluster of mountains from which a vast volume of steam is rising, and hovering above the summit in a huge mushroom shaped cloud; to our West lies a wide spreading lava field, arms of which stretch up among the adjacent mountains, like the troubled waters of a cindery ocean; while behind all, the rude outlines of fire wrought mountains form a fitting back ground.

Our provisions are running short, so a series of forced marches are necessary to enable us to reach the nearest farm. Fifteen hours' march over sand and lava brings us level with the steaming mountains before mentioned; they are evidently the Dyngjufjoll mountains, whence the pumice was ejected which last spring did so much damage in the north of Iceland; the ground around us is strewn with pumice which has fallen in a band of ever extending radius eastward towards the sea shore, destroying in its course six farms and injuring others. As we advance we find the country around is covered with pumice to the depth of several feet, some having been swept into banks of many feet in depth. This pumice is of a highly vitreous nature, and of a remarkably cellular structure, often resembling masses of flossy hair, coral, sponge, and grained wood.

It is a lovely yellow sunset as we descend the Valalda, some outlying hills on the Vatna, and the ashen covering of the mountains reflect an unearthly light, which adds a ghastly grandeur to the chaotic desolation around, and we ourselves, as we travel noiselessly in our moccasins, dirty, brown, and wayworn, seem fitting representatives of the outlaws and evil spirits with which tradition has peopled this wild region. We are soon at the farm of Grimstaller, where we are welcomed by the farmer and his family. We have journeyed from Nupstad in the south, across the Vatna to Grimstaller in the north, in sixteen days, twelve of which have been passed in the region of perpetual snow.

After two or three days' rest we will return across the lava and sand desert of the Myvatus Orœfi, to the volcano whence the pumice has been erupted. We find it situated in the extreme south corner of the little plain of Askja. Askja is a little piece of elevated land shut in by semi-detached sections of mountains of considerable height; the crater is a triangular pit, about five miles in circumference it is bounded on the north by a wall of rock, which descends in a sheer precipice of about 200 ft. from the level of the plain of Askja; it is enclosed upon the east and west sides by lofty mountains, which rise in some instances to the height of 1,000 ft. They appear shorn of their inner faces by the violence of the eruption; avalanches occur at frequent intervals, and form, in one or two places, steep slopes of pumice and *débris*, which it is quite possible to descend. Right thankful are we to rest ourselves under the hospitable roof of Herra Guthmindson, the merchant, at Husavick, whose guests we are most happy to remain for a few days, in order to recruit our strength. Husavick is situated upon the beautiful fjord or frith of Skjalfundi fljot, and a merry time we have of it, for we fall in with a party of English gentlemen, who think of working the sulphur mines of Husavick; and after nearly three months' absence from home, it is pleasant to converse in one's own tongue again. At many of the little inlets in the north of Iceland are stores, upon which the country people depend for their supplies. If we were to go on to Hjilsfjord we should find another store. This is a whaling and fishing station besides, where the odoriferous employment of preparing shark-oil from sharks' livers is carried on to a considerable extent, polluting the pure air in the most disgusting manner.

Accompanied by our friend the merchant, we will now pay a visit to Archeray, the second

largest town in Iceland. It is beautifully situated on the Bay of Eyjafjoid, or the Island Firth, surrounded by mountains, many of which rise to great height, and shelter it from the fierce storms which assail so violently many other parts of the island, giving it by far the most beautiful and the safest harbour in the north of Iceland. It is the emporium of the north, and, besides its commercial reputation, it is noteworthy as containing the largest tree in Iceland; this is an ash tree, the age of which is uncertain; it flourishes in front of the house of one of the principal merchants, and is considered the greatest lion of the place. Archeray, likewise, boasts of one of the finest houses we have seen in Iceland; it is the house of the apothecary, and is very comfortable, though, like many of the Western American habitations, it reminds us of living in a large lantern or conservatory, on account of its wooden walls and numerous doors and windows. Returning southward, whilst sojourning amongst some of the principal sheep farms of the north, our attention is arrested by stupendous columns of smoke rising from the direction of Myvatus Orœfi, and spreading themselves out like phantoms of mammoth palm trees in the calm atmosphere of an autumn Sabbath morning. It was in the Myvatus Orœfi that the terrible eruptions occurred last spring; let us hasten to the spot and see what new ruin is being piled upon the old.

On emerging from a valley which runs through the hills of Myvatu and borders its plain to the west, a line of some twenty columns of smoke proclaims the principal seat of volcanic activity. At the extreme northern end a mound of some 150 feet in height is erupting violently, and casting up a column of stones, ashes, and scoriæ to perhaps twice the height of the mountain; it is rapidly forming a cone within a larger crater, which has evidently been formed by some previous eruption, and a copious lava stream is flowing from a breach in its most northern side. It is night, and the gloom is rendered tenfold more oppressive by the dark sulphurous vapours which hang over us; the wind is freshening from the north-west, from which quarter it has fortunately been blowing all day, thus enabling us to gain a little neck of land, now nearly encircled by lava, within two or three hundred yards of the volcano itself. Showers of ashes are falling around us, in spite of the adverse wind; columns of fire, with loud explosions, spring from the grim jaws of the volcano, falling in torrents of fiery sparks and fragments upon its glowing lips and blackened sides. Yet how meagre, and how utterly insignificant is this glorious display, to what those mighty fires must be which are occasionally let loose from the icy bosom of the Vatna and other mountains; how terrible must be their outburst, and how entirely unapproachable. Yes, that is the unsatisfactory part about them; when they are in full going order, there is no getting near them, and at other times one can only climb, shudder, and freeze oneself over their temporary tombs.

The morning light shows a line of some twenty smoking mounds, which mark a lengthy fissure in the plain, caused by the expansive force of the erupting lava. Perhaps the most remarkable feature of Icelandic eruptions is their eccentric drifting; first they break forth amongst the snows of the Vatna, then amid mountains that for ages have stifled volcanic energy, now in the middle of a plain already devastated by previous volcanic outbursts.

The Chairman, observing that the hour was too late for any discussion on the interesting paper they had heard, said he would only propose a vote of thanks to Mr. Watts for the very eloquent and entertaining manner in which he had described the beauties of Iceland.

The vote having been carried, and briefly acknowledged by Mr. Watts, the proceedings concluded.

The Paper was illustrated by numerous photographic views of Iceland, taken by Mr. Watts, and by a series of specimens of different volcanic rocks, exhibited by means of the oxy-hydric lantern.

MISCELLANEOUS.

ADULT EDUCATION BY PUBLIC MUSEUMS.

Number of visitors for the month of December, 1875. When they are counted by sight the words "by sight" are used, when by turnstile the word "machine":—

	Amounts voted in 1875.	Number of Visitors in December	How counted.
	£		
1. British Museum[1]	17,471	36,850	(by sight).
2. National Gallery[2]	6,346	47,956	"
3. Kew Gardens and Museum[3]	4,273	5,578	"
4. South Kensington Museum[4]	39,019	74,477	(by machine).
5. Bethnal-green[5]	7,325	46,410	"
6. National Portrait Gallery[6]	1,956	...	"
7. Geological Museum, Jermyn street[7]	9,070	2,873	"
8. Patent Office Museum[8]	..	41,001	"
9. Edinburgh National Gallery[9]	2,100	7,664	"
10. Edinburgh Museum of Antiquities[9]	...	8,415	" "
11. Edinburgh Museum of Science and Art[10]	10,509	30,242	"
12. Edinburgh Botanic Gardens	1,750	1,633	"
13. Dublin Museum of National History[11]	1,717	5,284	"
14. Glasnevin Botanical Gardens and Museum[12]	2,224	4,050	"
15. National Gallery of Ireland	2,339	11,694	"
16. Museum of Royal Irish Academy, Dublin	200	...	"
17. Zoological Gardens, Dublin	500	20,802	"
18. Tower of London	1,500	21,725	(by sight).
19. Royal Naval College, including Greenwich Painted Hall	...	13,328	"
20. Royal Naval Museum, Greenwich	1,190	2,468	"
21. East India Museum[13]	5,883	3,137	(by machine).
22. Hampton Court Palace[14]	3,465	...	"

1 Return refused. Number for corresponding month last year given.
2 Seventeen days. Total for the year 1875, 806,250.
3 Open on Sundays.
4 Total for year, 830,212.
5 Total for year, 522,098.
6 Return refused.
7 Return for November received late, 3,278.
8 Total for the year 1875, 265,233.
9 Open on Sundays.
10 Total for 1875, 455,784.
11 Return for November omitted, 4,991.
12 Return for November omitted, 3,597.
13 Paid for by Indian Government. Admission daily by payment of 1d., except Thursday and Friday, 6d.
14 Open on Sundays.

NOTICES.

SUBSCRIPTIONS.

The Christmas subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to Mr. P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

February 2.—"Condensed Beer," by Dr. Bartlett.

February 9.—"The Cultivation of Hardy Fruits, with a view to improvement of quality and ensuring constant and abundant production," by Shirley Hibberd, Esq.

February 16.—"The Combustion of Gas, and its application to Heating Purposes," by John Wallace, Esq.

February 23.—"Contagious Diseases of Animals as affecting the Health and Wealth of the Country," by George Fleming, Esq., Royal Engineers.

March 1.—"Aquarium Construction and Management," by W. Saville-Kent, Esq., F.L.S., F.Z.S.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

February 15.—"Ostrich Farming and the Ostrich Feather Trade of South Africa." By P. L. Simmonds, Esq., F.S.S.

March 14.—"The Diamond Fields of South Africa, and their Influence on the Native Races of the Neighbourhood." By J. B. Currey, Esq.

March 28.—"The Industries of South Africa." By T. B. Granville, Esq.

April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following papers will be read:—

February 18th.—"The Land Revenues of India," by Major-General Marriott, C.S.I.

March 24th.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

May 19th.—"Competition and its Effects on Education," by Dr. George Birdwood.

Chemical Section.

Friday evenings at 8 o'clock. The following papers will be read:—

February 11.—"Sole-Leather Tanning, with some Remarks on the the Import of Hides and Cattle." By Sparke Evans, Esq., of Bristol.

March 17.—"Some Recent Metallurgical Processes." By J. Arthur Phillips, Esq.

March 31.—"The Methods of Estimating the Illuminating Power and Purity of Coal Gas." By A. Vernon Harcourt, Esq., M.A., F.R.S.

April 28.—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Widnes.

Cantor Lectures.

Monday evenings at 8 o'clock. The Second Course, "On Iron and Steel Manufacture," by W. Mattieu Williams, Esq.

Lecture III.—January 31st.

Finished Iron.

Cort's invention and subsequent improvements.—The construction of puddling furnaces and the operations of the puddler.—Puddler's "physic."—The theory of puddling.—Mechanical puddling.—The intelligence of the puddler.—Modern attempts to supersede puddling.—Reheating.—Squeezing.—Shingling.—Rolling.—Bar iron.—Rail making.—Angle-iron.—Iron wire, &c.—Piling.—Plate rolling.—Boiler plates.—Ship plates.—Armour plates.—Sheets.—Fibre of iron.—Hot and cold shortness.—Lamination and blistering.—Testing of wrought iron.—The tenacity, elasticity and toughness of iron.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. Mattieu Williams, "Iron and Steel Manufacture." (Lecture III.)
Royal United Service Institution, Whitehall-yard, 8½ p.m. 1. Mr. George Quick, "A Proposed New Combination of Propellers for Ships of War." 2. Mr. R. Griffiths, "Report of Further Trials with his Cased Screw-Propeller, as recently fitted to H.M. Gunboat *Bruiser*."
British Architects, 9, Conduit-street, W., 8 p.m.
Institute of Actuaries, Burlington House, W., 7 p.m. Mr. Cornelius Walford, "The Finance of Fire Insurance."
Medical, 11, Chandos-street, W., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Bryce, "The Early History and Institutions of Iceland."

Tues. ...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "Classification of Vertebrated Animals."
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Harrison Hayter, "Holyhead New Harbour."
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.
Biblical Archæology, 9, Conduit-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Dr. Bartlett, "Condensed Beer."
Geological, Burlington House, W., 8 p.m. 1. Prof. Owen, "Evidence of a Carnivorous Reptile (*Cynodrakon major*) about the size of a lion; with remarks thereon." 2. Mr. R. Ethridge, "The Occurrence of the Genus *Astrocrinites* (Austin), in the Scotch Carboniferous Limestone Series; with the Description of a New Species (*A. Bennici*), and remarks on the Genus." 3. Mr. G. T. Bettamy, "The Genus *Merycochœrus* (Family *Areodontidæ*); with Descriptions of two New Species." Communicated by Prof. Hughes.
Entomological, 11, Chandos-street, W., 7 p.m.
Microscopical, King's College, W.C., 8 p.m. President's Annual Address.
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m.
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.

Thurs...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. R. Bowler Sharpe. "The Geographical Distribution of Vultures." 2. Dr. James Murie, "Notes on a Newfoundland Frog."
London Institution, Finsbury-circus, E.C., 7 p.m.
Chemical, Burlington House, W., 8 p.m. 1. Mr. H. E. Armstrong, "The Formation of the Hydrocarbons of the C_nH_{2n} and C_nH_{2n-2} Series, and their combinations with the Haloid Acids and other Compounds." 2. Mr. W. H. Perkin, "Note on the Formation of Anthrapurpurin." 3. Mr. Thos. Carnelly, "High Melting Points, with Special Reference to Metallic Salts." Mr. W. Ackroyd, Metachromism, or Colour Changes."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Walter Hamilton, "The Origin of English Dramatic Art."
Royal Institution, Albemarle-street, W., 3 p.m. Dr. Gladstone, "Chemistry of the Non-metallic Elements.
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Special Lectures.) Dr. Benjamin W. Richardson, "Industrial Pathology, or the Influence of certain Injurious Occupations on Health and Life." (Lecture VI.)
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Mr. W. H. Preece, "The Applications of Electricity to the Protection of Life on Railways."
Geologists' Association, University College, W.C., 7½ p.m. Annual Meeting.
Philological, University College, W.C., 8 p.m.
Archæological Institution, 16, New Burlington-street, W., 4 p.m.

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Mr. Pullan, "Excavations in Asia Minor."

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,211. Vol. XXIV.

FRIDAY, FEBRUARY 4, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

OFFICE ARRANGEMENTS.

At the last meeting of the Council, January 31st, it was decided to fill up the vacancy caused by Mr. Davenport's death by appointing Mr. H. Trueman Wood (the Editor of the *Journal*) as Assistant Secretary, and Mr. Howard H. Room (Chief Clerk) as Cashier.

SUBSCRIPTION FOR THE FAMILY OF THE LATE S. T. DAVENPORT.

The following subscriptions have been promised, amounting to £1,021 12s.

It is requested that members will accept this notice as an acknowledgment of their subscriptions :—

	£	s.	d.
F. A. Abel, F.R.S.	10	0	0
W. P. Andrew	5	0	0
Sir William G. Armstrong, C.B., F.R.S.	20	0	0
William Atkinson	10	0	0
Mrs. Atkinson	10	0	0
H. F. Austin	1	1	0
Lawrence J. Baker	5	0	0
Professor Barff	5	5	0
W. B. Barker	2	2	0
G. C. T. Bartley	5	0	0
Charles Bath	3	3	0
Edward Beanes	5	0	0
John Bell	5	0	0
Sir John Bennett	2	0	0
Francis Bennoch	5	0	0
James Bentley	5	0	0
J. Bergtheil	1	1	0
Mrs. Berri	2	2	0
Henry Bessemer	10	10	0
W. H. Biss	2	2	0
George Blackie	1	1	0
E. T. Blakely	1	0	0
John Bloomer	5	5	0
W. P. Bodkin	2	2	0
Charles P. B. Bosanquet	1	1	0
William Botly	20	0	0
H. A. Bowler	1	0	0
F. J. Bramwell, F.R.S.	21	0	0
Ebenezer Breillat	2	2	0
Thomas Briggs	5	0	0
W. W. Brocklehurst	3	0	0
Edward Brooke	25	0	0
Henry Brooks	2	2	0
Henry Brown	2	2	0
James Brunlees	10	10	0
H. Burkinyoung	3	3	0
William S. Burton	2	2	0
Rev. H. M. Butler, D.D.	2	2	0
Henry Butter	5	0	0
R. Russell Carew	5	0	0
Cassell, Petter and Galpin	3	3	0
Andrew Cassels	10	0	0
Edwin Chadwick, C.B.	5	0	0
J. H. Challis	5	5	0
Charles Chatfield	5	0	0
Lord Alfred S. Churchill	10	0	0
Charles Clark	5	0	0
Joseph Clark	1	1	0
Hyde Clarke	10	0	0
R. G. Clarke	2	0	0
Charles Clauson	1	1	0
George Clowes	5	0	0
John, Clutton	3	3	0
Sir Henry Cole, K.C.B.	10	0	0
John Colebrook	2	2	0
Sir Daniel Cooper, Bart.	10	10	0
Henry Cooper	1	1	0
Thomas Cordes	1	1	0
F. W. Costar	2	2	0
Major-General F. Cotton, R.E., C.S.I.	5	0	0
Samuel Courtauld	5	0	0
J. G. Crace	2	2	0
J. D. Crace	1	1	0
Charles Critchett	20	0	0
Col. A. Angus Croll	21	0	0
Ardaseer Cursetjee	2	0	0
R. P. Daniell	5	0	0
Frederick Davis	2	2	0
Robert Dawbarn	5	0	0
Henry Dawson	2	2	0
James Deane	1	1	0
Lord De L'Isle and Dudley	5	0	0
Alfred Denison	5	0	0
J. Bailey Denton	2	10	0
C. J. Denton	2	2	0
James Dixon	5	5	0
Major Donnelly, R.E.	5	0	0
Henry Doulton	5	0	0
W. C. Dutton	5	0	0
Maj.-Gen. F. Eardley-Wilmot, R.A., F.R.S.	5	0	0
Right Hon. Sir William Erle	10	10	0
John Fair	3	3	0
R. F. Fairlie	5	0	0
W. S. Fitzwilliam	2	2	0
W. Fletcher	5	0	0
James Forrest	5	0	0
Michael Fort	2	2	0
Hon. Dudley F. Fortescue	5	5	0
P. Le Neve Foster	5	0	0
C. J. Freake	21	0	0
H. F. Freutel	1	1	0
"A Friend"	30	0	0
Capt. Douglas Galton, C.B., F.R.S.	5	0	0
Professor John Gamgee	5	5	0
Mrs. Edward Glynn	5	0	0
Charles Goding	5	0	0
Joseph Henry Good	5	0	0
G. R. Greenhow-Relph	2	2	0
Arthur Hall	3	3	0
Right Hon. Lord Hampton, F.R.S.	10	0	0
James Lyne Hancock	5	0	0
Michael Hanhart	2	2	0
Colonel C. S. Hannington	5	5	0
Rev. Charles Harris	2	2	0
Right Hon. Lord Hatherley, F.R.S.	10	0	0
John Harvey	2	2	0
James Heywood, F.R.S.	1	1	0
Sir Rowland Hill, K.C.B., F.R.S.	5	5	0
Edward Hibbert	5	0	0
Mrs. Holtzapffel	2	2	0
G. N. Hooper	20	0	

	£	s.	d.
J. Hopkinson	3	3	0
F. J. Horniman	1	1	0
Thomas Hughes	2	2	0
Edmund Johnson	3	3	0
John Henry Johnson	3	3	0
John King	1	1	0
Horatio Kemble	1	1	0
F. J. Lace	1	1	0
H. Reader Lack	5	5	0
Edwin Lawrence, LL.B.	10	10	0
C. J. Leaf	10	10	0
Robert Leighton	1	1	0
Sigismund Leoni	1	1	0
William Low	2	2	0
John Mackay	1	1	0
Dr. Mann	5	5	0
Major E. W. Mathew	5	0	0
James Matthew	5	5	0
A. W. Miles	3	3	0
F. D. Mocatta	5	0	0
George Moffatt	10	10	0
William Mort	2	2	0
H. B. Muir	2	2	0
John Murray	3	3	0
Walter Neilson	2	2	0
George Norbury	5	5	0
Vice-Adm. Erasmus Ommanney, C.B., F.R.S.	5	0	0
Tito Pagliardini	3	3	0
Alfred B. Pearce	1	1	0
W. H. Perkin, F.R.S.	25	0	0
Houghton Perkins	1	1	0
J. S. Phillips	1	1	0
W. T. Raymond	1	1	0
Robert Rawlinson, C.B.	10	0	0
Samuel Redgrave	5	5	0
J. Russell Reeves, F.R.S.	10	0	0
B. W. Richardson, M.D., F.R.S.	2	2	0
H. J. Richmond	2	2	0
Rev. A. Rigg	5	5	0
Francis Rogers	2	2	0
J. Gouldsmith Rolls	2	2	0
H. H. Room	5	0	0
Philip Russell	2	2	0
Sir Titus Salt, Bart.	5	0	0
Philip Sancton	5	0	0
W. R. Sandbach	5	0	0
Sir John Scott	5	5	0
Benjamin Shaw	10	10	0
J. J. Shaw	2	2	0
W. Shelford	1	1	0
John Spiller	2	2	0
William Spiller	10	10	0
Allan Spowers	5	0	0
J. Stohwasser	2	2	0
C. H. Strachan	2	2	0
James Taylor	2	2	0
Seymour Teulon	10	0	0
George Treble	5	5	0
W. Trounce	5	0	0
E. Carleton Tufnell	10	10	0
T. R. Tufnell	10	0	0
Thomas Twining	50	0	0
Henry Vaughan	5	0	0
Dr. A. Voelcker, F.R.S.	5	0	0
T. R. Wagstaffe	3	3	0
Captain Charles Warren	2	2	0
Edgar W. Waugh	2	2	0
B. Waymouth	2	2	0
Thomas Wills, F.C.S.	2	2	0
Robert Wilson	2	2	0
G. F. Wilson, F.R.S.	10	10	0
Winsor and Newton	5	5	0
H. Trueman Wood	5	0	0
Edward Woods	5	0	0
Richard Worthington	10	0	0
William Young	1	0	0

NINTH ORDINARY MEETING.

Wednesday, February 2nd, 1876; Professor C. Tomlinson, F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Buckle, Captain Charles M., R.N., 3, St. James's-place, S.W., and United Service Club.
Rösing, F., 11, Billiter-square, E.C.
Sampson, Thomas, 252, Marylebone-road, N.W.
Smithers, Alfred Waldron, 24, Brandram-road, Lee, S.E.
Tooth, Robert, 10, St. Mary-at-Hill, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Burgess, Major Charles John, Naval and Military Club, S.W.
Cummins, Eaton T., 31, Lansdowne-crescent, W.
De Keyser, Polydore, Grosmont-house, Hampton-wick.
Duncan, Robert, Port Glasgow.
Fielden, Immer, 12, James Watt-street, Glasgow.
Hill, Arthur W., Heatherside, Cromthorne, Wokingham.
Hill, Richard Harris, 2, Storey's-gate, Westminster, S.W.
Honey, Henry, 1, Westbourne-square, W.
MacIntosh, James, 38, Langham-street, W.
Mackenzie, William, C.B., C.S.I., M.D., 3, Talbot-square, Hyde-park, W.
McShane, J. F., 73, Great Tower-street, E.C.
Majoribanks, Edward, 134, Piccadilly, W.
Milward, R. H., 41, Waterloo-street, Birmingham.
Moore, James H., C.E., Town-hall, Basingstoke.
Nubar, Boghos, C.E., 1, Stafford-street, Derby.
Ohlson, J. L., West India Committee, 9, Billiter-square, E.C.
Probyn, Clifford, 55, Grosvenor-street, Grosvenor-square, W.
Sandwith, Humphrey, C.B., D.C.L., M.D., Athenæum Club, S.W.
Short, Rev. Ambrose, Bodicote Farm. Bodicote, Oxon.
Stuart, Alexander, 8, Powis-square, Kensington, W.
Sugden, Henry Townley, 12, Buckingham-street, Strand, W.C.
Tayler, Christopher, Trowbridge.
Thurgood, Herbert John, 123, Chancery-lane, W.C.

The paper read was—

CONDENSED BEER.

By Dr. Bartlett.

If, during the last quarter of a century, there have been comparatively few new introductions to increase the catalogue of previously known articles of food, a real accession to our food imports has been secured, by means of certain preserving processes, which were until recently expensive, and, with the exception of Gamble's, unreliable. When the item of cost was not so much to be considered, preserved meats, poultry, and fish enabled yachtsman and Arctic voyagers to regale themselves upon delicacies which would otherwise have been unattainable; but they had to pay for their luxuries, and at prices which precluded a more general and extended use of such means of preservation.

Even ten years back, few could have supposed that we might rely, to some extent, upon foreign supplies. Whenever beasts are selling in Australia or New Zealand, so that butcher's meat can be quoted at a few pence per pound lower than our

market prices here, vast quantities are tinned and brought to this country, and afford a fair profit to the importer and salesman, after paying freight and the expense of cooking and of the preserving tins.

The general prejudice against preserved meat has already so far given way, that there is at the present time a much larger demand for it than can always be satisfied. Whatever difficulty attended the first importation on this score, none whatever is experienced in the preserved provision trade in disposing of all that comes to hand. On the contrary, nothing has tended to circumscribe the amount of importation, but the inherent obstacle interposed by so great a rise in the market price of meat abroad, as to leave too narrow a margin of profit to satisfy the importer and shopkeeper. This must always be liable to occur in the fluctuations in the price of stock. But when we come to consider the enormous trade in preserved provisions of a somewhat choicer kind than common butchers' meat, we find that one of the most striking features of the last ten years is its immense development. In every grocer's shop huge piles of tins may be seen containing salmon, oysters, lobsters, game, peaches, and endless other delicacies too numerous to specify; in fact, one of the largest and most remunerative portions of the grocer's trade of the present day undoubtedly consists in provisions preserved in such a manner as to keep over any practicable length of time.

Not only have solid goods been tinned up and saved from the effects of decomposition, so as to equalise to some extent the supply and demand, but the same important economy has been effected with regard to milk.

Most persons are aware that in summer time more milk can be procured throughout the country than can be carried to the consumers with sufficient rapidity to prevent its turning sour pefore it reaches them. Many are also doubtless aware that no small amount of sickness among children is caused by their drinking milk in which an acid change has already commenced, although, berhaps, not very perceptible to the organs of taste or smell. Whether sufficient importance has been generally attached to this circumstance, it is not for me to argue at this time, but the extraordinary growth of the condensed milk business is sufficient to attest the appreciation of the public for a really useful invention successfully carried out. I am enabled to speak with some authority on this point, inasmuch as I have been connected professionally for some time past with the principal condensed milk companies.

I have adduced the example of the marvellous success of condensing milk to show, in the first place, that the preserving or concentrating an article of food in general demand is one of the most practical and profitable of modern inventions. Secondly, it has an immediate connection with the subject of this evening's paper, inasmuch as the inventor of the process for condensing and preserving beer, which I intend to describe, is Mr. Lockwood, who was one of the founders of the condensed milk industry in Europe.

I have no doubt but that the success of the milk preserving or condensing has stimulated him to think of what other articles of food could be similarly treated, his attention being drawn to the possibility of condensing beer. Two years ago this gentleman consulted me as to the feasibility of his scheme, and I can assure you that at first I was by no means prepared to entertain any great expectation of success; but, after making a few preliminary experiments, I was led to the conclusion that the concentration of beer could be even more satisfactorily accomplished than that of milk, and that no real object hindered its being again re-made into its original bulk, nor is there anything to preclude the beer so re-made from being identical in flavour and condition with beer prior to condensing.

Since then I have assisted in conducting most of the experiments, the results of which I now propose to lay before you. I shall afterwards have the pleasure to submit specimens of the re-made ales and stouts.

I may as well explain that after the first laboratory experiments were concluded, it was deemed advisable to test the working of the invention on a manufacturing scale. Accordingly, I proceeded to the works of the Condensed Milk Company at Aylesbury, and at various times condensed the smallest amount of beer which their apparatus would permit, namely, three barrels—108 gallons.

I have here samples of ale and stout condensed in the months of February and March, 1874. I have also some which have remained open from that time to this, and the only difference perceptible is that it has become drier from the evaporation of moisture. But, before proceeding to enter upon the minutiæ of the process of condensing, it may be advisable to touch briefly upon some of the salient points of brewing beer, so as to show more explicitly the great advantages which must accrue from any satisfactory process of arresting the natural tendency of beer to become acid, or otherwise unfit to drink, which is at present only overcome by brewing export beers of great alcoholic strength or with a great excess of hops, and in other respects beers not the best calculated for consumption in warm climates.

To render the subject more intelligible, I will endeavour to explain a few of those points to which some attention must be given.

Firstly, as regards the preparation of the malt.

Secondly, the mashing, and the means of obtaining the extract of malt and hops, technically termed worts.

Thirdly, the fermentation of the wort with yeast, by which a portion of the saccharine is converted into alcohol and carbonic acid, and the beer thus attains its spirituous strength and briskness; or, in other words, the worts become drinkable beer.

These operations in brewing render the preparation of beer in any but a perfectly temperate climate not only difficult and very expensive, but next to impossible if any of our finer qualities of beer are demanded.

I will take the preparation of malt, for instance; and here, at the very outset, commence the difficulties of brewing in other climates. Neither in Australia, South America, China, nor in the greater part of India, can any barley be grown fit to produce a good pale malt; and as malting is a highly critical process, necessitating the greatest possible experience and judgment, it may be easily imagined that there can be but little inducement for maltsters to encounter additional risks, of

which they have no previous knowledge, by attempting to deal with the very inferior barley which can alone be produced in these countries. The consequence is that whatever beer is attempted to be brewed in our warmer colonies, it is always practically from imported malt. Unfortunately for the colonial brewers, malt cannot be shipped in bulk without the certainty of being spoilt, and is therefore only carried in 400 gallon iron tanks, the cost of which tanks, and the freight, very largely augment the original cost.

The great desire of all Englishmen abroad to obtain something resembling their national beverage, and at a more moderate price than the two shillings or half-a-crown now charged in many of our colonies for a bottle of English ale or stout, still induces the attempt to be made to overcome the difficulties of foreign brewing that have been alluded to. We could almost gauge the amount of beer so brewed by the amount of malt exported from this country, and it would then be seen how little has yet been accomplished towards brewing drinkable beers in those parts of the world.

Allowing the colonial brewer to obtain his malt as best he can, and no matter at what expense, a second and almost insurmountable obstacle stares him in the face when he commences to ferment. I need hardly detail the progress of scientific brewing in this country in regard to this most important particular; but this must be admitted by all the more successful of our brewers, that, to the extent they have been successful in reducing the temperature during fermentation, they have been also successful in the production of sounder and better beer, particularly as regards its flavour and keeping qualities. Of such vital importance is a moderately low temperature during fermentation, that even in this country during the summer months it is not advisable to attempt to brew beers for export.

If, then, it were attempted to carry on fermentation at some 20° above our own summer heat, as would be the case in many of our colonies, hardly a drop of sound wholesome beer could be expected to be produced.

Among other essentials, perfectly pure clean yeast is indispensable, and it must be in that condition of healthy reproductiveness which will carry on the fermentation of the worts, so as not to produce any other change than the transformation of as much as is desired of saccharine extract into alcohol. Those other ferments, which are so frequently to be found in yeast, cause the development of lactic and acetic acids, and even the best yeast, drawn from breweries where the greatest cleanliness is maintained, is certain to become deteriorated by being kept more than a few days.

A decomposition takes place in the yeast itself, and although some of the spores still maintain their vitality, and will reproduce alcoholic fermentation in beer worts, still, in the other portions of the yeast, false ferments of the worst possible kind are generated and reproduced in the beer, rendering it not only unsound *ab initio*, but so tainted with products of decomposition that it must be always coarse flavoured and decidedly unwholesome.

Few persons seem to be aware how much nauseous and unwholesome beer is consumed because no better can be obtained in the neighbourhood, many charges of adulteration having no other foundation than the ill effects experienced after taking beer of this kind.

From information which I have received from men who have travelled in various parts of the world, I am irresistibly led to the conclusion that brewing conducted under the difficulties incident to hot climates is productive of beer almost invariably objectionable, generally nauseous, and frequently injurious.

A fresh supply of good yeast must be frequently unattainable in the colonies, such breweries as there are being so few and far apart, that they have but little opportunity of exchanging their barm whenever it may be desirable; and, as it is considerably more difficult to continue to reproduce fermentation for any length of time at the higher temperatures, it must be evident that they will suffer much more for want of supplies of fresh yeast than is ever likely to occur, even in the remotest parts of this country. If, then, as we know, this is a difficulty of great moment to some of our English breweries, I can only anticipate such augmentation of all the danger and trouble that I have spoken of to those abroad as to make it wonderful that they can brew at all.

I have now to treat upon a point of almost equal importance; in fact, so much does the quality of beer depend upon the water with which it is brewed, that I am sure that I shall have but few dissentients in claiming a superiority for the beers brewed with waters from the best English springs to any other beers, come they from what country they may. If we take Burton-on-Trent as furnishing a type of water best adapted for brewing ale, whether mild or bitter, we shall be able to note that the peculiarity of the water consists in what some persons term its hardness; hardness being another name for the presence of certain salts of the alkaline earths.

It may not be considered that I shall be trespassing too much in the endeavour to show that this hardness is one of the most valuable qualities that brewing water can possess, when ales only have to be considered, and on the other hand the soft London waters have been and still are pre-eminently suitable for the extraction of the peculiar flavours of the high dried malt adapted for porter and stout. The rationale of the good effect of the Burton waters by which they give their own individuality to the beers of the district may be easily understood, when we discover that the pale malts, differing from those which are high dried, yield a solution in soft water of a certain portion of their constituents. This solution, being neither gum nor dextrine, but rather of a mucilaginous character, causes a considerable tendency to a most objectionable fermentation, so much so, that much of the unsoundness of the cheap ales brewed with soft water may be traced to this account. But while the solution of malt is carried beyond the degree that is desirable, the over solvent properties of soft water upon hops must also be deprecated, inasmuch as the beer becomes impregnated with the harsher and coarser bitters of the resinous portion, which are quite foreign to the aroma and delicate fragrance yielded by hop oil and other portions of the extractive.

No doubt can rest with any person accustomed to note the peculiarity of ales brewed with hard

water of the Burton type. The latter possess a sufficiency of the delicate bitter which is found to be agreeable to almost all palates; and enough tannin of the hop is extracted to render the lighter beers more fit to keep than would otherwise be possible. Bitter beers of the Burton character leave no harsh or acrid bitterness remaining upon the tongue after the beer is swallowed. This is exactly what denotes the difference between the ales of Burton and those of other localities using soft waters. I am not taking this for granted, merely scientifically, but it is proved beyond contradiction by the verdict of the whole world being in agreement with the theories adduced.

Nothing need, I should imagine, be said further upon this point, than to show that the essentials most important to the production of really good wholesome beer are those which are but little likely to be found conjointly abroad, and if Englishmen must drink beer equal to English beer, they stand but little chance of being able to obtain it when brewed away from England. English beers certainly are the finest in the world, and those best adapted for export.

Gigantic breweries are conducted on scientific principles, and the employés, from the laboratory to the cellars, have to acquire a special knowledge, scientific and practical, such as can alone successfully carry out the multifarious operations of the brewery.

In contradistinction to the accumulated experience of many years, sometimes carried from father to son through successive generations, brewing abroad must generally be conducted almost entirely by means of unskilled labour. That which no practical brewer would consider himself justified in leaving to any but the most responsible hands, must inevitably be performed in most other countries by the mere day labourer.

Considering the long train of difficulties, disadvantages, and inherent defects that naturally attach to any attempt at brewing abroad, it is not wonderful to find that a great part of the beer considered drinkable in other countries is beer that has been exported from this.

Until within some 35 years ago, none but the strongest, that is to say, most heavily alcoholic or saccharine beers, were enabled to withstand the long voyage and after land-carriage, before they could reach their destination. An immense spurt was given to the export beer trade when a pale ale, not nearly so strong as that previously exported, was enabled to pass through the ordeal of its shipment, by being, in the first place, brewed with more scientific accuracy, and secondly, by the addition of a large excess of hops.

To whatever extent this beer was rendered more wholesome, and less expensive, by reason of its lesser strength, to a corresponding degree all such saving was counteracted by the expense of the additional hopping. Moreover, of late years, the price of hops has become so high that the better classes of bitter ale have had to develop their flavours from the smallest quantity of hops that would suffice to keep them. A reaction has, however, already set in, by which any great preponderance of bitterness in the beer is objected to by the more refined palates of connoisseurs. Physicians are beginning to find that bitter beer may be over bitter, that the tonic properties of the hop may be too concentrated; in short, that a great deal too much bitter may be taken without drinking any unreasonable quantity of the beer.

The draught beers in largest demand throughout this country, are both lighter, less bitter, and consequently less expensive than those required for exportation. We are told of the enormous quantities of beer consumed by the draymen, hay makers, and others, and no doubt some of us have marvelled at the quantities of which we have ourselves witnessed the consumption. However much it must be deplored that men should ever find pleasure in absorbing beer in gigantic quantities, which is but too often the case, one thing is quite certain, that no man ever took strong bitter ale or indeed strong ale of any kind in the quantities alluded to.

Another difference between the draught beer that is so largely consumed and beer shipped for export, is that as soon as the first is brewed, it is immediately sent out for consumption; too rapidly indeed for the beer to be always in good condition; but with export beers, those brewed in one season from October to March are not considered fit to ship until they have passed through an entire summer in the export agent's cellars. More frequently, beer is retained for six months longer. If we give a rough estimate of two years intervening between the brewing of the beer and its consumption, we shall by no means exaggerate the loss which is liable to occur during that time. On this account, probably no article of exportation is attended with more risk than beer.

Even after it has attained the condition that is considered most favourable, prior to its shipment, a very slight, almost imperceptible amount of fermentation must still exist in it, or it would be flat and evidently unsound, but as this working may be excited from an almost comparative inertia to the most violent effervescence, both by the rolling of the ship and the jolting of the barrels in other conveyances, and the rise in temperature to which it is subjected, it is not uncommon to find whole shipments of beer wasted either by their becoming sour in transit, or by the bursting of the barrels or bottles in which they are contained. Supposing, however, that the beer reaches the foreign port in safety, it sometimes happens that other shipments have come in at the same time, and at the prices generally charged abroad it is not possible to clear out the stock in time to prevent its becoming deteriorated.

Our colonists know well enough that when once beer has been landed which is not perfectly sound it must be sold at any sacrifice, consequently none but the soundest beers realise the very handsome prices which those who can afford it are still compelled to pay for good beer. If instead of the necessarily enhanced value which good beer attains when successfully landed in proper condition, sound and wholesome beer can be exported at no very great increase upon the prices for which beer is retailed in this country, we may, I think, assume that the demand for such beer will bear no relation to that at present existing.

It has often struck me that the total export of beers from England, to all parts of the world, is strangely inadequate to the aggregate desire

manifested by all Englishmen to indulge in the drink to which they have been accustomed. Half a million of barrels of beer is, after all, an absurdly small export, when we are assured that there are several establishments in the brewing trade which could easily supply the whole of the beer at present exported.

I have devoted more care to the attempt to realise the reason for this than I should otherwise have done, because I felt certain that from these reasons we might ascertain the nature of the obstacles which have to be surmounted. I find the chief requisites considered desirable in beer abroad, particularly in warm climates, to be soundness, low alcoholicity, refined flavour, and perfect keeping qualities. The two chief hindrances to the export of beer having been the heavy freight in proportion to the value of the article, and the small value of the casks or bottles when empty, which cannot of course be returned.

I will now attempt to show how the process of condensing will obviate all the difficulties which at present impede the export of beer; how it will introduce a beverage more suitable to hot climates than those which are now being shipped, and draw attention to what I think I may term the success of the process, after a somewhat lengthy series of experiments on a working scale.

The use of the vacuum pan in condensing milk is based upon the principle, that as atmospheric pressure is removed, liquids attain a boiling point considerably below their normal one. If we take water and heat it in such a pan, removing the air by means of a suitable pump, instead of requiring a temperature of 212° before it passes into steam, water may be boiled 100° lower. In this manner we all know condensed milk is produced at a temperature of 130°, or even less, and is thereby rapidly reduced in bulk by evaporation of the water without injury to the solid components. The same system has also been employed in boiling down sugar and some other extractive matters.

It appeared to Mr. Lockwood that beer might be condensed in the same manner as milk, for the purpose of preserving it, and rendering it available for exportation at a much less cost than at present. Beer, however, is a very different article from milk, inasmuch as it contains a certain proportion of spirit or alcohol, varying from 7 per cent. of proof spirit in light draught ales, while the export bitter ales contain over 12 per cent., and strong beers considerably more. If our usual system of condensing were attempted, as we had to do in our first experiments at the Aylesbury Condensed Milk Works, all the alcohol would pass off with the vapour, and be lost unless it were conducted through a suitable condenser. This was obviated later on, when I obtained the sanction of the Commissioners of Excise to erect a vacuum pan and condenser for the purpose of perfecting many of the minute but not less important details of the operation.

It was no little testimony to the originality of the process, that on my application to the Commissioners they could find no precedent for granting such permission. In fact, although several persons have attempted to condense extract of malt, extract of hops, and extracts of both combined, for the purpose of being fermented into beer, no one had ever applied for the necessary permission to be allowed to condense or concentrate finished beer.

The apparatus employed consists of a copper vacuum pan, with which is connected a condensing worm of solid tin, immersed in a tank of water. Two copper globes are attached for the collection of alcohol.

A certain quantity of beer being drawn into the vacuum pan by a few strokes of the pump, the two under-taps are closed, and the steam permitted to enter the jacket which surrounds the pan, and the air-pumps are then carefully tended so as to maintain a vacuum of 25 or 26 inches pressure, and a temperature of from 130° to 160° during the first portion of the process. Some little attention is then necessary to work at the best advantage, but in a short space of time the whole of the alcohol comes over, and flows into the lower globe, the connection between which and the upper is then closed. By this means the alcohol can be collected without either breaking the vacuum or stopping the air-pump.

When it is found that the whole of the alcohol has come over, it is removed in a proper stoppered vessel, and is found to contain all of the delicate volatile flavours of the beer. As soon as the spirit is all removed, the operation of condensing is then assimilated to that of condensing milk, and consists simply in the removal of water to whatever degree may be considered desirable, and in practice the beer is thereby reduced to a thick semi-fluid state, after which it is drawn off from the pan.

A barrel of beer, containing 36 gallons, is in this manner concentrated into a bulk of little over two gallons, and there is besides an average of more than two gallons of alcohol of proof strength. The thick fluid extract consists of all the solid matters held in solution by the original beer, together with a small proportion of water, which is purposely retained to keep these matters fluid, so as not to change in the slightest degree the natural constituents of beer as they would inevitably occur if the condensing process were carried so far as to reduce the extract into a solid state. Following, in this instance, the experience derived from the practical condensing of milk, in which it is found that if the milk is absolutely dried, it is with difficulty redissolved, and never regains the whole of its former properties; so with the beer extract, we have ascertained that the fluid or semi-fluid condition into which it is reduced by Mr. Lockwood's processes, enables the remixing with the proper proportion of water to be effected with the greatest possible ease, while the peculiarities of each kind of beer are distinctly reproduced without the alteration which reproduction from a solid extract always entails.

When the condensed extract is taken from the vacuum pan, and cooled, the alcohol is remixed with it. In practice this has been found to be desirable, but it is by no means necessary, as the thick fluid extract of beer will keep by itself even if left in an open jar for nearly two years. I have a specimen, which has remained exposed to the air since the latter end of March, 1874. It can be put up in tin cans, similar to those used for condensed milk, but we prefer to remix the alcohol with the extractive matters, rather than export it separately, because it enables us to clear the solution, by rendering it much more fluid. We

have then a solution of all the extracts of malt and hops which were contained in the beer before condensing; we have the whole of the salts of the Burton waters, if the beer has been brewed in that district. All the aromas and volatile matters which having been carried over with the alcohol are retained in it, and returned in remixing with the extract. Every valuable constituent of the original beer is there present, minus only nine-tenths of the water. And if it were needed to prove how permanently unchangeable the condition of the finished condensed beer must be, I need only call attention to the fact that the extractives are dissolved in spirits of the strength of brandy, and that the temperature to which the beer has been subjected during the process of condensing is such that without being sufficient to injure or alter the character of the beer when re-made, in the slightest degree, yet is high enough to render inert all the fermentive germs, so long as the beer is kept in its concentrated form.

A barrel of beer is so reduced in bulk that it can be contained in cheap cases of wood lined with tin, the exterior dimensions of which are somewhat less than a cubic foot. Now, as freight is charged by what is termed barrel bulk, in which a beer barrel is generally reckoned as nine cubic feet, it is evident that a saving of eight-ninths of the total freight in shipping beers is saved by this means.

When it is desired to remake the beer, all that is required is to empty one of these tin cases, and make it up to the thirty-six gallons by the addition of water. Beer is at once produced substantially identical in strength and flavour with that before treatment. But when remixed with its proportion of water, the beer is necessarily without briskness. The constituents are all there, the flavours are still retained, but I doubt whether it would be recognised in this condition as being exactly the beer we are accustomed to. It must be distinctly understood that beer received from the brewery continues to develop a very minute portion of alcohol from the saccharine matters, and in this process gives off a certain amount of carbonic acid gas. Before this gas is thrown off from the beer in the form of froth, the liquid becomes completely saturated with this gas, and unless the beer is so saturated with carbonic acid, it cannot possess one of its most distinctive flavours; without which, in fact, beer would not be considered drinkable.

In the process of condensing we have driven out the whole of the carbonic acid gas, and we have now to restore its full equivalent. In dealing with this most important stage of the reproduction of the beer, I have had the advantage of the practical experience of Mr. Southby, whose intimate knowledge of all the processes of brewing has been acquired as chemist and brewer to Messrs. Allsopp and Sons, and in other breweries. and I may say his assistance has been invaluable. Treating the re-made beer as we should any other beer, which being quite sound has been "flattened" for bottling, as is always done, we soon found that the suggestion made by Mr. Lockwood of merely adding a little uncondensed beer in its original condition is all that is required to stimulate the reprodution of carbonic acid gas to any extent that may be wished for, but a very rapid development of the gas may be given by a little yeast. Take a tin of condensed stout and make up 36 gallons, by the addition of water, and a little stout which has never been condensed, an excellent stout will be produced equal in all respects to the original beer.

If the particular stout was that of Guinness, or of Messrs. Reid, or Barclay and Perkins, the distinctive peculiarities of each of these separate brews will be as marked and easily recognisable as before they were condensed. The same may be said with regard to ales, Burton ales being clearly distinguishable from those brewed with soft water.

The development of carbonic acid can be controlled by temperature to a considerable extent, and if it is desired to get the remade beer into condition rapidly, a higher temperature will greatly accelerate the result when no yeast is procurable, and it is for this reason that we prefer reproducing the aëration by the addition of fresh beer.

During the experience of the last six months, we have condensed considerable quantities of different kinds of beer, with what we deem a gratifying success. During the same period we, though but inexperienced bottlers, have bottled many grosses of these different beers. When the skill and experience which has to be devoted to the bottling branch of the beer trade is taken into account, and the inherent difficulties of dealing with comparatively small quantities at a time, we think that we have reason to be more than satisfied with what we have done.

We have noticed that by using a small quantity of extract and larger proportion of water, thinner beers, and of less alcoholic strength, can be reproduced of as sound a quality as the strongest. Such a beer is undoubtedly the most fit for use in tropical climates. On all hands it is agreed, both by the medical profession and those who consult them, that if a thin, light, and pleasant beer could be obtained in hot countries, much of the recourse to the brandy bottle would be averted. Beer is what is desired; the beer at present procurable in those regions, as previously stated, is a very strong or very expensive bitter beer. The consequence is that such beer is only to be drunk in small quantities, and hence the very small exportation of beer that I have alluded to. If, instead of brandy pawnee, gin slings, cocktails, juleps and a variety of other ingeniously deleterious mixtures of strong alcohol and bad soda water, good, sound, and pleasant beer can be cheaply sold, in which the alcoholicity is reduced to the most moderate proportions, I have little doubt but that the export of beer from this country will assume dimensions somewhat nearly related to that of its home consumption.

It now only remains for me to discuss the question of cost involved in the process of condensing beer, and as this is one of the greatest practical importance, I will ask you to grant me your indulgence while I pass rapidly over the items. In the first place, the cost of the beer barrel here is about 25s., abroad they are generally of so little use that the odd five shillings may be considered as beyond their average value. Against this must be placed the cost of two shillings for the tin-lined case which holds the equivalent of the barrel of beer when condensed. Here is a saving of at least 18s. per barrel, that of the freight is at least seven-

eighths, besides obviating the risks of transporting beer in casks, which are so great as to add at least from 10 to 15 per cent. to the other costs incurred, but more generally it is found necessary to make a much larger allowance for ullage, and beer which becomes sour. Not unfrequently whole cargoes are discharged from the ship, perfectly worthless from the latter cause, a risk which the process of condensing entirely obviates. The cost of a barrel of beer being roughly taken at 60s., the saving effected so far would be equal to some 25s., exclusive of the cheaper freight. But when it is remembered that beer is exported in bottles to many countries, and the bottles are enclosed in casks, the whole occupying at least double the amount of room which it would in barrel, a far greater saving is effected. In addition to this, the re-bottling of condensed beer in many countries can be accomplished at an almost nominal cost, bottles having become so superabundant as to be readily procurable at 3s. a gross, the price quoted in London being 22s.

Beyond the great economy so effected must be mentioned the still greater saving when the beer is required to be transmitted to inland stations. Against the savings which have been enumerated, the only additional expense incurred is the cost of condensing and remaking it. The most careful estimates have been made, deduced not only from the extended experiments which have been carried out by permission of the Commissioners of Inland Revenue, but also from data furnished by the experiments conducted at the Condensed Milk Company's Works. We have the assurance that the total expense attending the process of condensing cannot exceed the sum of 2s. per barrel, and that of remaking about twice that sum.

I have endeavoured to draw attention, hitherto, chiefly to the great economies which will be accomplished by the export of condensed beer. I have also dwelt upon the quality of remade beer being substantially identical with that from which it is originally condensed, but I must now speak of the quality of beers which it is proposed to condense for export.

The inventor of this condensing process does not anticipate that it will interfere in any way with the present exportation of the choicer kinds of bottled beer. He holds the opinion that most of the bottlers will always command high prices for beer sent out in bottles as a luxury. But to the far larger class abroad to whom English beer is now a forbidden extravagance, beer can be condensed and remade at such a low price as to avoid the necessity for any real competition with the fine old beers now exported.

If we have been successful in condensing a beer of less than the highest value, of reproducing it in at least as good condition as a good average quality of the draught beer sold in England, it is presumed that the main objects desired have been attained.

I am personally of opinion that more than this has been accomplished, because I maintain that a sounder and more wholesome beverage can be at any time produced from condensed beer than is afforded by the common draught beers. I can see no reason why beers of the most wholesome type, and, if desired, of the most moderate alcoholicity, should not be supplied at the antipodes at a moderate advance upon English prices.

Certainly, I need have no hesitation in affirming that during the time I have put the re-made beers to the practical test of drinking them almost daily, I have found them pleasant to the palate, and more suitable from a dietetic point of view than the general average of beer.

If the condensing of beer for export is carried out with the energy and commercial enterprise which marked the introduction of other preserved and condensed foods, it cannot fail to become of national importance as leading to a great increase of our exports, which are now steadily declining. This new branch of trade is the more likely to be secured to our own country, as English brewers are, and probably always will be, unapproachable in the quality of the articles they produce. We need scarcely anticipate the same kind of competition from the Continent in this business as is unfortunately not to be avoided in other manufacturing industries.

DISCUSSION.

The Chairman said he had seen some of the experiments connected with this process, which seemed to him quite in the direction which technological chemistry had assumed during the present century. It was now become the practice to put into small bulk many of the articles considered necessary both in food and medicine. For instance, it used to be customary for physicians to prescribe decoction of bark, large quantities of which had to be taken by the patient, but this was now replaced by small doses of the active principle in the shape of quinine. The same process had been applied to a great number of other drugs, and thus the whole character of the pharmacopœia had become changed by the very same kind of process as that which Dr. Bartlett had described. It seemed absurd in exporting beer to export an enormous quantity of water, in many cases amounting to 90 per cent., if they could send out the essential ingredient in a concentrated form, leaving the parties abroad to add the water required to make up the quantity. The only point of difficulty which occurred to him was the addition of carbonic acid, and that, perhaps, would be explained further, for at present it was not quite clear to his mind how it could be satisfactorily accomplished.

Mr. Branson thought if the extract could be shown to contain all the aromatic and nitrogenous constituents of high class beer, means could be found to add the requisite carbonic acid. The difficulty which occurred to him was of another kind. It was pretty generally understood that boiling would destroy the natural qualities of beer, and he was not quite clear that although the temperature was reduced by carrying on the operation *in vacuo*, that injurious effect would be prevented, though it might not be so complete. It was admitted that this condensed beer would not compete with the higher qualities of bottled beer, and he should like, therefore, to have an assurance that the extract, even when prepared at a low temperature, would contain anything like the valuable aromatic qualities of ordinary beer. If it would, he could only congratulate Dr. Bartlett on the success of his labours.

Dr. Overend Drewry said he had examined the properties of this beer, with a view to ascertain its dietetic value, and found it to contain some properties which would render it of great value even for home consumption. It was generally supposed that the reason why bottled beers were inadmissible in cases of weak digestion was, that they contained a large quantity of carbonic acid, but that was not so, the real evil being that

they were nearly always sour, from the presence of another acid, not carbonic acid. This beer, however, was singularly free from such acidity, and when in addition it appeared that the quantity of alcohol could be regulated with the greatest nicety, he could only reiterate the statement he had already made at the Medical Society, and in which he was supported by many other physicians, that those alcoholic beverages were most beneficial generally which contained the smallest proportion of spirit consistent with soundness, and that, therefore, he looked upon this beer as a very valuable article for dyspeptic patients.

Mr. F. J. Bramwell, F.R.S., gathered from the statement of Dr. Bartlett that about 32 gallons out of 36 were converted into vapour in the course of the process, which would require from 40 to 50lbs. of coal. Now, in order to effect a reduction in this quantity, and thus cheapen the process, it appeared to him that a similar apparatus to that invented for the purpose of distilling sea water, and also used in the reduction of sugar before it got to the vacuum-pan, called by the French the *triple effet*, might be introduced. It consisted of a series of three vessels, the steam in the first being at a greater pressure than that of the second, and that greater than in the third, the waste steam from one being utilised to heat the next, and thus the evaporation was carried on continuously. There might be a practical objection that the heat required in the first vessel would be too high for this particular purpose, but if that were not so, there would be a great economical advantage; and probably the danger which a previous speaker had alluded to, of the beer being spoiled by the boiling process, would not arise, even at a higher temperature than that described, in consequence of its being carried on in a close vessel, and all the volatile oils and extracts being preserved and restored to the finished extract.

Mr. J. Fordred was rather surprised that Dr. Bartlett had omitted all reference to previous inventions in the same direction, particularly that of Mr. Mertens, which had been carried on at Margate for the last 13 years, under which a product called solid wort was obtained, which had been exported to the colonies and foreign countries. There the manufacture of beer was only carried on as far as the production of wort, which was then evaporated *in vacuo*, until it ran off in such a state that it quickly solidified, when it was packed in tin cases and exported. In order to make it into beer it was only necessary to dissolve it in a sufficient quantity of water and add a little yeast, when in a few days it might be racked off into casks or bottles. With regard to the difficulty of obtaining yeast in foreign countries, it was well-known that yeast germs were always floating about in the air, and it was only necessary to provide a suitable soil for them to develope and propagate. A rather strong solution, therefore, was made of the solid wort, and exposed to the air, when a crop of yeast was produced which could be used to set up the fermentation. This manufacture had not succeeded commercially, not from any inherent defects, but from extraneous causes, such as the jealousy of colonial brewers, who had brought their influence to bear on the legislature in Australia and elsewhere, and obtained the imposition of a prohibitive duty. It appeared to him there would be great difficulty in carrying out this process, on account of the Excise laws, for though Dr. Bartlett had obtained permission to make experiments, he feared it would be different when they came to carry on the process on a manufacturing scale. He did not think it could be done at all without an alteration of the present laws. The use of a still was surrounded with great restrictions, and the moment spirit was distilled it became subject to a duty of 10s. a gallon; and this alone would be fatal to the success of the enterprise.

Mr. Bramwell asked if it would not be desirable to brew the beer intended for evaporation stronger than usual in the first instance, so as to diminish the quantity of water necessary to be evaporated.

Mr. Lockwood said he could reply to one or two of the points which had been raised. With regard to Mr. Mertens' process, he simply used a vacuum pan, without a still, which was the radical difference in the two methods, and only operated on wort, instead of concentrating the finished beer, so that it only remained to add the water and restore fermentation. Some persons might imagine that the carbonic acid gas was immediately generated by adding a small quantity of brisk beer, but that was not the case. The brisk beer merely furnished the ferment, which generated the carbonic acid in the same way as yeast would, and the beer contained enough fermentative matter to supply the requisite amount of the gas without losing its flavour. He had in his employ the man who superintended Mr. Mertens' factory originally, and he would have the direction of the process. The Excise difficulty he had got over by taking premises in the Channel Islands, where there were no Excise laws, and where there was a drawback on all beer exported. An Act of Parliament had, however, been passed to enable Mr. Mertens to manufacture his solid wort, and there was no reason why one should not be obtained hereafter, if necessary, to permit the concentration of finished beer. There was no provision for such a thing in the existing laws, but the process was never before known.

Mr. Fordred said the great difficulty in the present case was the distillation of spirit, which he thought would be a serious obstacle with the Excise authorities.

Mr. Grazebrook had been very favourably impressed with the mechanical means by which this condensed beer was produced, but felt serious doubts as to the addition of the carbonic acid gas, an essential constituent in all beers of high quality. He was surprised to hear it stated that carbonic acid was objectionable, because French physicians, and he believed most English medical men also, looked upon it as of great value; in fact, it was the principal element for which soda water, champagne, and many other beverages were prescribed; and it had been used in some cases for the cicatrization of wounds. He would suggest that instead of adding a little brisk beer, which would no doubt set up fermentation, but thereby tend to impoverish the beer, and thereby cause it to become hard, some other method should be adopted. In the second process of fermentation in bottled beer it frequently became hard, though the palate failed to detect it, on account of the presence of the carbonic acid, which had the property of masking acidity, though the stomach would find it out. There was a French invention by which any desired quantity of carbonic acid could be produced, and thus beer which had become perfectly flat could be restored in a few hours, the details of which he should be happy to explain to Dr. Bartlett, and he thought that would be preferable to the mode suggested. The economical advantages arising from saving of freight and prevention of loss were very obvious, and would render the invention very valuable both to the consumer, the merchant, and the manufacturer.

Mr. Liggins had listened to the paper with great interest both as a shipowner and as a colonist. He had spent much of his time in the West Indies, and both there and on board ship had often experienced great inconvenience from not being able to obtain a supply of good beer, a beverage which was highly valued by most Englismen. The only weak point about the invention seemed to be that mentioned by the Chairman, the re-introduction of carbonic acid, and he had no doubt that the same inventive genius which had perfected the other part of the process would be able to overcome that also. With regard also to the Excise difficulties he thought the same power which would require the with-

drawal of the Slave Circular would also insist on an Act of Parliament for this purpose being passed if necessary.

Mr. Smartt said Dr. Bartlett seemed to assume that all beer brewed in England was made from malt and hops, but it was well known that a great deal was produced from sugar, and the use of the same material in Australia and other colonies might get over the difficulty which had been mentioned with regard to a supply of malt. He also believed it had been elicited by a Parliamentary inquiry that one of the largest brewery firms used sulphuric acid; this would probably remain after condensation, and the question occurred to him whether it would not have a deleterious effect on the extract. The difficulty of brewing in warm climates had also been mentioned, but it was well known that English brewers used ice to lower the temperature during some part of their processes, and the same expedient might be employed abroad, though probably it would be more expensive.

Mr. E. R. Southby remarked that though yeast could be readily produced anywhere, it was not the kind of yeast which was fit to put into beer, so that the difficulty with regard to the solid wort process would always remain. In the condensed beer they did not require the same powerful fermentation, but only sufficient to produce the requisite quantity of carbonic acid. No doubt you could effect the desired object by artificially charging the beer by a machine analogous to that used in the manufacture of soda water, and that plan had been tried, but it did not prove so successful as was expected, and therefore they had returned to the original process of starting a slow fermentation. It was suggested that this would impoverish the beer; but they avoided that by using beer in its early stage as soon as it became fine, whilst it still had a large quantity of saccharine matter in it, quite enough to re-ferment, and produce the carbonic acid without injury. The fermentation could be started in various ways, three of which had been tried. First, by adding yeast, which was scarcely applicable in many foreign countries; secondly, by adding a few grains of rice or a raisin, but this sometimes injured the flavour; and, thirdly, by the addition of a little uncondensed beer, which was found to answer perfectly.

Dr. Bartlett, in reply, said that several points had already been answered, and the principal one, first mentioned by the Chairman, would best be settled by opening some of the beer in bottle, when it would be found to show quite as much effervescence as was desirable. As Mr. Southby had explained, the addition of a little uncondensed beer set up a slow secondary fermentation, such as always took place in bottled beer, and, in fact, if beer for export were not flattened down as much as possible before bottling, very little of it would ever reach its destination. It was for this reason that the perfection of beer in bottle was never attained until it had been in bottle a considerable time, and probably the saturation by this slow process was more perfect than if effected by the method alluded to by Mr. Grazebrook. He held that if it took place rapidly, there was not only the risk of breakage, but also the tendency to produce acidity which had been alluded to. He thought Dr. Drewry had been rather misunderstood, because he had stated that it was an error to suppose that the injurious acidity arose from carbonic acid; but, on the contrary, it was caused by acetic acid, which was covered by the carbonic acid, so as not to be discernible by the taste alone. It was for that reason, as he understood, that he placed such a high value on this concentrated and re-diluted beer. With regard to the *triple effet* process, he thought it quite possible that a great saving might be effected by its use, but the experimental apparatus had been made as simple as possible in the first instance, in order that the requisite improvements might be introduced by degrees, as had already been done to some extent. Mr. Lockwood had answered the difficulty about the Excise laws, but he held a license for the still at present in use, and had been given to understand that there would be no difficulty in obtaining an Act authorising the process being carried on commercially in this country. There seemed, however, to be several advantages in conducting it at present in the Channel Islands, both from the absence of Excise laws, and by facilities there afforded for shipment, obtaining the drawback, &c. He believed it was a mistake to suppose that sulphuric acid was used in brewing; the gentleman probably referred to the sulphurous acid which was sometimes employed for sweetening casks, and also in preparing hops for the market, and though that might be oxidised into sulphuric acid, the quantity was so minute that no one could be injured by it. Besides it would not exist in the free state, but would decompose the carbonate of lime present in the water, and merely increase the quantity of sulphate of lime, which was one of the most important constituents of the Burton water. He was glad to see that so much importance had been attached to the subject by many of the gentlemen present, but not more than it deserved, for he believed by this means they would not only vastly increase the amount of British exports, but possibly, as Dr. Drewry had suggested, produce a beverage which would be of great value for invalids; and he might add that a similar process was about to be carried out in some other matters, such as wines, for which Mr. Lockwood had taken out a patent.

A vote of thanks having been passed to Dr. Bartlett, the proceedings were concluded by the production and tasting of some bottles of the beer made under this process, which appeared to give general satisfaction.

During the evening Stewart's patent flag signal for railway carriages was exhibited. The following description is supplied by the inventor:—This is an invention for communicating between the passengers, guards, and drivers of railway trains. The apparatus employed is enclosed in a small wooden box, placed inside the carriage against one of the top corners of the compartment. On a catch being released, by means of a cord suspended from the roof, a flag is projected through the side of the carriage, and at the same time a rope in connection with the apparatus causes a bell to be rung in the guard's van and the whistle of the engine to be sounded. Thus, at the same instant, the guard and driver of the train are not only made aware that an alarm has been given, but are also informed, by means of the flag, of the exact situation of the compartment where the apparatus has been set in motion.

SPECIAL LECTURES.

The fourth of the series of lectures on "Unhealthy Trades" was delivered by Dr. Richardson, F.R.S. (appointed by the Council to make special inquiry into the subject), on Friday evening, January 21st, as follows:—

Lecture IV.

On the Industrial Diseases of Workers in Earthenware.

In the last two lectures I have described as fully as time would permit the action of certain agencies which, amongst the industrial classes, are effective in inducing the injuries included under the first and second divisions of our table of injuries. We have thus become familiar with the influences of a hurtful kind which occur from exposure to dusts. We have also become familiar with the injuries which accrue from exposure to preparations of lead.

It seems to me that at this stage of our learning I may with some practical effect rest, and devote one special illustrative lecture to the study of one particular class of industrials, who suffer from the influence of two of these sets of causes of disease, namely, from dust

and lead. The class I refer to is composed of those who are engaged in the manufacture of earthenware, commonly called potters.

Amongst the useful and industrious, none of the workers on the earth are more ancient than these moulders and burners of clay. They were amongst the first of human artists, and they brought artistic design into union with usefulness earliest, perhaps, of all mankind. In England the skill and taste of the potter have been for many centuries exercised; but at no time in our history, as a nation, has it been so splendidly exercised as at the present hour. Our artisans in clay imitate now so perfectly the exquisite work of the olden time, that the old may pass for the new, and the new for the old, in the eyes of even the gifted connoisseur. In addition to this, these workmen daily add some new triumph to the beautiful and useful art which they pursue. They carry artistic excellence into the most common specimens of earthenware work, so that in the cottage, not less than in the mansion, the mind, through its inlet of sight, is gratified and chastened by their all but imperceptible touches of silent grace and beauty.

As we look at the work, we are gladdened with the sight. The oil and water colour pictures of our great painters are not more wonderful than the pictures on clay which these artists in earth present to us. There is something in their best productions which, though apart from nature in her skilful designs, and awakening a different but not less pleasing sensation, suggests that they who produce such results must needs be amongst the brightest, healthiest, and happiest of producers. It may be hope, it may be tenderness, it may be admiration that suggests the idea; I know not which, but most men share it.

When we turn from this ideal picture to the stern realities, we are distressed to discover how differently the facts stand, and how far away from what we had hoped and might have expected. We discover the workers in earthenware to be amongst the three sections of our community who represent the lowest vitality. We find that the males of fifteen years and upwards die at the rate of 38 per cent. above the males of all ages; and we discover that the commencement of this increased mortality is at the period when the men are approaching their prime of life, namely, at 35 years, and that it extends onwards to the end of life.

Here is a short table, in which the mortality of all males, in stages of ten years' duration, extending from 15 to 75 years, is shown, reduced to 100 as a standard at each stage. The comparative ages of the makers of earthenware at the same periods are shown by this standard; and, for further comparison, two occupations of lower mortality, grocers and woolworkers, are introduced. One occupation of the same mortality, the publican's, and one of lower mortality, the cabman's, are also shown.

Deaths of Males aged 15 years and upwards, and at Seven Groups of Ages, in the Three Years 1861, 1862, and 1871 engaged in Five Occupations, to 100 Deaths of Males of all Occupations at the same ages, during the corresponding period.

Occupations.	All Ages.	15.	25.	35.	45.	55.	65.	75.
All males in England aged 15 years and upwards	100	100	100	100	100	100	100	100
Grocers	76	75	96	73	73	70	72	78
Workers in Wool and Worsted	100	91	87	78	91	101	115	126
Workers in Earthenware	**138**	**93**	**72**	**154**	**182**	**181**	**192**	**141**
Publicans, &c.	138	129	147	157	154	134	112	131
Cabmen, Coachmen, &c. (not domestic)	143	120	124	155	159	147	150	121

From this table we learn that the earthenware worker at 15 years of age and on to 25 years ranks favourably. At 15 years his mortality is 7 per cent. below the average, and at 25 it is 28 below the average. At 35, however, *i.e*, when the influence of his occupation is beginning to tell on his life, his mortality rises to 54 per cent. above the average; at 45 it rises to 82 above, at 55 to 81 above, at 65 to 92 above, and at 75 to 41 above the average.

It is our business to inquire into the reasons of this high mortality, for which purpose we must investigate the numerical details of the workers; their social details; their physical condition; their diseases, general and special; the causes of their diseases, also general and special.

Numerical Details.

The number of persons employed in the earthenware manufacture at last census was 45,122. Thirty-nine other occupations exceeded this in respect to the number of persons occupied in them. Ninety-two other occupations, more or less definite, presented numbers in each less than the earthenware community. Amongst the 45,122 earthenware manufacturers, 29,169 were males and 15,953 were females. Of the 29,169 males, 8,421 were under 20 years of age, and 20,748 were over 20 years of age. Of the 15,953 females, 7,360 were under 20 years of age; 8,593 were over 20.

At the census of 1861, 26,138 males were employed in the earthenware trade, as compared with the 29,169 employed in 1871; an increase of 3,031. In 1861, 11,934 females were employed in the earthenware manufacture, as compared with the 15,953 of 1871; there was, consequently, an increase in the ten years of 4,019 females.

The grand districts for this manufacture are in Staffordshire, and are called the world over, "the Potteries of England." These districts are included in the registration returns, under two heads—the district of Wolstanton and of Stoke-upon-Trent. Their population, according to the Registrar-General's general report of the census of 1871, of male and female earthenware workers, runs as follows:—

Locality.	Males.		Females.
Wolstanton	4,480	..	1,841
Stoke-upon-Trent	7,405	..	4,857
	11,885		6,698
	18,583		

Under the head Wolstanton is included the sub-districts of Tunstall and Burslem; and under the head Stoke-upon-Trent is included the sub-districts of Stoke, Hanley, Fenton, and Longton. Connected with Hanley is the famous hamlet founded by Wedgwood, and called Etruria.

The principal facts bearing upon the industrial pathology of earthenware manufacturers are best obtained in the Potteries proper. What is learned here embraces what would be learned in the smaller localities, and with less liability to error. I shall consequently follow, with most profit, the plan of considering the

subject from the Staffordshire potteries, as the base of observation.

The population we have to deal with is, according to the census of 1871, 18,583, of whom 11,885 are males, and 6,698 are females.

Special Details.

The conditions under which this population carries on its employment deserve a preliminary notice.

The town of Stoke-upon-Trent is, nominally, the centre town of the district; but the best point, I think, from which to gain a general view of the locality is Basford Bank, which is situated out in an easterly direction, at a little distance from Newcastle-under-Lyme. A short way down this descent or hill, we take in, in a birdseye view, nearly the whole of the district in which the manufacture is carried on in this part of England. One might almost imagine that a century or two ago Basford Bank would have yielded a beautiful outstretch of rural scenery, but the local historians tell us that before the potteries were established, the district wore a bleak and barren aspect; that the villages were detached, straggling, and thinly populated; and that the trade was insignificant. The exertions of the agriculturists were paralysed, but Nature amply compensated for the want of a genial surface by the rich and inexhaustible mineral treasures which were buried underneath. In the early part of this century, the Staffordshire potteries were everywhere famous, and in 1817 the population of the district amounted to 60,000.

Standing so as to face the east from Basford Bank we see on the right hand, that is, towards the south, the municipal borough of Stoke-upon-Trent, and further away, south by east, above it northwards is Shelton, and spreading out over a large area is the largest of this group of towns, the borough of Hanley. In front is modern Etruria, lying like a straight street; to the north-east is Burslem, and further to the north Tunstall. Newcastle-under-Lyme, although it contains some persons engaged in pottery work, is not a pottery town.

Burslem is the place in which pottery work is believed to have been first established, and it is therefore designated by Pitt "the mother of the Staffordshire potteries." The town was originally called the "butter pottery," because a manufactory was established there for making butter pots. These pots, which were of cylindrical form, were made under the provisions of an Act of Parliament of 1670. They were of certain size, and weighed 6 lbs., and were made to contain not less than 14lbs. of butter. This act was obtained in consequence of a fraud practised upon the public by the inhabitants of the moorlands, who made butter pots thick at the bottom so as to increase the weight.

The earliest description of the work of the potteries was written by Dr. Plott in 1686. The history is most interesting, especially from the circumstance that it contains an account of the primitive glazing process followed by the Burslem potters. For this process Plott says "they use a lead ore which they call 'smithum,' which is the smallest ore of all beaten into dust, finely sifted, and strewed upon the vessels, which gives them the gloss but not the colour." He adds that when the workmen "have a mind to show the utmost of their skill in giving their wares a fairer gloss than ordinary, they lead them with lead calcined into powder, which they also sift fine, and strew upon them as before, which not only gives them a higher gloss but goes much further too in their work." For obtaining a motley colour they mix the lead with manganese, which the workmen call magnus.

From these beginnings the potteries have advanced up to the present day; their celebrity increased by the genius and industry of their leading manufacturers; by Ralph Daniel, and especially by Josiah Wedgwood.

Social Details.

At the present time the social position of the workers in the potteries is much more favourable than is that of many other manufacturing communities where a better state of health and longer life prevails.

The wages which the men and women receive are good, and even children are fairly paid. In short, poverty is a word that need never be used amongst them. "The best of it is, sir, we can all work, so that we all earn," was the observation of one of the workmen to me in speaking of himself, his wife, and his family. Hence those mental worries and struggles for existence, common to many men in a higher social sphere, are little felt by those who are content to remain at the labour to which they are trained.

The labour to which the earthenware workers are subjected is not physically severe on healthy, fully-developed persons, neither is it labour demanding mental strain. Some of the more refined parts of it, the moulding for example, and the finishing of the finer artistic work, of vases, pedestals, and ornaments, for instance, give rise to labour which is both light and harmonious. The hours of labour are regular, extending over nine hours and a-half, and the workers are not harassed by that most wearying and wearing of all exercise, night work. Those who really feel the labour are the young, and at one time they were severely over-taxed. In 1864 I was compelled to record that children so young as six and seven years of age, were to be found earning their bread. In some of the factories I learned that the boys worked even longer than the men, for they had to light the stove fires first in the morning, and they remained, after their seniors had left, to clean up the shops and clear the stoves. The work to which they were subjected was also heavy. Some of them acted as "jigger-turners," at which work they were engaged turning a horizontal wheel, which set in motion the wheel on which the potter forms his ware. Others carried the ware, with the mould on which it was made, from the maker to the drying-room or stove, doing this many hundred times a day, and experiencing a change of temperature each time of as much as 80° Fahr. I took the temperature in one case, and found it at the jigger to be 50°, in the drying-room 130° Fahr. Others dusted and cleaned the earthenware, or received the ware from the dipper; again, others were engaged in what is called wedging the clay, lifting up a mass of clay above the head and throwing it down several times on a slab or another mass of clay, in order to drive out the air which is present in the clay, and which, left there, would prevent the perfect working of the material afterwards.

Of these operations, the mould-carrying, jigger-turning, and wedging seemed to be the worst, and I wondered how, for hours at a time, such feeble limbs could carry on such heavy labour.

Of late years the pug-mill has been introduced for working the clay before it comes to the wedger, by which means considerable labour is saved. The force of the jigger-turner is now also considerably represented by the force derived from machinery. Lastly, by the introduction of the Factory Acts, the labour of the young is limited in respect to time.

Children, young persons, and women, are now prevented being employed after 6 or 7 in the evening. The hours are twelve; from 6 to 6 or 7 to 7, with half-an-hour allowed for breakfast, and an hour for dinner. Children between 8 and 13 attend school half-time, so that their work is either from 6 to 12, or 7 to 1, or from 1 to 6, or 2 to 7.

The potters have the advantage of living pretty near to their work, and by comparison with those industrials who live in cities and towns, and by comparison also with agricultural labourers who live in villages, they are certainly comfortably housed. There is nothing very artistic in the construction of their homes, nor are their residences picturesquely diversified by gardens and varieties of flowers, for the soil is not favourable to

cultivation of plants; but the houses are comfortable, are not over-crowded, and are often kept remarkably clean.

The drinking water with which the potteries are supplied is chiefly derived from a water company, and taking it altogether, the supply of water is fair throughout the district. From the history of the various epidemics that have occurred, of cholera and diarrhœa especially, I should infer that before 1849 water was very liable to contamination with sewage. In the epidemic of cholera in 1849, there were 103 deaths in the district of Stoke from this disease, and 63 from diarrhœa. In the district of Wolstanton there were 79 deaths from cholera, and 65 from diarrhœa. We may look, however, upon the faults of the water as accidents of ignorance not peculiar to the pottery district, and distinct from the causes of special industrial disease prevalent there. At that time the water company was not in existence.

The drainage of the various pottery towns remains still very imperfect, a fact more to be regretted because the towns are favourably placed for the carrying out of an effective system of drainage with a good natural flow, except in the case of Stoke. The soil under foot is muddy and dark, and small pools or puddles are of constant occurrence. All this tends to cause excess of humidity in the atmosphere. The odour of cesspool and sewer emanations is not marked, and indeed is much less distinctive than the sewer emanations in many parts of this expensively drained metropolis—London.

The potters are essentially a country people, and their ranks are supplied, almost exclusively, from those who are born either in the district or in the surrounding counties. Their surnames, their build, their features, their complexion, their fondness for remaining at home, and their steadiness at work, all proclaim their Saxon blood. Few immigrate into their ranks from a distance; Celtic and Jewish admixture is not frequent. Dr. Arlidge, a physician who has resided in the Potteries for many years, and whose knowledge of the district may be considered the most perfect of any observer, made a memorandum on this point of birth. Of 226 potters, male and female, he found that twenty-nine were born in the country at a distance from the potteries; nine in the neighbouring borough of Newcastle-under-Lyme, and six in surrounding rural hamlets. These, making a total of forty-four, constituted one-sixth of the whole number. The remaining 222 were born in the pottery towns. Both parents in thirty-nine instances, and one parent in fifty-four amongst these, came from the country. Almost all the immigrants into the potteries were from towns and villages in North Staffordshire, or from the adjoining counties of Salop and Cheshire.

PHYSICAL CONDITION OF THE EARTHENWARE MANUFACTURERS.

From the details of the social condition of the industrial class we are now considering we may pass, with advantage, to the study of their physical position as a community, before we enter upon the discussion of the special diseases to which they are subjeeted.

The facts, which up to this time lie before us, suggest that the potters, as a class, possess many and striking advantages, and that their sanitary condition is far more favourable than is that of numbers of other classes; such, for example, as miners, copper smelters, tailors, needle pointers, and even clerks and printers. The observer cannot fail to notice, however, that in the general state of their health there is something radically wrong. The men present a feeble and languid appearance, a pallor and a deficiency of vital energy which is striking. The women are languid, pale, worn; the children small, and if not actually mis-shapen, indifferently shaped. The young are deficient of the colour and ruddiness of youth. It is by no means uncommon in the small streets and alleys and mews of London to find ruddy, chubby, active children. City dwellers as these are, they rank in health beyond measure in comparison with the children in the potteries, who have much more space for breathing, and, as one would imagine, a purer atmosphere.

That I may not be charged with over-stating, from my own personal observations, the physical condition of the potters, let me fortify the statement by the description given of them by Dr. Arlidge, who is a factory medical officer of the district at this time, and who thus wrote in 1866:—"The potters, as a class, both men and women, but more especially the former, are too frequently stunted in growth, ill-shaped, and frequently ill-formed in the chest. They become prematurely old, and are certainly short lived. They are phlegmatic and bloodless, and exhibit their debility of constitution by obstinate attacks of dyspepsia, and disorder of the liver and kidneys, and by rheumatism. But of all diseases they are specially prone to chest disease, to pneumonia, phthisis, bronchitis, and asthma."

DISEASES OF THE DISTRICT—GENERAL AND SPECIAL.

(a) General.

From the physical condition of the people we turn, naturally, to the diseases from which they suffer. Epidemic diseases or those which spread by communication prevail in the district, but not more acutely than in the other parts of manufacturing England. Scarlet fever is a prevalent disorder and of rather frequent occurrence. Typhus fever is very rare, but typhoid is very common. Diphtheria has now and then been widely extended. Cholera, as we have seen, has visited the district severely. Cancer, by comparison with other districts, is here of rare occurrence, but heart disease and dropsy are a little above the average as causes of death.

Some influeuces of a local kind exist—not specially connected with occupations, as far as we know at this stage of our learning—which lead to the presence of certain other maladics, in this district. Goitre, or Derbyshire neck, is a rather common affection amongst the women of the population of the lower class, and Mr. Garner, of Stoke-upon-Trent, an eminent surgeon and admirable observer of natural facts, has noticed, in some examples, the relation of this disease to cretinism, an association of diseases, which in some parts of the world, as in the Alpine valleys, is inseparable. The nature of the influences leading to this malady is unknown, barring heredity.

There are some special influences also at work in the district to produce a slight tendency to the disease known as calculus, or stone in the bladder, and it has been observed that the very young are not unfrequently affected. During a late visit I saw an infant in arms suffering from this disease, and was present while Mr. Folker, the surgeon to the new and extensive North Staffordshire Infirmary, most skilfully extracted a large calculus from this little patient, by the operation of lithotomy. The calculus is usually of the form known technically, as the uric acid calculus.

The two diseases named have been connected by some writers with the peculiarities of the water supply of the districts in which the diseases are present. There is nowhere evidence of any weight for such an hypothesis, and certainly in the potteries there is no shadow of such evidence. The diseases as they appear to me, from the various observations I have been able to make in different parts of England where they occur, are indications of a vital deterioration of the people. They are most prevalent and are most marked in communities where the organic construction of the skeleton is impaired, and the nervous system is enfeebled.

That bad condition of health known generally as struma, or scrofula, prevails considerably in the potteries. It is a diseased condition, which extends, I believe, in a special degree among Saxon populations, and is easily recognisable by the practised eye as indicating a deteriorated state of body and a deficient vitality.

Rheumatism, epilepsy, and among females the disease known as anæmia, are also present. Rheumatism and rheumatic affections are common in the district, but are less common among potters than among other residents.

Taking into consideration all the diseases I have named so far, it cannot be said that they, either singly or combinedly, hold any relation to the cause of that extreme mortality which, at the beginning of this lecture, we found to belong to the potters as a particular industrial class.

(b.) Special Diseases.

The three grand maladies which send up the mortality amongst earthenware manufacturers are: (*a*) *bronchitis* with "*potter's asthma*;" (*b*) *phthisis pulmonalis*; (*c*) *lead paralysis*. Subsidiary to these are the rheumatic affections and affections of the stomach.

The statistics on this part of our subject have been admirably worked out by Dr. Arlidge, who obtained every fact that was obtainable from the register of deaths in Stoke parish, and who deduced that in that parish lung diseases and phthisis kill 13·41 per 1,000 living; in Longton, 24·20 per 1,000.

Among 210 males at 10 and upwards who died from those diseases in Stoke, 85, or 40·47 per cent. were potters.

Of 148 male potters, 46, or 31·08 per cent., died from phthisis alone, and 85, or 57·43 per cent., from that malady and lung disease together.

On comparing the mortality of male potters, at 15 and upwards, from diseases of the lungs and phthisis combined, with that prevailing in England at the same ages, it is as 57 to 32 per cent. of the deaths that take place.

Among 100,000 adult males living, aged 20 and upwards, there die in Stoke from diseases of the chest 505, and from consumption 505; whilst in England the proportions are, for diseases of the chest 339, and for phthisis 373. Adult females die in Stoke in the ratio of 323 from lung diseases, and 461 from consumption. In England 259 die from lung disease, and 349 from consumption.

Of children under 10 years old, 22·61 per cent. perish from diseases of the lungs and consumption together. Of individuals above 10, 41·52 are cut off from the same causes.

Eighty-three out of 100 potters die before completing their sixtieth year.

The mean age of adult male potters was 46½; of adult men in all England, 56 years.

Among male potters themselves nearly 60 per cent. die from diseases of the lungs.

Here then we have the key to the excessive mortality of the industrial class which is now before us. To the affections of the lungs from which they suffer we have still to add, as a cause of mortality, the influence of lead paralysis.

To what extent these special diseases influence, and the relations which exist in the district between the diseases of those who are engaged in pottery work and those who are not so engaged, much may be learned from the following table, which has kindly been supplied to me by Dr. Arlidge. The facts have reference to 800 persons who were engaged in one or other department of the pottery manufacture, viz., 463 males, and 337 females; and to 200 persons, 130 males and 100 females who were not engaged as potters.

A perusal of these tables indicates at once the special diseases to which those who work at the manufacture of earthenware are subjected. It shows that diseases of the lungs amongst male potters are as 56.66 per cent. to 31 per cent. amongst other persons in the same district, following different occupations. It shows that the disease consumption is a little above the average in female potters when they are compared with women working at other occupations in the district, it being nearly 17 per cent. in the former, and 11 per cent. in the latter. It shows that lead poisoning is special to the potters, male and female, being 8 per cent. in the male, and 5 per cent. in the female. It shows that rheumatic affections among male potters are nearly two-thirds less than amongst other males in the locality, while amongst females the reverse obtains. It shows that stomach disorders, both amongst males and females, are greatly less amongst the potters than amongst other classes. It shows that amongst male potters heart disease and epilepsy are less frequent than amongst males following other trades; and that amongst female potters heart disease, epilepsy, and hysteria are less prevalent than amongst other classes of females in the neighbourhood.

Dr. Arlidge's Statistical Comparison of the Diseases of Potters and Non-Potters, Male and Female, in the Pottery Districts.

Potters—Males.		Non-Potters—Males.	
Bronchitis	= 36·57	Bronchitis	= 18·00
Phthisis	= 20· 9	Phthisis	= 13·00
Rheumatic affections	= 7·79	Rheumatic affections	= 21·00
Stomach disorders	= 8·44	Stomach disorders	= 19·00
Lead-poisoning	= 8·00	Lead poisoning	= 0·00
Cerebro-spinal diseases	= 4·32	Cerebro-spinal diseases	= 5·00
Cardiac diseases	= 2·81	Cardiac diseases	= 6·00
Epilepsy	= 1·73	Epilepsy	= 5·00

Potters—Females.		Non-Potters—Females.	
Bronchitis	= 7·14	Bronchitis	= 16·00
Phthisis	= 16·96	Phthisis	= 11·00
Rheumatic affections	= 4·46	Rheumatic affections	= 1·00
Stomach disorders	= 19·64	Stomach disorders	= 31·00
Lead-poisoning	= 5·06	Lead-poisoning	= 0·00
Cerebro-spinal diseases	= 2·97	Cerebro-spinal diseases	= 2·00
Cardiac diseases	= 2·08	Cardiac diseases	= 3·00
Epilepsy	= 4·46	Epilepsy	= 7·00
Chorea	= 2·08	Chorea	= 1·00
Hysteria	= 1·49	Hysteria	= 5·00
Anæmia, with debility, &c.	= 10·41	Anæmia, with debility, &c.	= 10·00
Uterine maladies	= 18·15	Uterine maladies	= 13·00

Causes of Disease.—Disturbing Influences.

With perfect clearness we see now in what manner the potters differ, in respect to their diseases, from other classes of the community, local and general. We are led, therefore, straight to the inquiry:—What are the special influences or agencies which are at work to produce the special differences?

And, firstly, what is the influence of those disturbing causes, irrespective of occupation, to which I called attention in the first lecture?

The potters must not be held free from the charge of intemperance, but as a class it may be claimed for them that they are, comparatively, temperate. I believe that intemperance is not so widely spread amongst them as it is amongst some other more favoured classes of the community. When we come to the study of the diseases which produce the deaths of the potters, the presence of organic changes arising from drink is moderately marked. Alcohol, therefore, is excluded as a determining cause of their higher mortality.

Heredity plays a more important part. If we could introduce an entirely new and healthy population into the place of the population that is now present it would take, at least, three or four generations for the development of the present deterioration; but the deterioration would certainly come under existing conditions. If, on the other hand, we could transfer the existing population to some perfectly healthy spot, to Hygeia itself, and give the people most natural occupation, it would require some three or four generations to remove, by hereditary purification, the existing deterioration. We must, therefore, give to this element of heredity its proper weight as a disposing cause of vital failure.

The moral surroundings of the life of the earthenware manufacturer are unfavourable. To work from year to year turning clay into shape; to stand from year to year dipping the earthenware into the glazing mixture; to be ever engaged at the ovens, implies a persistent monotony and deficiency of change in the nervous microcosm, which leads of necessity to an enfeebled nervous organism, and therewith to reduction of nutritive force and feebleness of organic build.

It would be wrong to conclude that the diet of the pottery operatives and its mode of preparation are perfect. But by comparison the diet is good and simple. The potters do not subject themselves to a temporary luxurious diet, like the mining operatives of Wolverhampton, while they are better fed than their immediate neighbours of the working class, and they suffer less than do the latter from dyspeptic affections. Dietary and cooking may consequently be set aside as causes of the special high mortality which prevails amongst potters.

When amongst the disturbing influences we come, lastly, to consider the subject of cleanliness, we discover that in the homes of these workmen there is so much of comparative comfort and order that uncleanliness in the household must, of necessity, be excluded as a cause of their excessive mortality. The case is different when in relation to one special disease to which they are subject, lead paralysis, we touch on the personal cleanliness of the worker. Generally, even in this respect, the earthenware artisan is as cleanly as any other member of the industrial body, and is vastly superior to many, if not to the majority, of his compeers. It is only in one particular habit that he fails, and for this failure he pays a heavy penalty. It is the habit I have before referred to, that, namely, of retaining on his hands the poisonous lead. This is peculiar only to those who work in the lead, especially to the dippers. The uncleanliness specified may be accepted, I believe, as the one and only cause of the increased mortality which is due to lead poisoning, and which adds amongst males 8 per cent., and amongst females 5 per cent. of special disease.

Climatic Influences.

In addition to the social influences to which I have now drawn attention, it is fair to look also at the climatic influences under which the workers in the potteries live. The action of climate modifies largely the effects of injurious occupations. In some cases it lessens, in other cases it increases the dangers of disease which are peculiar to occupation. In the pottery districts the climatic influences are unfortunately an added evil to the evil that springs from the work.

The climate is variable, and from the winds, easterly and northerly, which are most distressing, there is no sufficient protection of mountain side or hill. The atmosphere is not considered to be so humid as it is in South Staffordshire, but it is nevertheless damp, and as the soil is of clay there is slow absorption of water after wet, and a long continued vaporisation of water into the air, which renders the air moist even in moderately dry weather. Unfortunately no important meteorological returns have been made on the spot, so that the precise relation of climatic variations to the course and severity of disease is not obtainable.

Of this fact, however, modern science has become perfectly conversant, that a steady dampness or humidity of the atmosphere, with deficient protection from cold winds, are conditions singularly favourable to certain of the most fatal diseases; to no disease more than to *phthisis pulmonalis*, or pulmonary consumption.

In the pottery districts these two influences, damp and exposure to cold wind, prevail to a considerable degree, and their independent importance must not be overlooked. In Haviland's maps of disease in England which I have placed on the board, the relation of the diseases, phthisis in females, cancer, and heart disease and dropsy, in the pottery district,—as compared with the same diseases existing in other parts of England and Wales, will be seen at a glance. It is again noticeable from these maps that cancer is a small cause of mortality in the potteries; that heart disease and dropsy are but slightly above the average as causes of death; and that phthisis is above the average in females, but is far below that which obtains in the district that runs away north of Staffordshire, and includes the towns lying between Leeds and Congleton, on to Saddleworth and Ashton-under-Lyme.

The condition of the atmosphere throughout the whole of the pottery district is commented upon as unfavourable to the health of the inhabitants generally, and this apart from the humidity which, as we have seen, prevails. "There is," says Dr. Arlidge, "a constant belching forth of smoke into the atmosphere from scores of ovens in which the pottery is baking, from a multitude of slip-house chimneys, of chimneys of mines and iron works, and, what is worse, from the blast furnaces for smelting iron; for the smoke from these last is loaded with poisonous gases, such as sulphurous acid, which tell the tale of their destructiveness on surrounding vegetation. Other sources of contamination are derived from the heaps of ironstone in process of calcining on the surface of the ground, and from the numerous flues of brick and tile ovens, which emit a very dense suffocating smoke."

Special Causes of Disease.

I pass now to the final study of the special causes connected with the occupation of the potter, and which give rise to special disease.

The chronic bronchitis and asthma which is presented among the potters is most developed in those who are exposed to variations of heat and cold, and to dust. The part played by dust in the production of lung disease in this class of the community is very definitely proved. I have stated in a previous lecture the means provided by nature for preventing the entrance of particles of dust into the lungs, and I have indicated that in the opinion of some physiologists and physicians the protection is so perfect that the entrance of foreign particles, under any circumstances whatever, is problematical. Bernard, by an experiment on an inferior animal, a rabbit, thought he had proved that fine particles of carbon dust could not be made to enter into the minute structure of the lungs, so as to produce irritation. It has also been reasoned, from the examination of the lungs after death of men who have died from disease induced by inhaling fine particles of stone, that because no evidence of the presence of particles of stone could be detected by the

sense of sight, therefore the proof that such particles were the primary and continued cause of irritation was wanting.

Other physicians had, however, detected these foreign particles in suspected cases, and in the case of rapid death from inhalation of fine sand dust, which I have already reported, and which came before me in 1857, I obtained abundant evidence of the presence of the minute particles in the parenchyma and alveolar structure of the lung. Traube and Rindfleisch, in 1860, discovered in a carbonised lung of the human subject numerous pieces of carbon dust, one of which showed the dotted cells of coniferous wood.

The difference of opinion which so long existed on the point in question was dependent on two circumstances, the limitation of the mode of examining, and the periods at which the examinations took place after the commencement of the disease. The method of examination was confined to a microscopical search for the foreign substance in the lung tissue, and, in the great majority of cases, that examination was not conducted until many months after the injury from the inhalation of the dust had been inflicted. During this interval the structure of the lung had undergone extensive change and destruction, so that the opportunity had readily occurred for the elimination of the foreign matter with the fluids that were coughed up.

In my case the death of the sufferer took place within a month after the infliction of the injury, and before any great destruction had time to be developed. I found the foreign agent, therefore, without difficulty, and the same, probably, obtained in Traube's case, and in other cases where a similar discovery has been made.

At the present time all previous difference of opinion has been set at rest by the institution of a new mode of inquiry, I mean, by the chemical analysis of the lungs of those who have never been exposed to dusts, and of those who have. Two chemists, Riegel and Hauser, from an analysis of lungs which have never been exposed to dust, discovered that no silica is present in the lung, but that after exposure for many years, even to ordinary dust, silica occurs in the ash yielded by the lung. In a day-labourer, aged 47, 13·39 per cent. of silica was found in the ash from the lung, and in a woman cook, 69 years of age, 16·69 per cent.

These new researches have led Dr. Arlidge to institute an inquiry into the condition of the lungs of the potter, in instances where death has occurred as the result of disease induced by inhalation of the dusts of clay. A portion of potter's lung analysed for him by Prof. A. H. Church, of the Royal Agricultural College of Cirencester, gave the following results:—

Water	76·37	per cent.
Organic substance	20·91	„
Ash of mineral matters	2·72	„

A further analysis of the ash of the mineral matters yielded:—

Mineral ash, silica	47·78	per cent.
Alumina	18·63	„
Peroxide of iron	5·55	„
Alkalies and undetermined matters	28·04	„

This analysis tallies with others which have been made by Meinel and Riegel on the lungs of stone-cutters, the latter observer having detected as much as 58·3 per cent. of silica in the ash in one case; but the analysis made by Professor Church for Dr. Ardridge stands alone in that it determines, not only the presence of silica, but also of alumina, a substance which forms a distinct ingredient in the clays used in pottery.

After many years of very active controversy, in which men of great ability have taken part on different sides of the question, we are led, then, at last to an absolute demonstration based on two processes, microscopical and analytical, to the fact that fine particles of dust—particles of sand, of stone, of carbon, of silica, and of alumina—may not only be inhaled into the human lung, but that so inhaled they may be carried into the minutest structure of the lung; may be the centres round which there is condensation of living tissue; and may be the direct cause of the irritation and inflammatory action which results in mechanically induced bronchitis, and in phthisis pulmonalis—pulmonary consumption.

The effects of the dust of clay, to which the potters are subjected, are partly those of a cutting, partly those of an obstructing dust. Dr. Arlidge has found that the dust does not penetrate the lung in so diffused a manner as coal dust, and this, as he very justly remarks, for the reason that the dust is more irritating, and provokes at once more distinct inflammatory action. "At the same time," he adds, "both forms of dust exhibit a preference for the upper and back part of the lungs, in other words the dust accumulates most in those parts first reached in the inspiratory act." This is somewhat different to that which I observed to occur in the case where fine sand dust was inhaled. In that instance the irritating particles were well diffused over the whole structure of the lung.

At the points where the dust accumulates in the potter's lung, the structure of the lung assumes a greyish black colour, and in cases where the structure is not broken by extreme destructive changes, the substance of the organ, at the points of deposit, is condensed and hardened. When cut, the condensed mass, says Dr. Arlidge, presents great resistance, and the surrounding lobules are often emphysematous; that is to say, the minute air vesicles of the surrounding parts of the lung have become ruptured, owing to the unequal pressure that is exerted when a part of the lung structure is interrupted in its action.

In addition to the action of dust as a source of lung disease, there is another cause which especially affects the female workers in the potteries, and which gives that additional degree of phthisical disease to them which their mortality, over that of other females in the pottery district, indicates. I refer to the closeness of the rooms in which some of these work while engaged in burnishing and painting the earthenware. In the better constructed factories this cause—I may say all but certain cause—of phthisis does not now exist; but still it remains in the buildings where deficient space and bad ventilation are combined, and these buildings are too common.

Summary of Special Diseases.

The major diseases of the manufacturers of earthenware are the diseases of the lungs known as phthisis pulmonalis, bronchitis, asthma, and emphysema.

There are also some minor forms of disease which bear on the severer, to which I might, if there were time, direct your attention. The men who are called pressers suffer from a deformity arising from a depression in the side of the chest, at the lower part in front. The injury is induced by their work, and it leads to a deficiency of power in expanding the chest, and so favours the development of the more serious pulmonary diseases.

The men and boys who are at the ovens and kilns, and are subject to great variations of heat and cold, are rendered liable to a congestive state of the lungs, which again is favourable both to bronchial and phthisical maladies. These operatives are also disposed through their occupation to rheumatism and to the heart disease which follows, conditions again favourable to the diseases of the lungs, which are such permanent factors of mortality.

On the whole the chief direct cause of the chest diseases is the dust. This is primary in its operation; it promotes the tendency to the very malady, it excites and it never ceases to be an exciting cause.

After the diseases of the chest, amongst the potters, come specially the paralytic diseases induced in them by lead. The dippers, and the women who are employed in assisting the dippers, and in the minor processes of laying lead colours on the ware, are the victims to these diseases. They are often affected very early in life, and they may be affected through any stage of their lives, while they

are employed. The results, though they be less intense and less suddenly mortal than those produced by the dust, are, in the end, in proportion to the numbers injured, hardly less mortal, and by prolongation of symptoms are certainly not less painful to the afflicted.

In conclusion. Could we relieve the earthenware manufacturers from the two grand causes of diseases to which they are exposed, dust and lead, though some generations would be required in order to restore them, as a community, to perfect vitality, there is no reason why their death-rate should not, at once, be reduced to at least half its present excess, and the steady progress of their vital regeneration be immediately commenced.

The problem looks easy as it is first surveyed, and whether easy or difficult it is sufficiently solemn. I shall endeavour to touch its solution in a future lecture.

MISCELLANEOUS.

SEWAGE POLLUTED WATER AND TYPHOID FEVER.

An article lately appeared in the *Times* on infectious fevers. The following passages are extracted from it as likely to be useful in the Sewage Conference, shortly to be held at the Society's rooms:—"The third form—'typhoid,' or 'enteric' fever—is the common fever of this country, which spares neither age, sex, nor social condition, which destroyed the life of the Prince Consort, and nearly destroyed that of the Prince of Wales, which destroys an average of about 10,000 or 12,000 people annually, and which sickens and endangers about 100,000 more. It is essentially an eruptive disease of the lining membrane of the intestines; a sort of smallpox, which affects the bowels instead of the skin; and, like some other eruptive diseases, its destiny is to run a definite course over a stated period of time. It is spread abroad chiefly, and probably exclusively, by the discharges from its specific eruption—that is to say, by the discharges from the intestine. These, in the natural course of things, find their way into cesspools and sewers, and when they do so so they render poisonous the solid or liquid contents of the receptacles, and also the gas which is evolved from them. The fever is reproduced, mainly in three ways—first, by the poisoned sewage obtaining direct access to drinking water, by leakage or soaking, and so being swallowed; secondly, by the poisoned gas escaping from sewers into water-mains or cisterns, so that it is absorbed or dissolved by the water, and so swallowed; thirdly, by the poisoned gas making its way through badly-trapped drains or other channels, into dwelling or sleeping-rooms, and so being breathed by the occupants. To one or other of these methods of diffusion every outbreak of typhoid fever may be referred, and nearly every single case, the tendency of modern research, by increasing our knowledge of the outlets for sewer poison, and of the distances which it may travel unchanged, being constantly to bring apparent exceptions within the general rule. Hence two things are manifest—first, that typhoid fever is very little infectious in the ordinary sense, or through the atmosphere which surrounds the patient; secondly, that it is very actively infectious through concealed channels of indefinite length or tortuousness, so that B may derive his fever directly from A, of whose very existence he is ignorant. The connections which constantly exist between sewers or cesspools and the water or air supply of dwellings, however disagreeable or disgusting, are harmless, as far as the production of typhoid is concerned, until the sewers or cesspools have themselves received the typhoid poison. In towns which have an intermittent water supply, and in which mains and sewers lie in close proximity in the streets, as soon as the mains are empty of water they become filled by the sewage gas, which makes its way through chinks; and in the many houses in which an untrapped overflow pipe descends from the cistern to the sewer, the gas ascends by this pipe, and the water contained in the cistern is always more or less contaminated. In both cases the water may be made to stink, or it may be rendered more or less unpalatable or unwholesome, but it does not become a source of typhoid until typhoid poison has been cast into the sewer. There are few villages in which there is not continued soaking from cesspools to wells, but this soakage is likewise—*quâ* typhoid—harmless until the specific material is supplied. The danger of such structural defects is that they leave an open door for the entrance of the typhoid poison whenever it does get into the sewers, and the typhoid poison is so widely diffused in this country that it is never safe to speculate upon its absence. When the fever appears, the only question is, practically speaking, 'How and when does the sufferer drink water which was contaminated by typhoid tainted sewage, or breathe air with which typhoid tainted sewer gas was mingled?' All the popular talk about 'exposure to cold,' or about 'bad smells,' or 'over fatigue,' or other vague speculations of like kind are entirely erroneous and misleading. Typhoid may be assumed, for all practical purposes, to spring only from antecedent typhoid, and to come only by the path of sewage pollution. If it ever does arrive *de novo*, the cases are entirely exceptional, and we have no certain evidence of their occurrence."

CORRESPONDENCE.

ELEMENTARY EDUCATION.

Sir,—With reference to the statistics regarding elementary education which appeared in the Chairman's address in November last, showing that only 20,000 out of two millions reached the VI. Standard, it may be well to point out that the former was about the total number presented at the annual visits of Her Majesty's Inspectors at the schools coming under inspection for an annual grant. These, however, were of all ages from 3 to 13 or over, and include over half a million who attended on an average less than three out the five days of the school week.

As shown by the report of the Education Department, comprising the returns for the year ending 31st August last, the numbers are as follows of children who had been to school 250 times morning or evening, the schools being open five days in the week for, generally, about 42 weeks, or 420 times in all:—

Infants under 7 years of age........		440,007
Over 7 years of age, not less than 250 attendances ..	904,650	
Over 7 years of age, under half-time Acts	90,509	
Rural boys making not less than 150 attendances....	17,909	
		1,013,068
		1,453,075

If the scheme were working efficiently, about one sixth of this 1,013,000 (the whole representing six years of school life), might possibly be passed in the 6th Standard, for though there is a natural decrease in the numbers of children with every year of age, some remain past the age of 13 contemplated by the scheme. Children, of course, may well, and some few do, pass this standard at an earlier age, but as it can only be passed once this will not much affect the average proportion. Instead of the full number of about 169,000 reaching this standard, only 17,617 are returned as presented in it, and of these only 16,345 passed in reading, 13,443 in writing, and 9,942 in arithmetic. The proportion of those who passed in all three of the rules is 47·15 per cent. only. These figures taken from the Blue

Book give a different impression from the bare statement that about 20,000 out of two millions reached the VI. Standard. Moreover, as most schools who work up to the V. and VI. Standard at all, also earn grants for extra subjects under the Science and Art Department, the results are not to be hastily condemned as altogether meagre.

The real and great evil is the large number of schools which make no attempt to attain the level of inspected schools, and have not the teaching power to reach the IV. or even the III. of the Standards of the Code. The inspected schools, though in a condition utterly unsatisfactory to rest in, are far from stagnant, but for a large proportion of children to reach the VI. Standard the instruction must begin in the infant school. Increase in the lower standards is at this period a sign of good work: often of the best kind of work done under most unfavourable conditions—the result of ages of neglect.

The year 1873 showed an increase of 28·2 per cent. in Standard II., and 19·8 per cent. in Standard III. over the year 1872, and this exceptionally large rate of increase appears in 1874 in the III. (26 per cent.) and the IV. (21·66 per cent.) Standards. So far good, but we are but at the beginning of the task, and all true friends of national education must lay this truth to heart: viz., that the ignorance of children hereditarily illiterate, the opposition open and covert of parents, employers, and of all those who think the "lower orders should be kept down in their 'proper place,'" present difficulties which cannot be overcome by any assault however brilliant, but call for exertions more akin to the laboured operations of a formal siege, or the more varied and arduous resources required for a campaign in an enemy's country; and further, that we have not only to fight the battle, but to raise and discipline the army. Teachers will not be forthcoming if there be not an "effective" demand for them, but however urgent the demand for them they cannot be made in a day. The rashness of indiscriminate censure and of indiscriminate satisfaction are equally hurtful, so also is the too common tone which speaks of the work for years of vigorous exertion, either as a task to be entered upon "with a light heart," or abandoned or dwarfed in the face of difficulties which should only serve as a healthy stimulus to persistent exertion.

In May last I read, before a meeting of School Board managers and others held in your rooms, a paper, from which the following is taken:—

The Blue Book issued about this season by the Committee of Council on Education gives the returns of schools inspected during the year ending 31st August, and which must, therefore, have been opened for a year or more before that date.

I have, therefore, taken the reports published in 1873 for the bases of comparison, as they fairly represent the position of education when the Act of 1870 first came into practical operation; though, no doubt, some indirect stimulus had been given by anticipation to those concerned in the work.

1. The increase in schools, and the number of children in average attendance, is—

	Schools.	Children.
1871-72.		
Total number inspected ..	9,854	1,336,000
Of these, School Board Schools	82	8,700
1872-73.		
Total number inspected ..	11,094	1,482,000
Of these, School Board Schools	520	70,000
1873-74.		
Total number inspected ..	12,246	1,679,000
Of these, School Board Schools	838	138,000

On the actual numbers of children over seven years of age attending, morning or afternoon, over 250 times in the year (about three full days in the week, excluding holidays), or, in the case of "half-timers," 150 times in the year, the increase has been as follows:—

1871-72 ..	793,000	
1872-73 ..	888,000	increase 12 per cent.
1873-74 ..	1,013,000	„ 14 „ and 27$\frac{3}{8}$ on 1871-72.

On actual numbers presented—

1871-72 ..	662,000	
1872-73 ..	752,000	increase 13$\frac{3}{4}$ per cent.
1873-74 ..	856,000	„ 14 „ or 29$\frac{4}{5}$ on 1871-72.

The disproportion of those presented in the lower Standards I. to III., as compared with IV. to VI., remains much as before—viz., about 82 per cent. in the former against 18 per cent. in the latter, instead of being nearly equal.

The average number of "complete passes" is somewhat less, the proportion being 59·26 per cent., 60·68 per cent., and 60·74 per cent. respectively, but the passes under each standard are—for reading, 88·37 per cent.; writing, 80·59 per cent.; and arithmetic 70·9 per cent., showing a slighter decrease.

It must be remembered, however, that this falling off is in the face of the increase of nearly 30 per cent. of children above noted, a large proportion of whom will have been very imperfectly taught previously. Last year's report showed a relatively large increase in the numbers presented in the II. Standard. This report shows the increase is satisfactorily carried on in the III. and IV. Standards.

Comparing the work done in these inspected schools with the whole task before us, it appears that, deducting one-seventh of the population of England and Wales as provided for by schools above the class now under consideration, there is an estimated gross total of 4,750,000 children, of which about 2,000,000 may be taken roughly as between three and seven, and 2,750,000 as between seven and thirteen years old.

Of the latter nearly 55 per cent. are returned on the registers of inspected schools, but this number will, especially where the population is shifting, contain many names more than once over.

The proportion attending regularly, in the sense explained, is 35 per cent. against 31 and 28 per cent. in the two previous years respectively.

The number presented—29·65 per cent. against 26·25 and 23·5 per cent.

The average passes—23·7 per cent. against against 21·2 and 19 per cent.

The complete passes—17$\frac{1}{2}$ per cent. against 15·9 and 14·25, all as compared with the two previous years respectively.

The "infants" attending inspected schools are about 20 per cent. of the whole estimated number of children between three and seven years old, but, probably, about 30 per cent. of those between five and seven years old.

The proportion of children over ten years old presented in the I. (or standard next to the infant class) has also decreased from 22·3 in 1871-72 to 20·6 in 1872-73, and is under 17 per cent. in the last report. In Standard II. the decrease is from 77·5 per cent. to 70 per cent., and 40 per cent. in the three years respectively.

In extra subjects, in the years—

	1873-74.	1872-73.	1871-72.
Numbers presented..........	85,000	78,000	71,500
	Per cent.	Per cent.	Per cent.
Proportion to whole number of those presented in Standards IV. to VI.	55	60	60
Passed in two subjects	31	30	16
„ one „	41	41	25

Teachers employed 31st December in the years—

	Male.	Females.	Total.
1872.			
Certificated Teachers......	7,632	7,778	15,410
Assistant Teachers........	460	947	1,407
Pupil Teachers	11,605	13,976	25,581
1873.			
Certificated Teachers......	8,323	8,412	16,735
Assistant Teachers........	468	1,037	1,505
Pupil Teachers	10,277	14,849	25,126
1874.			
Certificated Teachers......	9,651	10,511	20,162
Assistant Teachers........	650	1,349	1,999
Pupil Teachers	10,548	16,773	27,321

—I am, &c., Rowland Hamilton.

ELEMENTARY EDUCATION AND COMMON SENSE.

Sir,—Allow me to send to the *Journal* the following extract from a leading article in the *Times*, which I hope the Council will bring to the special notice of Lord Sandon, the Vice-President of the Committee of Council on Education.—"The youth and the very children of this age hardly know how much they have to be thankful for in the achievements of science and art which brings India before their eyes, its peoples, its manners, and its scenes; and tells them to-day all that happened yesterday, and what is now going on at the very hour that they read the news. Were elementary education conducted on common sense principles, every village teacher would be this day instructing all above mere infancy to trace the route of the Prince, to point out where he is to-day, to describe what climate, what sort of people, and what real or nominal rulers he sees about him, and, if it be permissible, what is their religion. This would associate them with tho Empire and with the world, and would make great events part of their lives and landmarks in their recollection." It may be hoped that Lord Sandon will pass this on to Sir Francis Sandford, instructing him to make instruction in geography as well as other subjects in the Code vehicles for teaching the three R's., reading, writing, and arithmetic, instead of being difficult abstractions, might be taught easily, if connected with facts which children may have under their eyes. The inspectors, too, would be made much more realities than they are now.—I am, &c.,

A Member of a School Board.

January 14, 1876.

UNHEALTHY TRADES.

Sir,—I have a few words to say concerning the death rates of persons variously employed, shown in your issue of the 7th instant.

I am of course unacquainted with the returns which the Registrar-General is about to publish, but it is fair to assume that they are of greater accuracy and consequent value than those already published relating to the years 1860 and 1861. However that may be, I am of opinion that the facts should be separately shown for each year, so that their general similarity may confirm the conclusions to be deduced from them, or their violent contradictions deprive them of all credence.

There are various reasons for entertaining misgivings, not as to the advisability of procuring such returns, but as to the safety of the conclusions drawn from them, in these early days. When a larger store of observations has been accumulated and thoroughly studied, information of value will certainly be obtained. I proceed to indicate a few points which I think important.

1. Many occupations employ an increasing or a decreasing percentage of persons at successive ages, that is to say, people turn to occupations in later life which they did not follow in their youth. When a lead miner turns a cottage gardener at the age of forty he is already an old man, and cannot safely continue to follow his old employment.

2. The returns of occupations of the living are made by themselves; those of the dying by other people. If the Registrar-General would trace out the returns made in 1871 by the men who died later in that year, and compare them with the death registers, he might find some curious discrepancies. Even if this would give too much trouble, we must marshal the whole of the facts before we can judge whether the living or the dying are to the largest extent returned under indefinite or otherwise unsatisfactory headings.

3. Comparison of the mortality of particular trades in districts of large population would tend to confirm or to shake the conclusions derived from the figures for the whole nation. There ought to be two at least of large urban districts and two at least of great agricultural divisions, for example: 1, London; 2, North-western division; 3, South-western division; 4, Eastern division.

4. Observations should be perhaps confined to those ages at which a given trade or profession includes many people actively engaged therein—otherwise the small numbers yield fluctuating results, or the elderly people who no longer really follow the pursuit may not fairly exemplify its effects; perhaps the best lives of those formerly engaged in it, have taken to some other occupation under which they are placed.

5. Mr. Ansell's observations published a short time since should be compared.

Finally, I think we ought to be sceptical on grounds of common knowledge, as to the value of some of the figures in the Table on page 122. Solicitors and physicians are, I believe, much healthier classes of men than either grocers or bakers. There may be some truth in the low vitality ascribed to commercial travellers, but no one would say all commercial clerks were equally likely to be unhealthy or to die prematurely. Brass manufacturers and braziers are perhaps really less healthy then schoolmasters. One or two other lines in the table surprise me, but may nevertheless give correct indications; those mentioned are what I should challenge and sift in the first instance, and if they were sustained, I should easily believe all the rest.—I am, &c.,

Thomas A. Welton.

6, Offerton-road, Clapham, 14th Jan., 1876.

GENERAL NOTES.

National Training School for Music.—The committee of management have appointed the professional staff as follows:—Mr. Arthur Sullivan to be principal of the school, to act in concert with the board of principal professors, and to be professor of composition; Herr Ernst Pauer, to be professor of the pianoforte; Dr. Stainer to be professor of the organ; Signor Visetti, to be professor of singing; and Mr. Carrodus to be professor of the violin. The Rev. John Richardson, M.A., has been appointed registrar of the school. The committee look forward to opening the school after Easter, 1876, if the local competitions are sufficiently advanced.

Through the delay of a proof, several errors occurred in the report of Mr. W. L. Watts' paper on Iceland, in last week's *Journal*. The name Reykjavick, which occurs several times, was mis-spelt Regbjavick, and the word jökull was printed johull. Also p. 174, line 35, for 615 feet, read 6,150 feet.

NOTICES.

SUBSCRIPTIONS.

The Christmas subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made :—

February 9.—"The Cultivation of Hardy Fruits, with a view to improvement of quality and ensuring constant and abundant production," by Shirley Hibberd, Esq.

February 16.—"The Combustion of Gas, and its application to Heating Purposes," by John Wallace, Esq.

February 23.—"Contagious Diseases of Animals as affecting the Health and Wealth of the Country," by George Fleming, Esq., Royal Engineers.

March 1.—"Aquarium Construction and Management," by W. Saville-Kent, Esq., F.L.S., F.Z.S.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made :—

February 15.—"Ostrich Farming and the Ostrich Feather Trade of South Africa." By P. L. Simmonds, Esq., F.S.S.

March 14.—"The Diamond Fields of South Africa, and their Influence on the Native Races of the Neighbourhood." By J. B. Currey, Esq.

March 28.—"The Industries of South Africa." By T. B. Granville, Esq.

April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Chemical Section.

Friday evenings at 8 o'clock. The following papers will be read :—

February 11.—"Sole-Leather Tanning, with some Remarks on the the Import of Hides and Cattle." By Sparke Evans, Esq., of Bristol. On this evening G. Hepburn, Esq., will preside.

February 25.—"Some Recent Metallurgical Processes." By J. Arthur Phillips, Esq.

March 31.—"The Methods of Estimating the Illuminating Power and Purity of Coal Gas." By A. Vernon Harcourt, Esq., M.A., F.R.S.

April 28.—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Widnes.

Tickets for the meetings of the Chemical Section are sent out with this *Journal*.

Cantor Lectures.

Monday evenings at 8 o'clock. The Second Course, "On Iron and Steel Manufacture," by W. Mattieu Williams, Esq.

Lecture IV.—February 7th.

Direct Steel and Semi Steel.

Mechanical puddling.—Rail making.—Angle-iron.—Iron wire, &c.—Piling.—Plate rolling.—Boiler plates.—Ship plates.—Armour plates.—Sheets.—Fibre of iron.—Hot and cold shortness.—Lamination and blistering.—Testing of wrought iron.—The tenacity, elasticity and toughness of iron. What is steel? The composition of different kinds of steel.—The difference between steel and cast iron, and the mischievous consequences of popular and learned fallacies concerning it.—Steel making directly from the ore, and the conditions demanded for its success.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr Mattieu Williams, "Iron and Steel Manufacture" (Lecture IV.)
Farmers' Club, Salisbury-square, E.C., 5½ p.m. Mr. James Howard, "Our Meat Supply."
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Vaughan Pendred, Inaugural Address.
Royal United Service Institution, Whitehall-yard, 8½ p.m. Mr. John James Hall, "A Proposed Signalling Masthead Lamp, designed for the prevention of collisions at sea."
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on the Agricultural Holdings Act.
Medical, 11, Chandos-street, W., 8 p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Rev. B. W. Savile, "Heathen Cosmogonies compared with the Hebrew."
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Bentley, "Unfermented Beverages." (Lecture I.)

Tues. ...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. H. Garrod, "Classification of Vertebrated Animals." (Lecture IV.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. James Barton, "Carlingford Lough and Greenore."
British Scandinavian Society (at the House of the Society of Arts), 8 p.m.
Photographic, 9, Conduit-street, W., 8 p.m. Annual Meeting.
Anthropological Institute, 4, St. Martin's-place, W.C.

Wed. .. **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr Shirley Hibberd, "The Cultivation of Hardy Fruits."
Graphic, University College, W.C., 8 p.m.
Royal Literary Fund, 10, John-street Adelphi, W.C., 3 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Thurs...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Ella, "Lyrical Music." (Lecture II.)
Royal Historical Society, 11, Chandos-street, Cavendish-square, W., 8 p.m. 1. Mr. George Harris, "The Domestic Every-day Life, Manners, and Customs of the Ancient Britons" 2. Rev. Samuel Cowdy, "What I saw in Norway."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gladstone, "Chemistry of the Non-metallic Elements." (Lecture IV.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Civil and Mechanical Engineers Society, 7, Westminster-chambers, S.W. Mr. W. C. Street, "Permanent Way of English and Foreign Railways"
Mathematical, 22, Albemarle-street, W., 8 p.m.
South London Photographic Society (at the House of the Society of Arts), 8 p.m.

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Mr. Sparke Evans, "Sole-Leather Tanning, with some Remarks on the Imports of Hides and Cattle."
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Mr William Crookes, "The Mechanical Action of Light."
Antropological Society, 1, Adam-street, W.C., 8 p.m.
Astronomical, Burlington-house, W.C. 3 p.m. Annual Meeting.
Quekett Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Prof. Thiselton Dyer, "The Vegetable Kingdom." (Lecture I.)
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,212. Vol. XXIV.

FRIDAY, FEBRUARY 11, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The Examination for the Society's Scholarships commences to-morrow, Saturday, at the School-house, Kensington-gore. The examiners appointed by the Society are Mr. John Hullah, Mr. Otto Goldschmidt, and Mr. W. G. Cusins for the musical portion of the examination, and the Rev. J. Richardson, Registrar of the School, for the literary portion. The Scholarships to be competed for will be ten in number; four given by the Society, five by Mrs. Freake, and one by Mr. Frank Morrison. Each candidate has had notice of the time when his or her examination will be taken.

NATIONAL TRAINING SCHOOL FOR COOKERY.

The Examination for the Society's Scholarships commences to-morrow at 10 a.m., at the offices of the School, Exhibition-road, South Kensington.

SUBSCRIPTION FOR THE FAMILY OF THE LATE S. T. DAVENPORT.

The following subscriptions have been promised, amounting, with sums previously acknowledged (£1,019 11s.*), to £1,465 6s.

It is requested that members will accept this notice as an acknowledgment of their subscriptions :—

	£	s.	d.
Sir Thomas Dyke Acland, Bart., M.P.	10	0	0
Samuel Andrews	5	0	0
T. H. Bastard	2	0	0
Sir Antonio Brady	1	1	0
Robert Brooks	5	5	0
Edward Browne	3	3	0
Boyd Burnet	2	2	0
Madame R. A. Caplin	3	3	0
David Chadwick, M.P.	2	2	0
Edward Chambers	5	5	0
Major Owen Clutton	1	1	0
Alan S. Cole	1	1	0
Coutts and Co.	31	10	0
Abraham Darby	5	0	0
W. Dean	2	2	0
Duke of Devonshire	10	0	0
George Dines	5	5	0
James Duncan	10	0	0
Lord Ebury	5	5	0
W. Dashwood Fane	3	0	0
G. F. Francis	2	2	0
G. H. Frean	3	3	0
Peter Graham	5	5	0
J. M. Herbert	1	1	0
G. O. M. Herron	2	2	0
Samuel Hocking	3	3	0
E. D. Hodgson	1	1	0
E. R. Holland	3	3	0
William Hudson	1	1	0
W. W. Hughes	5	0	0
E. J. Jerram	5	0	0
E. D. Johnson, F.R.A.S., F.M.S.	1	1	0
James Judd	2	2	0
Thomas Kell	2	0	0
G. T. Kemp	5	0	0
J. E. Killick	1	1	0
Thomas Kingsford	1	1	0
T. Hayter Lewis	2	2	0
W. J. Lockyer	2	2	0
W. Drury Lowe	2	2	0
Walter Macfarlane	15	0	0
C. McGarel	5	5	0
Mrs. McGarel	2	2	0
John MacGregor	2	0	0
Charles Manby, F.R.S.	5	0	0
Horace Martin	2	2	0
F. Nettlefold	5	0	0
R. Nicol	3	3	0
George Nutter	1	1	0
Martin Olsson	1	1	0
F. A. Ormiston	2	2	0
John Pendergast	5	5	0
John Penn, F.R.S.	20	0	0
G. D. Peters	2	2	0
T. Adams Phillips	2	2	0
James Pitkin	1	1	0
Frederick Pitman	1	1	0
John Pritchit	1	0	0
A. J. Prothero	2	2	0
W. T. Radford, M.D.	1	1	0
Alexander Redgrave	2	2	0
E. J. Reed, C.B., M.P.	5	5	0
H. O. Robinson	5	5	0
Captain Robinson, R.N.	1	0	0
T. Robinson	1	1	0
T. A. Rochussen	1	1	0
Richard Rotton	2	2	0
Skinner Row	1	1	0
Edward Ruff	5	0	0
John Rutson	5	0	0
Colonel T. H. Salo	2	2	0
G. T. Saul	2	2	0
Chevalier de Scherzer	1	1	0
R. J. Scott	2	2	0
James Shand	10	0	0
Bentley Shaw	3	3	0
C. W. Siemens, D.C.L., F.R.S.	21	0	0
A. M. Silber	2	2	0
N. P. Simes	1	1	0
Col. J. Smith, R.E.	2	2	0
R. M. Smith	1	1	0
George Stanton	2	2	0
Dr. Stenhouse	1	1	0
J. J. Stevens	5	0	0
W. Stevens	2	2	0
John Sykes	2	2	0
Captain, Symonds, R.N.	1	1	0
T. K. Taplin	1	1	0
Charles Telford	5	0	0
W. H. Thomas, F.R.G.S.	1	1	0
Sir W. C. Trevelyan, Bart.	5	0	0

* The amount stated last week (£1,021 12s.) included a sum of £2 2s. which should have been charged to another account of the Society's.

	£	s.	d
John Turney	2	2	0
M. Ventura	1	1	0
Henry Wagner	1	1	0
Henry Walker	1	1	0
Z. Watkins	2	2	0
Sir Thomas Watson, M.D.	5	0	0
J. J. Weinberg	1	1	0
Jonah S. Wells	3	3	0
W. Westley	5	0	0
Duke of Westminster	5	0	0
John White	1	1	0
C. T. Wilson	2	2	0
Benjamin Winstone	5	5	0
W. Lloyd Wise	1	1	0
J. T. Wood	2	2	0
J. T. Woodhouse	10	10	0
F. Wrentmore	1	1	0
William Wybrow	2	2	0
Leonard C. Wyon	1	1	0
John Yeats, LL.D.	5	0	0
Colonel W. Yollond	5	0	0
Henry Yool	5	5	0

TENTH ORDINARY MEETING.

Wednesday, February 9th, 1876; The Hon. Dudley Francis Fortescue, F.R.G.S., F.G.S. (Member of Council), in the chair.

The following candidates were proposed for election as members of the Society:—

Austin, C. E., The Beeches, Barlow Moor-lane, Didsbury, near Manchester.
Dods, Lieut.-Colonel P., 3, West Cromwell-road, South Kensington, S.W.
Mitchell, Aurelius Bruce, 40, Calthorpe-road, Edgbaston.
Walker, Frederick, 47, Frederick-road, Edgbaston.

The following candidates were balloted for and duly elected members of the Society:—

Bird, Robert, Belmont-villa, Roath, Cardiff.
Lockwood, Philip Embury, 19, Cromwell-place, S.W.
Montagu, John Montagu Pulteney, J.P., Downe-hall, Bradpole, Bridport; and 51, St. George's-road, Eccleston-square, S.W.

The paper read was—

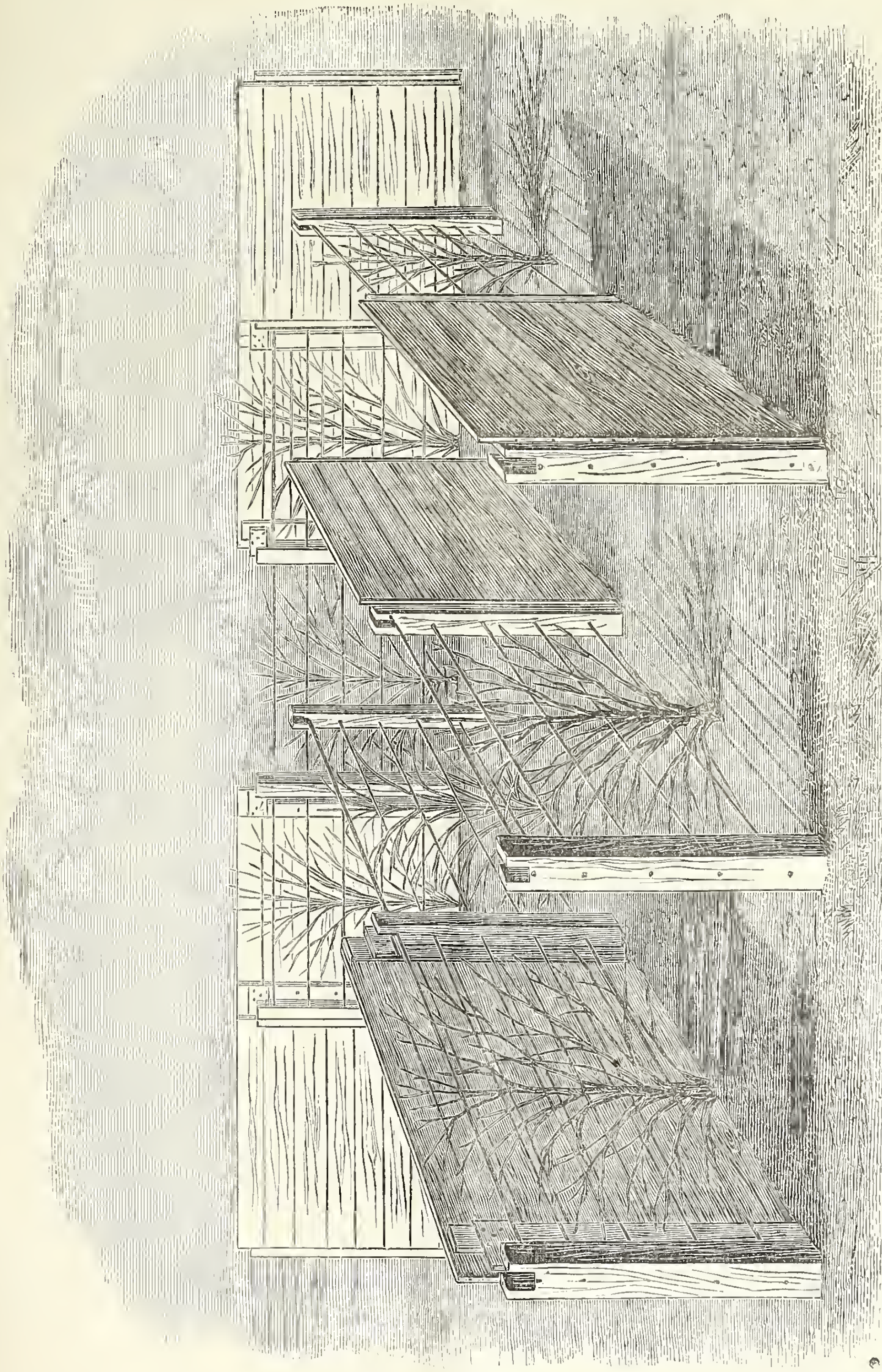
THE CULTIVATION OF HARDY FRUITS, WITH A VIEW TO IMPROVEMENT OF QUALITY AND INSURING CONSTANT AND ABUNDANT PRODUCTION.

By Shirley Hibberd.

During the past five-and-twenty years the subject of fruit culture has been largely illustrated and fervently discussed by both trade and amateur cultivators, and some very curious conclusions have obtained currency, and have come to be regarded in the aggregate as constituting a kind of pomological gospel. Those who have been constant readers of the horticultural papers will be as well able as myself to enumerate the chief points in the modern and generally accepted doctrine of fruit-culture; but it will be proper for me to attempt a summary, to serve as a preface to the proposals I have to submit for your consideration. It appears to be generally agreed that the treatment of fruit trees at every stage of their existence should be such as to prevent their growth, so that the orchard and the garden shall no longer be adorned with fully developed examples of the several kinds, but they shall be simply disfigured with stunted things called "miniatures," the production by which of a few quarts or pecks of fruit is to afford more delight than the production by real trees of fruit requiring to be measured by the bushel, and carried from the ground by the aid of the market-cart. Accordingly, the producers of fruit trees have sought out all the starving stocks, on which they graft the sorts required, and they have urged on the amateurs who purchase them a code of management avowedly intended to keep the trees within bounds, or, in other words, to thwart the course of natural growth by artificial modes of repression, with a view to prevent development. The roots are to be periodically pruned, the branches are to be treated in like manner, and during the summer the soft shoots are to be several times pinched, to prevent extension in the natural way, to keep the tree down when it would fain go up, and check the spread of its branches, so that it shall make no shadow. Truth is truth, and it must be admitted that the system has succeeded far beyond the expectation of those who supposed that systematic repression must result in utter barrenness. The tormented trees do produce fruit of good quality, and as garden toys have their value. The joy with which an amateur gathers a score or so of apples from a tree that has cost him money, and labour, and anxiety sufficient to produce a ton of fruit, instead of a score, by a more rational method —the joy of the amateur in taking this miniature reward for a world of labour in pruning and pinching—ought not to be trifled with, but truth is truth, and we must not describe this pretty pastime as fruit-culture. As men are but children of a larger growth, it must be permitted them to have play-grounds and toy fruit trees; and so the starved, stunted, pinched, and crippled trees that thousands of persons take delight in are not to be condemned in a ruthless manner; but it is high time the public mind should be freed from the incubus of a delusion that stands sheer in the way of the possible development of our resources in respect of fruit production.

It is impossible for me, on this occasion, to treat at length the very many important matters that the remarks I have already made will suggest to you, but I may be enabled to state with clearness, though briefly, certain conclusions I have arrived at, as the result of experiments and inquiries of my own, that have been systematically pursued during the past twenty-five years. In the course of this time every system of fruit-culture has been fairly tried, and the results compared with the most scrupulous impartiality, and the general result is that, at the present moment, with all our supposed advance in this department of rural industry, the old-fashioned orchard trees are in no way superseded, provided fruit trees are grown for fruit, and are expected to produce enough to pay the rent of the land they cover.

To go to the root of the matter, it must be said that, as a rule, dwarfing stocks are objectionable because they are dwarfing. They promote early fruitfulness by starving the trees they are made to carry, just as the starved and stunted populations of the darker parts of great cities become precociously fruitful, and their offspring are comparatively worthless in the labour market. I



Moveable Walls for Fruit Trees.

submit to you the proposition that what are termed "free stocks" should always be selected for the making of fruit trees that are intended to produce fruit; but if toy trees are wanted, the Chinese system of starving, pinching, and cramping may be commended. The free stocks are so called because they promote free growth, and it is above all things necessary to have a tree first, and then we may hope for fruit in due time. If all that is said in modern books be true, there can be no need of a tree, because you must prune and pinch the tree down to nothing, and that nothing will produce fruit prodigiously. Between stock and graft there should be the closest possible homogeniety, as in the so-called free stocks; but we are not so closely shut up to the system of grafting as is generally supposed. Every fruit we possess can be reproduced from seed, and seedling trees have roots of their own, and, nine times in ten, surpass in fruitfulness the best grafted or budded trees to be found in the same enclosure. The stone-fruits are, for the most part, grown on free stocks, because dwarfing stocks are not to be found. The apple and the pear, however, have been demoralised by dwarfing stocks, the one being grafted on the paradise and the other on the quince. These stocks starve the trees, and thus promote early fruitfulness. If small quantities of fruit satisfy the cultivator these stocks are well enough, but they can do nothing towards the supply of the markets or the feeding of the people. As regards the paradise stock there are at least half-a-dozen distinct varieties of apples bearing this name in cultivation, and they vary considerably in their degree of fitness for the purpose of the propagator. The one which Mr. Rivers, of Sawbridgeworth, has for many years employed in the production of miniature apple trees is the worst of them all, and the one employed by Mr. Scott, of Crewkerne, is the best; but they are all objectionable, because less vigorous in habit than the varieties of apples commonly grafted upon them.

In the making of fruit trees, the customary modes are by whip and tongue grafting. I submit to your consideration a proposition that grafting should be abolished, and budding should be substituted as a far better practice, because calculated to produce a more vigorous and a longer-lived tree. We have an established illustration of the difference between budding and grafting in the rose garden, for, as the standard of quality in the flowers of the rose has been raised by severe judging at competitive exhibitions, grafting has been abandoned, and all roses on foster roots are now made by budding exclusively. It cannot be doubted that a properly inserted bud will in any case make a better tree then the best possible graft, for the shock to the stock and bud is a less shock then to stock and graft, there is no core wood to carry weakness into the heart of the future tree, and the operation must be performed in summer, when the junction and the healing are rapidly accomplished.

In respect of planting it seems needful to say that fruit trees require food, because the books generally favour planting on a poor soil, and instil into the minds of their followers a fear of the employment of manure. It will be found, however, that the markets are supplied with fruit from the very best soils and most genial climates, proving that food and shelter are primary requirements of fruit trees. The starving soils, equally with the stunted trees, may adorn with fruit the private table, but they are powerless to influence the markets, and at the very best are adapted only for toy fruit tree culture. Fruit trees of all kinds require deep nourishing soils, and, after they have borne a few good crops, should be periodically assisted with manure, for the production of fruit is an exhaustive process, and removes from the soil much of its precious alkalies and phosphates.

It unfortunately happens that, as a rule, the best soils for fruit-culture are in valleys and low bottoms, where, in consequence of the prevalence of atmospheric humidity, late spring frosts prove peculiarly destructive. Usually, a severe and prolonged winter benefits the orchard, by retarding its spring movements; but the frosts of April and May weaken the bloom, and destroy the incipient fruit, and hence the fortunes of the season mostly turn on the weather prevailing at this critical time. It follows that shelter is, in most cases, a *sine qua non*. Amongst the many experiments I have carried out, one series had for its object to determine if exposure might be made to supersede shelter, and trees of many kinds were planted where the keen east winds that prevail in spring could ravage them as it pleased. The failure was complete. During seven successive seasons not a single fruit was produced, and in three seasons out of the seven the trees were nearly killed by untimely frost, and, indeed, of about thirty trees so exposed in the spring of 1874, at least half-a-dozen were so crippled that they were no longer worth keeping, and were chopped up and converted into firewood. The bursts of warm spring weather that occur in February and March contribute as much to the damage of the orchard as the killing frosts that follow, for they force the trees into premature activity, and so render them the more susceptible of injury by subsequent cold. In a backward spring, trees exposed are as safe as those sheltered; but as we never know what is in store for us, I consider it a matter of the very first importance to provide shelter for fruit trees; and it is well to remember that a very slight shelter will often make the difference between an enormous crop and no crop at all.

The simplest mode of ensuring shelter for a large plantation, is to arrange the trees so that they shelter each other. There is no shelter so safe as that of trees; where there is a broad belt of wood to the north and east, an orchard is calculated to enhance its annual value in the ratio of, say, five heavy crops in seven years, in the place of one crop in the same period. Circumstances alter cases, and to lay down a rule for the shelter of fruit gardens is impossible. But it may be advisable to remark that walls and fences are as likely to be baneful as beneficial, for while an enclosed garden with substantial walls, twelve to twenty feet high, may have a climate of its own, and produce fruit enormously, yet, in a general way, walls promote destructive currents of air, and, if not wisely designed and well built, are directly destructive to fruit trees. In planting a bleak, open situation with fruit trees, the surest way of rendering them self-protective will be to plant the apples on the northern and eastern boundaries, the pears next, then the plums, and,

finally, give the cherries the very best aspect on the southern and western boundaries, corresponding with the apples on the north and east.

In respect of management, the plain truth must be told, that there is almost nothing to do. The modern fruit grower is like Naaman, he yearns to do some great thing, and as there is not a great thing to be done he invents a lot of little things, and accordingly takes up his trees as soon as they are large enough to be visible, in order to chop off their roots; and if they recover from this ill-usage he prunes back their branches, and if this does not kill them he pinches the young shoots, his object being to prevent healthy growth, to repress natural vigour, the fundamental hypothesis of the practice being founded on the idea that the smaller the tree the more mighty will be its product of fruit.

Why do we prune an apple tree and avoid pruning an oak, a beech, or a lime tree? They are all fruit trees in the most proper sense of the word; for, although we prefer apples to acorns, the pig has a preference the other way, and, in his estimation, the oak is probably the grandest of all fruit trees, and produces the more abundantly because it is never pruned at all. I beg you to consider the case of a young shoot on a tree; it is, we will say, a foot long, as thick as a lead pencil, and as brown as a nut. It has cost one whole year of frost and snow, and rain and sun, to produce that shoot, and your pruner has his sharp knife ready to cut it away, and, in so doing, waste a whole year of Nature's kindly work. The result of its removal is, that in its place rise three or four more shoots, and if you cut them away, three or four more shoots will spring from the base of each. Thus you go on warring against Nature, and the few fruits that you obtain in return for your trouble, are produced from the matured wood that you have not dared to touch, because you must stop somewhere, if you do not intend to whittle the tree away. Let us now suppose, that instead of pruning back the young shoot we began with, that you leave it alone, then there is a year's work saved to begin with. A certain number of buds on the young shoot are in the next summer developed into spurs, and if the shoot is again spared, these spurs in the next season produce fruit; and hence, in the plantation where the knife is never seen, we see the fruit hanging on the long boughs in imitation of ropes of onions, while in the garden where root pruning, and branch pruning, and summer pinching are systematically practised, the fruit appears in distant dots; and if the owner is delighted with the result, it is not to be questioned that his knowledge of the capabilities of fruit trees is extremely limited.

In this general denunciation of pruning as a ridiculous proceeding, I am speaking of well made trees that have been properly planted, with a view solely to the production of fruit. In the nursery the knife must be used, and in the fruit garden both knife and saw must sometimes be used, and in all cases where the *form* of the tree is a matter of primary importance, the knife and the thumb nail must be incessantly active. And at this point it occurs to me to remark that the various methods of pruning practised on the Continent have not in any marked degree obtained a settlement in this country, and there are two powerful impediments to the establishment here of what are especially known as French methods of pruning fruit trees. In the first place, our climate is unfavourable, because a tree several times pinched requires a long, bright, dry autumn to ripen its late-formed wood, and of that the Frenchman is fairly assured, while the Englishman is not. In the second place, the Frenchman delights in delicate manipulations, and the Englishman abhors them. It is a question of climate in part, and for the remaining part it is a moral question. It is absurd to abuse Englishmen because they are not Frenchmen, but, in the supposed interests of fruit-culture, this absurd thing has been attempted, and of course resulted in harmless laughter. We must take the race and the climate as we find them, and make the best of both in the fruit garden, if we are more anxious for fruit worth money than for trees wonderful in outlines and proportions that, in respect of fruit production, are worth nothing at all. I repeat, it is the tendency of every healthy tree to become beautiful and fruitful, but pruning destroys the beauty of the head, cuts away the fruit in embryo, and diverts the energies of the trees from the head to the feet, and so, instead of plenty of fruit we get a forest of suckers.

In a hasty summary of the work of many years, many things must be disposed of briefly that should be treated at a considerable length. Therefore, I must beg permission to close this paper with three short paragraphs, in each of which I will endeavour to furnish a forcible illustration of the principles I have thus far endeavoured to set forth.

In the autumn of 1869 I obtained, through the aid of my friend, Mr. Ware, of the Hale Farm Nurseries, Tottenham, a collection of fruit trees in accordance with instructions given to this effect—the sorts were to be the very best known, but the trees were to be the very worst that could be found. There is always a demand for handsome trees, and in every nursery quarter some are left at last that appear only fit for pea-sticks. These refuse trees were requisite to my purpose, but I stipulated for certain sorts for reasons that need not be explained. Mr. Ware sent me the ugliest lot he could find, and all I did for them was to plant them honestly on a clay soil capable of producing anything from a pineapple to a pyramid. These trees have never been touched with the knife and they are now, without a single exception, handsome, vigorous, and fruitful. Had they been systematically pruned we might have to wait some years yet to see fruit, but as a matter of fact, we were overwhelmed with the products of these trees last year, the fifth summer only from the planting. The collection comprises apples, pears, plums, and cherries, and about equal proportions of standard and dwarf trees, and in a few instances the difference between their original appearance and that which they now bear, is so great, that I find it hard to believe that nature has done so much where man has done so little.

Some fifteen years ago I noticed that a tree of Bishop's Thumb pear threw up a crowd of long rods from the centre, like a cluster of willow wands. Instead of cutting out a certain number as the orthodox pruner required, I tied pebbles and pieces of tile and brick to the long rods so as to weigh them down gently, and thus brought them

from a vertical to a horizontal position in order to promote the formation of fruit spurs. This very simple method succeeded perfectly, and the tree became in the third year from the commencement of this practice a perfect marvel of fruitfulness. This practice I have since followed, and have called it "pulley pruning." By suspending weights on the long rods of a vigorous tree we check the flow of the sap in the most gentle manner possible without inflicting a shock on the tree, and the re-result is that the long rods become fruitful their whole length, and the tree bearing "ropes" of fruit, is not only a beautiful object, but well able to pay its rent.

Finally, as to wall and espalier trained trees. In the making and managing of these the knife must be freely used, for a strictly artificial form is a matter of the very first necessity. But the operator should always aim at securing the required form with the least possible mutilation of the trees. The rule followed is to cut close and train with exactitude; but a better rule would be to cut the least possible, to train in the branches a proper distance apart, and leave a bristling of breastwood all over the tree. The more a tree can be allowed to grow, *ceteris paribus*, the better for the tree and its owner. In my home garden is an east wall, on which peach and nectarine trees are trained. When severe pruning and training are practised we get no fruit; when a bristling of breastwood is left we have a fine crop. The breastwood is the cheapest kind of shelter, for its existence is favourable to the health of the trees, and it produces a fringe of leaves that protects the incipient fruit from frost more effectually than any artificial covering could do; and with the help of a coping to arrest radiation, renders an east wall as safe for peaches as one facing west or south. The bursts of sunshiny weather that occur in February and March do more harm to wall trees than to trees in the open, for they promote premature growth, and thereby bring the trees into a condition to be the more seriously damaged by late frosts. It would be well if we could turn the wall round and screen the trees from the sun, that is to say, if we could give trees on a south wall a north aspect during February and March, for they would then be retarded, and, coming into flower somewhat late, would escape the most destructive of those visitations when "winter lingers in the lap of spring," which are so peculiarly characteristic of this climate. After much meditation on the desirability of turning the wall round, to keep the trees quiet until April, I at last hit upon a happy idea, in the invention of my Reversible fruit wall, which enables the cultivator to reverse the aspects of the trees by a simple operation. It consists of fixed posts, between which are lengths of wire, on which the trees are trained. The walls are of wood, made in lengths to suit the posts, and they are hung up on either side of the wires, so that a tree facing south now, may, in the course of five minutes, be made to face north, and a tree facing east be, as it were, turned round to a western aspect. The illustration represents a small peach garden on this plan, that was constructed some five years ago by Mr. John Overall, of 16, Shacklewell-lane, London. The posts are eight feet asunder and six feet high from the ground line. The top of each post has a deep square cleft to receive the cleats which are attached to the walls. These walls are in lengths of eight feet and six feet high, made of deal planks, tongued together. They are hung upon the posts by means of the cleats, and it is but a few minutes' work to lift one off and take it round and hang it on the posts it previously occupied, but facing in an opposite direction. The sizes may be varied to any extent, provided always that they are not too heavy for convenient handling by two strong men, and speaking generally, the larger they are the more useful will they prove, and any village carpenter can make them.

DISCUSSION.

Mr. William Paul had listened with the greatest pleasure to the paper, and agreed with nearly all that had been advanced. There were, however, one or two points which as a practical cultivator, he might mention not in opposition, but in addition. The miniature fruit garden was very little more than a plaything, but still it was a pretty plaything, and it had the great advantage of early production. There was an old saying, "Plant pears for your heirs," and with pears on a pear-stock or apples on a crab stock, there was no doubt you must wait a long time for fruit; but when grafted or budded on dwarf stocks, they might be planted in the spring, and the fruit gathered the same autumn; and if they were judiciously cultivated the crop would continue to increase from year to year. He had gathered a bushel, but more often half a bushel, or a peck of fruit from one of these dwarf trees. Again, the finer varieties of fruit thus cultivated were better suited to some soils than green growing trees. Some years ago, the late Captain Peplow told him that at his place in Herefordshire he could grow plenty of apples and pears but no cherries; he recommended him to try them on dwarf stocks, and he then found they bore very well. He quite agreed with what had been said about spring frosts, but the practical conclusion he drew was that orchards should be planted, when possible, on high ground. Mr. Hibberd's ground, like his own, lay in a low and damp situation, where spring frosts were more destructive than anywhere else. He had some thousands of pyramidal fruit trees planted in one piece of ground, and one year he found he had no fruit on them below a certain imaginary line, whilst another year he might have none above a certain line; this was explained by the fact that spring frosts were sometimes much more severe near the ground, and sometimes higher up, and on investigation he found that when there was no fruit below a certain line the frost had been most severe near the ground. With regard to wall fruit, he had been perpetually annoyed by a total loss of crop when the trees had been covered with bloom, and the plan he had adopted was to grow them under glass, but in houses with wooden sides; on placing a thermometer in a house of this construction, and in one with the ordinary glass sides, he had found a difference of 8°, which was quite sufficient to make all the difference between having fruit and having none. No artificial heat was used. There was also the advantage that being under glass the trees were kept free from rain or dew, and thus, if a slight frost did occur it had not so much effect upon them. This plan was of course only suited for private purposes, not for raising fruit on a large scale, but he believed it would not be more expensive than Mr. Hibberd's system of moveable walls. The quality of fruit depended on climate and soil; that grown in a dry warm soil had the best flavour, whilst a damp rich soil gave the largest produce. In conclusion he would repeat that orchards should, when possible, be planted in an elevated situation, such as on hill sides.

Mr. Earley said he had found that where the grass in orchards was constantly fed off or kept mown, the blossom came much later, and consequently the fruit was more certain; he did not know whether others had noticed the same thing. He thought young trees should be moderately pruned, but when they had attained some age they might be let grow freely. His opinion was that every branchlet in a tree acted as a sort of filter, by means of which the sap became more subtle, and was thus better adapted to produce fine fruit than when it ascended without any break through a perpendicular branch.

Mr. Botly, after alluding to the national importance of a good fruit supply, mentioned a plan which he had known to succeed for discouraging the early spring growth, which often proved so detrimental. This was to draw the nails of nectarines and peaches a few weeks before they bloomed, the consequence of which was that the tree came out a few inches from the wall, and the blooming was retarded accordingly, and thus a crop was almost always secured. Some few years ago he had the pleasure of going over a large fruit garden, of about 17 acres, near Reading, which he was informed by the owner had been in 1851 a wheat field, and had never had any manure upon it since except the leaves which fell from the trees. These were of all kinds—apples, pears, plums, &c., and there was a vine there larger than the well-known one at Hampton Court. The trees were planted very thickly, and were very little pruned, but they bore very abundantly, the produce one year being of the value of £4,000.

Mr. Smartt said it had often occurred to him that fruit trees might very usefully be planted along hedgerows throughout the country, whereby the production would be very much increased, and this would tend to improve the health of the population, and prevent the necessity of importing fruit from abroad. He had been accustomed to a garden all his life, though only as an amateur, and had tried some methods which might appear peculiar. Having obtained some fruit trees of fine quality, he planted them so deep that the graft was below the surface, and then by banking up the earth around them he was able to bend down the branches, so that they struck root, and thus he obtained several trees from each. He also thought young seedlings might be more rapidly brought to bear, by transplanting them into pots. With regard to the frost cutting off the blossom, he suggested that as various sorts blossomed at different times, it might be advisable to graft several varieties on one stock, so that there would always be a chance of one or more escaping the frost every year, and producing a crop, and at the same time being but a partial crop, the tree would not be so much exhausted, whilst occasionally, if they all escaped, the produce would be very large. He had always been accustomed to prune pretty freely, but his friends told him his crops were enormous, and he had certainly had as many as seventeen apples on a branch not a foot in length. His gooseberries he had kept so much dwarfed that the ends of the branches grew into the ground, where they took root, and by cutting off a number of shoots which grew up around the roots, the nourishment was thrown into the parent stem; and thus he obtained such fine fruit, that he was awarded four prizes for them, though he had not grown them for competition. It was often supposed that mulberries did not bear for a few years after being planted, but he had a tree which bore the first year, and had continued to do so ever since.

Mr. Cannon wished, to some extent, to defend the use of the pruning knife from the attacks which Mr. Hibberd had made upon it. Some trees grew naturally into pyramidal shape, which was now so fashionable, but others were very ugly growers, and required careful and judicious pruning to bring them into shape, and even when formed, there were occasionally strong growths, shooting out, which had to be removed. Dwarfing stocks were very useful for amateurs who had but a limited space at command, but who, nevertheless, desired a greater variety than they could obtain if they had only one or two free growing trees. This gave them a greater interest in their gardens, and much pleasant occupation. At the same time, there was no doubt that the dwarfing system was often carried too far. The system of "double working" had lately been introduced for the purpose of growing varieties which did not adhere well to the stock, but would graft well on to another kind, which itself would grow well on the quince. By this means a greater variety of fruit was obtained, and the further development of this system would, no doubt, yield useful results, though it was not adapted to growing fruit for market purposes.

The Chairman then moved a vote of thanks to Mr. Hibberd for the vigorous and interesting manner in which he had brought forward his views. The vote having been carried unanimously,

Mr. Hibberd, after acknowledging the compliment, explained more fully the method of double grafting. A pear was grafted on to a quince stock, was then cut off, and another pear grafted upon it, so that the tree consisted of three parts instead of two; the Prince Albert pear was generally the most useful for the first graft. He knew there was a great temptation to prune trees which were ugly growers, but it was astonishing how much they improved if they were left alone. He called to mind a fine old Swan's Egg pear tree, as high as the room, growing opposite his bedroom window, which if narrowly inspected, with an artist's eye, was certainly ugly, but taking it as a whole, in the midst of the garden where there were trees of different forms, it was quite acceptable, and so was the fruit which grew upon it. He had been much interested by Mr. Paul's example of the line of frost, but the lesson he drew was, that trees should be allowed to grow tall, because it was not once in a hundred years that the frost would touch the top only, although it might the bottom. Experiments had been made to ascertain the relative temperature on the surface of the grass and a few feet above it; and it frequently happened that ten feet above the ground there was no frost at all, when there were 5° of frost on the grass. In fact, if you could only grow potatoes ten feet above ground he did not believe they would ever be injured. If, therefore, the trees were allowed to grow up there would generally be a crop at the top, and that was always where the finest fruit were found. He would conclude with one observation. Those who smoked and drank generally disliked fruit; whilst, on the other hand, the eating of fruit created a distaste for alcoholic liquors; and he defied any man who was a real fruit eater to take to drink. He was satisfied that the more consumption of fruit was promoted the more you would promote the sobriety of the people; not that every apple contained a temperance society ready made, or a number of good resolutions, but whilst farinaceous and vegetable food generally was antagonistic to the use of alcoholic liquors, the use of fruit was still more so, because it brought the palate into that delicate condition that strong drink was distasteful.

SPECIAL LECTURES.

The fifth of the series of lectures on "Unhealthy Trades" was delivered by Dr. Richardson, F.R.S. (appointed by the Council to make special inquiry into the subject), on Friday evening, January 28th, as follows:—

Lecture V.

I propose in the present lecture to resume the thread of our discourses from the point where we left off at the close of lecture four. This was, at class II. of

our table, viz., at injuries from exposure of the body to chemical agents, soluble or suspended in solution.

So far, we have studied under this head the injurious effects produced by lead. There are several other substances that call for notice.

Bi-chromate of Potassa.

In the latter part of last century, viz., in 1797, the distinguished chemist, Vauquelin, discovered the mineral substance to which he gave the name of "chrome," from the Greek *chroma*, colour. The salts of the metal have the property of communicating colours of a beautiful kind to many varied substances.

Vauquelin first obtained chrome from the red lead of Siberia. He took 100 parts of this mineral reduced to fine powder, mixed them with 300 parts of saturated carbonate of potash, and 4,000 parts of water. He exposed this mixture for an hour to a boiling heat, and observed that when the matters began to act upon each other there was first a brisk effervescence, and afterwards a change of colour from the orange colour of the red to a brilliant red. This led him to believe that with the lead ore there was combined another metallic substance, and by careful analysis and synthesis he succeeded in proving the point. The name of chrome, he says, was suggested to him by the chemists, Fourcroy and Hauy, because all the combinations of the substance are more or less coloured. He suggested that perhaps chrome might afford beautiful and durable colours to the painter and the enameller; he adds, I have found the oxide of this metal in the emerald, which receives from it its colouring part.

The anticipations of Vauquelin respecting his discovery have been fully realised; numerous applications of the salts of chrome have been made in the arts. These salts have been used specially as pigments, and for some years past, bi-chromate of potassa has been employed as a solution for the galvanic jar. The persistent bi-chromate battery is now in general use in the laboratories of the world. The substance known as chromic acid, the oxide of the metal, has also been used in many chemical scientific processes.

Since Vauquelin's time the metal chrome has been discovered to be in combination with ironstone, and the name chrome ironstone is given to a mineral found in Sweden, the Shetland Islands, and America; and this mineral is, in fact, now the chief source of chrome. For the market, it is produced in large quantities in the form of bi-chromate of potassa, the red crystalline salt with which, I dare say, you are all familiar.

Various manufactories of bi-chromate of potassa exist in different parts of the world; in England, France, America, and Germany. The manufacture is important to our present studies from the circumstance that a peculiar form of disease arises during the process. The first observer who took a note on the disease in question, was a French physician, Dr. Bécourt. By an accident, Bécourt met with a man who was engaged in a manufactory of bi-chromate of potassa, and who was suffering from a peculiar kind of ulceration in the face. The case was studied by Bécourt in consultation with the distinguished hygienist, Chevalier, and they both came to the conclusion that the manufacture of the bi-chromate was probably the cause of the disease. They failed to obtain from the man, however, any such particulars as they could consider satisfactory: they therefore looked in other directions for more knowledge.

After a time they obtained from the director of a manufactory at Graville the information that many of the workers in the manufactory were subject to a peculiar form of disease.

In transforming a neutral chromate of potassa, by means of the acid, into bi-chromate, the vapour arising carries with it an infinity of pulverised molecules of the product which spread through the workshop. A cloud of particles is easily visible in a ray of sunlight. The particles inspired abundantly, give to the palate a bitter and disagreeable taste; but as saliva is profusely produced, the chromate is thrown off and has not time to inflict injury.

If instead of breathing by the mouth, which for long periods of time seems impossible, the particles are drawn in by the nose, great irritation of the delicate membrane lining the nose is produced, there is a violent sensation of pricking, suffusion of tears, and irresistible sneezing. There follows upon this ulceration of the septum of the nose—the partition that divides the two nostrils—and ultimately the septum is destroyed altogether and lost. Upon this the symptoms cease and the workmen, as a rule, continue steadily at their employment without further suffering.

Chevalier and Bécourt are of opinion that this process of ulceration of the nose is not produced in those men who take snuff.

From the inquiries I have made respecting the manufacture of the bi-chromate in this country, I learn that this peculiar ulceration is of very rare occurrence, and of late years, owing to improvement in manufacture, has not been observed at all. The accidents that are met with are certain ones which arise from contact of the bi-chromate with wounds of the skin.

The two French physicians, to whom I have already referred, noticed the same fact. They determined that if the skin of the body be entire, it may be exposed to a strong and even to a heated solution of the bi-chromate, or that it may remain for many hours in contact with the salt itself without any bad effect. But if the skin be torn, or abraded, or cut, and the salt be left in contact with the wound, the caustic action is so intense that severe inflammation follows with decomposition of the living tissue. The caustic action is so great it does not cease until it has penetrated to a bone. The pain of the ulceration is excessively severe. It has also been observed that when a large surface of the skin is exposed to this irritation, a peculiar irritability of the skin, and a violent itching is set up. This is unattended by ulceration if the skin be not abraded by rubbing, then a troublesome and very painful ulceration occurs.

M. Clouet, a manufacturer of bi-chromate of potassa at Havre, has added to the above facts others which are of importance in their bearing on this subject. He shows that the inferior animals suffer from the effects of the bi-chromate as severely as man. Horses employed in the manufactory, and which walk over the bi-chromate salt, are attacked in the feet; the hoof falls off, and the ulceration extends to the upper part of the leg. In one instance of this kind, recorded by Chevalier and Bécourt, a horse was attacked in one of its hind feet, and was quite disabled. The master of the animal, not suspecting the cause, knew nothing of the treatment, so merely sent the horse to rest. The ulceration extended through the limbs, and through nearly half the body of the animal, and death occurred within a month of the commencement of the malady. Both legs on the affected side were entirely ulcerated. It was as though when the decomposition had commenced it went on indefinitely as a veritable metamorphosis of the skin and flesh altogether, analogous to a fermentative action. Dogs and cats, and rats were discovered in the manufactory suffering in a similar manner.

Bi-chromate of potassa taken internally by the mouth is a purgative, and in large doses of from 15 to 20 grains is poisonous. It causes severe colic and purging, but no vomiting. M. Clouet, to whom we are so much indebted for information on this subject, and who first made observations respecting the internal action of the bi-chromate, states that in one manufactory some workmen inflicted the foolish and practical joke of putting some bi-chromate of potassa into a barrel of cider, from which other fellow workmen drank. The cider was rendered of a dark colour, but notwithstanding the workmen drank of it, and were all affected with severe colic and diarrhœa.

CYANIDE OF POTASSIUM.

Serious symptoms are sometimes produced by the absorption of cyanide of potassium in those who are engaged at work where solutions of this substance are employed. The danger affects specially those who are engaged in photography. It seems to me to arise by direct absorption of the poison by the skin, but only when the skin is wounded, abraded, or chapped. My attention was first called to this subject by a photographer, who consulted me for a series of symptoms with which I was not familiar, and which could not be accounted for by any evidence leading to the suspicion of organic nervous disease. The symptoms came on only when he was at his work, but they lasted for some hours after he had left his work. I suspected they might be due to the inhaling of the vapours which are present in the working room of the photographer; but this theory was excluded by the fact that he had worked many years in the same place without being affected in the same way, and that none of the workmen who were with him in the same room were similarly affected.

These circumstances led me to look out for local absorption, and I found on inquiry that the hands of the man were severely chapped, and that they were so on every occasion when the phenomena recurred; for the phenomena were repeated many times before their cause was discovered. We were now on the right track, and by his giving up that part of the employment which involved exposure of his chapped hands to the solution, the patient experienced a quick cessation of his symptoms, and recovery from them without their recurrence.

The symptoms are exceedingly characteristic; they begin with vertigo. A sense of giddiness is gradually developed, with a sensation as if all objects were passing in a circle, and then as if the body of the affected himself were turning round. At times there is a further sensation of falling, as though, of necessity, the body must pitch forward, and as if the lower limbs were unable to support the weight of the body. These symptoms may last for some hours, and if they are not exceedingly severe they will subside when the work of the day is over, and will not recur until the resumption of labour on the following day. They may be entirely misunderstood, and indeed often are misunderstood. They are attributed to biliousness, or to indigestion, in their lighter manifestations. When they become more severe another symptom is added, the giddiness or vertigo is attended with nausea and faintness, so that it is impossible to go on with the work. But even from this more extreme condition, recovery is rapid after exposure to the cause ceases.

Under still further exposure the body becomes cold, and an extreme shivering takes place, which is succeeded by a prostration that altogether incapacitates from work, and is connected with a series of new nervous phenomena of great moment. The first of these nervous signs is double vision; the patient, that is to say, in looking at a single object sees it as if it were two objects, or as if both eyes were separately discerning the one thing. Finally, there are muscular tremors which are altogether beyond the control of the will. The tremors do not amount to spasms of the muscles, but they are sufficiently active to cause involuntary movements of the limbs, and they are attended with occasional starts and twitchings. The temperature of the body is lowered, and the appetite is greatly reduced: the secretions are confined, the face pale, the action of the heart quick, weak, and irregular, and the sense of exhaustion urgent. The mind throughout is unaffected, but there is perhaps an unnatural tendency to sleep.

The poison being soluble finds its way out of the system with moderate rapidity, and thereupon all the severer symptoms are removed, but some remain for several weeks. The strength returns but slowly; dyspepsia continues as a very troublesome symptom; anæmia is a marked condition, and the blood, which has been rendered very fluid, escapes too freely from wounded surfaces.

Some examples of poisoning by the local absorption of cyanide of potassium have been recorded, in which symptoms still more alarming than any I have seen have followed upon the accident. One remarkable case of this kind is given by Dr. Davanne. A gentleman who had stained his hand with nitrate of silver, endeavoured to remove the stain by rubbing it very freely with cyanide of potassium. In this process he slid under the nail of one of his fingers a small portion of the cyanide salt. At first he did not notice what had happened, but in a little time he felt a severe pain in the part, which, after a few minutes, was followed by an intense vertigo, so that all objects appeared to be moving around him. To relieve himself promptly he conceived the idea of washing the part freely with vinegar. The vertigo now increased, was accompanied by shiverings, extreme pallor, complete loss of sight, and entire prostration; even the power of speech was lost, but the intelligence was throughout preserved. The limbs were very cold, and as the sight returned, the phenomena of double vision were manifested. These alarming symptoms were not altogether removed within a period of ten hours, but perfect recovery ultimately took place.

Davanne assumes that in this instance the symptoms were intensified by the application of the vinegar. He believes that by the use of the vinegar the cyanide salt was decomposed; that hydrocyanic acid was thereby directly produced, and that on the absorption of this poison, the symptoms were so actively developed. It is worthy of remark, however, that the symptoms appeared before the acid was applied, and might, therefore, have been due to the direct absorption of the salt. The changes which the salt undergoes in the presence of the animal secretions, and in its course through the body, have not as yet been discovered. It is known, however, that the iodide of potassium salt is decomposed within the body, and the probabilities are strong that the cyanide is also decomposed, and that the symptoms are due either to cyanogen, or, as Davanne supposes, to hydrocyanic acid.

While on this topic I may with advantage offer a word of precaution respecting a practice which is commonly adopted by gentlemen who are engaged in photographic pursuits, and which had better be avoided. It is customary for the photographer, when his hands are deeply stained with nitrate of silver, to clean them of the stain by using cyanide of potassium. The process effectually removes the stain, but it is always attended with some risk, and when there are any sores or wounds on the hand, the risk becomes actually dangerous. It is best, therefore, to use some other potassium salt than the cyanide, for the purpose named.

SALTS OF CADMIUM.

In the year 1817, Strohmeyer discovered the meta known as cadmium in oxide of zinc, and it has since been obtained from calamine and other compounds of zinc. It exists as a native compound, as the sulphide in what is called Greenochite in Renfrewshire, and some of the compounds of it, the green sub-oxide especially, and the sulphide or cadmium yellow, are used in the arts as pigments. Some of the salts of cadmium have been applied to medicinal purposes, and are found to have an emetic action, but their use is comparatively limited.

I refer to these salts because one of them, the white carbonate, is said to be used in the form of a fine powder for the purpose of cleaning or burnishing plate, and from the absorption of this powder symptoms of a very serious character have occurred. Dr. Sovet published the first account of these phenomena. He records three cases of accident from the use of cadmium in the manner described. The symptoms, he says, which were observed were brought on from the absorption of the powder used in cleaning plate, and on inquiry it was found that car-

bonate of cadmium was the only metallic salt that entered into the composition of the powder.

The symptoms from which those who were affected suffered were well marked, and were of a choleraic character. They consisted of giddiness, followed by difficulty of breathing, and afterwards by vomiting and diarrhœa. There was great exhaustion, and severe cramps in the legs. Recovery took place in every case.

Crude Paraffin.

Within the last two years a new form of local disease has been discovered, which is due to the action on the skin of crude paraffin. We are indebted to Dr. Alexander Ogston for the first observations that have been made on this eruptive disorder. The workmen engaged in this manufacture have the skin of the hands and other portions of their bodies, and also of their feet and legs, brought daily, for many honrs at a time, into contact with the paraffin shale and with the oily matters mixed up with it.

The result of this proceeding, Dr. Ogston tells us, in a report to the *Edinburgh Medical and Surgical Journal* for 1872, is "an eruption of nodules and pimples on the skin so exposed, speedily breaking out on those who are for the first time engaged in the work, lasting for a few weeks or months, and then generally diminishing or disappearing. In a few exceptional individuals the eruption does not disappear, but assuming a chronic character, produces so marked and prolonged an affection of the skin, that the general health becomes impaired, and the cessation of the employment becomes a necessity."

Two distinct classes of symptoms characterise this disease, one acute, the other chronic. In the acute form the parts of the skin exposed to the crude paraffin are covered with a rash of bright red nodules which lie close together, and are largest and most numerous on the wrists, and where the dress fits tightly. The palms of the hands and the soles of the feet enjoy complete immunity, but what is called the dorsal aspect of the hands and feet, that is, the back of the hands and the upper surface of the feet, are severely affected. Similar nodules arise though to a lesser extent on the face, neck, and other parts of the body to which the oily matters find access. The size of each bright-red nodule in the acute form of the disease is about equal to a grain of barley; it is hard to the touch, tender on pressure, and rounded in form. Dr. Ogston discovers that each nodule consists of a single hair follicle with the parts immediately surrounding it; the whole in a state of active inflammation.

Physiologically we divide a hair into two parts; the shaft and the bulb. The bulb is lodged in the follicle; it is sometimes called the root of the hair. It lies below the true skin, dipping into the cellular tissue beneath, and surrounded by fat cells. At the lower part of each follicle in which the bulb is embraced is a formative substance, from which the hair derives its nourishment. If the hair is coloured, the pigment charges the cells at this point.

The inflammation then which is induced in the workers in crude paraffin begins in the hair follicle which is the centre of enlargement. The hair, says Dr. Ogston, emerges from the very summit of the nodule, and the orifice of the hair follicle is much enlarged and easily visible to the naked eye as an aperture of a magnitude similar to that of a pinhole in a card. The dilatation extends to the deeper part of the follicle which forms the kernel of the inflamed knot. The nodule shows little tendency to suppurate: on the contrary, the redness and hardness after a time diminish and disappear, leaving the hair follicle enlarged and its mouth gaping, so as to show retained masses of epithelial scale, rendered more distinct by retention and accumulation of dirt. In fact, the acute form of the eruption consists of successive crops of these nodules.

"In all paraffin workers," Dr. Ogston remarks, "openness and enlargement of the hair follicles continue to some extent, so long as they are engaged in this manufacture, and the black dots on the skin of their hands and face strike the eye of the observer at once. Men with dark complexions and strong hair are specially deformed in this way, while those of fair complexions and of light or reddish hair escape comparatively unaffected. A few exceptional individuals with swarthy complexions and hairy skins suffer so much that they are compelled to quit their occupation and seek a more suitable calling.

"The chronic form of the disease exhibits the following characteristics. The backs of the feet and toes, the backs of the hands and the backs of the fingers, between but not over the joints, present a honeycombed appearance of the skin. The skin is elevated, thickened, and inclastic, so as to prevent and render difficult and painful the flexion of the fingers and hand. The raised honeycombed patches are of natural colour, and are not inflamed, but consist of deeply grouped arrays of hair follicles with a hard deep skin between and around them, the follicles packed with dry, brittle accumulations of epithelial scales, so extensive as to be easily visible through the follicle, the latter being large enough to admit the extremity of an ordinary probe. The hairs themselves have disappeared from these patches, having probably become atrophic from the pressure of the epidermic masses, while cracks and bleeding fissures traverse the indurated parts, and in rare instances a follicular abscess gives variety to the picture. The knuckles of the fingers and toes, the palms of the hands, and the soles of the feet, remain unaffected by the disease."

When the malady produced in this simple but singular manner becomes confirmed, the general health of the sufferer is greatly affected, the complexion becomes pale, the skin becomes loaded, and the body wastes. The constant irritation and pain of the skin produce sleepless nights, and the general disorder is then declared.

Dr. Ogston accounts for the production of the disease in a very clear and satisfactory way. "The oily matters in the shale called *blae oil*, when separated, are both penetrating and irritating to the skin; coming continually in contact with the epidermis, they soak into the hair follicles, where they create an irritation soon leading to hardening and increased shedding of epithelial scales. This shedding of the scales is not counterbalanced by increased expulsion, owing doubtless to the large quantities cast off, and to the natural fatty and lubricating substances being dissolved out and removed by the blae oil. Thus the brittle epidermic masses or scales plug the follicles and increase the irritation. Parts of the kind supplied with sweat glands and no hair follicles—palms of the hands, soles of the foot, and knuckles of the fingers and toes escape the irritation. After a time the hairs and the most exposed parts waste and fall out, but the retention of the epithelial masses keeps up the process in the follicles and the hardening of the surrounding skin."

The observations that have been made on the paraffin disease by Dr. Ogston, and which have been so ably described by him, are new in the history of industrial pathology. He has carried out his researches at the chemical works of the Messrs. Miller at Aberdeen, and he has been so good as to post to me two photographs showing the condition of the hands of the affected during the chronic stage of the malady. The photographs are on the table for those who would like to see them after lecture. They are perfect delineations of the disease. They show how entirely the knuckles of the hand escape, and how exclusively the disease is confined to the parts of the skin that are covered with hair. Each of the dark raised points is an open follicle.

Soot.

In some way connected, and perhaps closely connected, with the action of crude paraffin on the skin, is the action

of soot on the same surface of the body. In the old times, when the chimneysweeper swept the chimneys with his little human machines—sweep boys and youths—and before the cleaner, though still uncleanly, habits of the sweep as they now are, were introduced, there was excited on the body of the worker in soot a peculiar and even fatal disease, which got the name of soot cancer. The disease was produced by the local action of the soot on the skin, and in extreme instances it was so severe that death occurred from it. The disease in these cases commences as an induration or hardening produced by the contact of the soot with the skin in parts where the skin is enfolded. This is followed by ulceration, and the ulcer is so difficult to heal, and so often extends, involving more tissue, that it partakes, as I have said, of the character of a malignant ulcer or cancer. I have myself seen but one true example of this disease, and I learn that now it is rarely known amongst those who work in soot. The workmen are candid enough to admit that by attention to cleanliness, even in a moderate degree, they escape from irritation. To be merely begrimed with soot does not suffice to produce actual ulceration; it is necessary for the soot to remain on the body for some time in accumulated quantity for it to produce mischief. Then it causes abrasion and soreness, and upon that the ulceration follows.

There is an impression amongst the workers in soot that the quality of the soot makes a marked difference in the effects of it as an irritant to the skin. Soot derived from the burning of wood is believed to be more injurious than coal soot, and soot from swiftly-burning and slatey coal is held to be more injurious than that from good, solid, slow-burning coal that leaves little ash.

Scheele's Green, or Arsenite of Copper.

Arsenite of copper, or Scheele's green, is extensively used as a pigment for colouring paper hangings, for various kinds of ornamental papers, as writing paper and cards, for various ornaments connected with the dresses of ladies, artificial flowers, candles, and even, at one time, confectionery.

Some years ago a girl named Matilda Scheurer died from phthisis pulmonalis, excited, as it was believed, by the absorption of arsenic dust to which she was exposed in making artificial flowers. Her death created a profound sensation, and led to many inquiries relating to the process of absorption of arsenic when it is brought into contact with the body. It was believed at first that the injury that was inflicted was caused entirely by the inhalation of dust, but Dr. Hassall, to whom science is so much indebted for his varied and laborious inquiries on sanitary subjects, dispelled this view, and in a paper published in the *Lancet*, February 21st, 1863, showed that the local action of the poison on the skin is directly injurious. The green powder diffused through the workroom settles on the head, face, neck, and hands. The hands, Dr. Hassall stated, become stained of a green colour which no washing will remove. At length ugly looking sores appear on various parts of the body, including all the exposed parts; there is constant soreness of and running from the eyes; the chest and throat are sore; there is cough; and, finally, the irritation extending from the throat along the alimentary canal, there is irritation and pain of the stomach, absorption of the poison, diarrhœa, and all the symptoms of acute arsenical disease.

Dr. Hassall pointed out, further, that ball dresses coloured with this same pigment were a source of danger to the wearers of the dresses as well as to the manufacturers of them; and to him, again, we are indebted for the discovery that sugar confectionery was tinted with this poison. At one time, he tells us, bushels of sugar confectionery coloured with arsenite of copper might be purchased in London in the course of the day. After the revelations of the fact in the report on adulteration of foods, in the *Lancet*, this sale of poisoned food has considerably diminished. The time has come when perhaps it will be as well to look it up again.

I collected a considerable number of cases of disease induced by the absorption of arsenic. They were chiefly among artificial flower makers, a class which has certainly suffered most from this cause, and which, I fear, still suffers. My experience is to the effect that the danger is most frequently developed through the lungs, the arsenical substance being apparently absorbed by the mucous surface. The more serious disease to which the workers are subjected is commonly called consumption, but it is not a consumption of the ordinary kind. although it is attended with wasting and sometimes ends fatally. It is attended with that remission of fever and flush of the face to which the name of hectic is commonly applied, but it is rarely attended with spitting of blood, and often proceeds for a long time without any cough, except the throat cough which springs from irritation at the back of the throat. There is also, as Dr. Hassall describes, irritation of the membrane of the nose and of the eyes, neither of which symptoms are necessarily connected with consumption. In the end the sufferer, if she be removed from the work in time, makes a fair recovery, which she would not do if she were attacked with true tubercular consumption.

There are some other signs which the physician may discover by an examination of the chest with the stethescope, and which indicate a different form of disease in the lungs themselves from that which is known as tubercular disease. I should be entering into details of diagnosis, that would be out of place here, if I were to follow this point further; but, generally, it deserves this brief notice.

Lastly, I infer from what I have seen, that when symptoms of real danger arise from the local absorption of an arsenical colouring compound, they are connected with injury inflicted on other organs than the lungs. The digestive organs, the activity of which is impaired from the first, suffer from the persistent irritation, and serious organic changes, amounting even to ulceration, ensue.

I have now brought forward the chief injuries which arise from the exposure of the body to chemical substances, soluble or in a state of solution, and I might pass directly to the third head on our table of injuries, viz., to injuries induced by purely mechanical causes.

I recall, however, that there remains for me only sufficient time for the completion of this lecture and for the delivery of the final lecture of the course next week. To enter upon a new series of subjects at this late stage would be to open a chapter which could not possibly be finished. I propose, therefore, as the most practical course, to cease descriptions of details at the point we have now reached, and to fill the time remaining at our disposal, firstly, by summarising the facts we have gleaned, and by looking at them so as to gain an idea of their relative importance; and secondly, by considering what methods may with advantage be adopted by legislation, by education, or by the application of science, to bring under control at least some of those injurious and fatal injuries with which we have already become conversant.

Summary of Leading Facts.

In order to carry out the object stated, I have constructed a table, which shows at a glance the field over which we have so far travelled.

I have put down on this table the diseases which spring directly from industrial labour in the thirty-six industrial occupations which have been referred to. The table is divided into three columns. The diseases are classified on the first column according to the system of organs of the body that are primarily the seats of the disease. In the second column the special diseases of each system of organs are noted in detail. In the third column the occupations are recorded in connection with the special diseases, and with the class under which the special diseases rank.

It will be profitable, from this survey, to gather one or two practical lessons. The first of these lessons may

DISEASES INDUCED BY INDUSTRIAL LABOUR IN THIRTY-SIX OCCUPATIONS.

PARTS OF BODY.	DISEASES.	OCCUPATION.
Diseases affecting the Chest.	Phthisis pulmonalis or pulmonary consumption. Bronchial phthisis. Bronchitis. Emphysema. Asthma. Spasmodic flax-asthma. Chest spasm. Bronchial irritation.	Potter. Millstone and stone cutter. Pearl cutter. Sand-paper maker. Needle and knife grinder. Hemp and flax dresser and spinner. Rag worker. Miller and flour worker. Wood and ivory turner and carver. Cigar and tobacco manufacturer. Walking-stick maker. Hairdresser. Brush maker. Fellowship porter. Burnisher. Paper-stainer and artificial flower maker. Miner. Trimming maker.
Diseases affecting the Heart and Blood.	Palpitation and irregular action of the heart. Intermittent action of the heart. Cyanosis. Extreme fluidity of blood. Anæmia.	Cigar maker. Lace frame-worker. Bleacher. Hat maker. Fur dyer. Aniline dye manufacturer.
Diseases affecting the Glands.	Irritation of salivary glands & salivation. Nephrosis: chronic inflammation of kidney.	Worker in mercury. " " lead.
Diseases affecting the Stomach and Digestive Organs.	Dyspepsia. Gastro-enteric irritation. Nausea and vomiting. Pyrosis (water brash). Choleraic diarrhœa. Colic. Constipation.	Cigar maker. Lace frame-worker. Potter. Painter and lead worker. Fur dyer. Bronze founder. Paper-stainer. Tinman and brazier.
Diseases affecting the Skin.	Ulceration and exfoliation. Follicular inflammation. Soot ulcer.	Aniline dye maker. Worker in mercury. " " bichromate of potassa. " " arsenic. " " crude paraffin. " " soot.
Diseases affecting the Bones and Teeth.	Osteitis—inflammation of surface of bone. Necrosis. Caries of the teeth.	Pearl worker. Fur dyer. Worker in mercury. " " phosphorus.
Diseases affecting the Brain and Nervous System.	Vertigo. Cerebral exhaustion and paralysis. " congestion. Apoplectic coma. Neuralgia. Mercurial rheumatism and neuralgia. Dementia.	Potter. Painter and lead worker. Aniline dye maker. Chemical manufacturer. Worker in bisulphide of carbon. " " mercury. Brazier. Fur packer.
Diseases affecting the Muscular System.	Paralysis. Mercurial tremors. Cramp. Spasm. Atrophy.	Potter. Painter and lead worker. Fur packer. Cigar maker. Worker in mercury. " " bisulphide of carbon. Bronze founder.
Diseases affecting the Organs of Sense.	Ophthalmia. Double vision Impairment of vision—amaurosis. Deafness.	Cigar maker. Vine dresser. Worker in bisulphide of carbon. " " cyanide of potassium—photographer.

relate to the relative importance of the different diseases with which we have become conversant, and which have their origin purely in and from industrial pursuits.

The diseases affecting the chest are all serious, the degree of their importance being somewhat after the manner in which they are placed in the table. True, *phthisis pulmonalis*, or consumption of the lungs, when it is once induced, by or through any occupation, and whether it be or be not marked by hereditary taint, is a fatal disease. It is quickened in development, and it is rendered more rapid in its course by hereditary proclivity; but when it takes hold it destroys life. The modern improvements in medical science have done much towards ameliorating the sufferings incident to this disease, and very much towards discovering the conditions which are favourable or are unfavourable to its development. Moreover, a great deal has been learned of late years of the mode of detecting physically the earliest symptoms of the malady, and something has been acquired that is useful towards meeting the earliest symptoms, and effecting a partial removal of them. Here we stop in our progress. From a knowledge of the disease, extending now over thirty years, and including for fourteen years the most extensive observation of it in public practice, from an experience gathered during the observation of not fewer than from ten to eleven thousand examples of the malady in all its varied phases, industrial and general, I have gathered nothing that I dare honestly call a successful method of treatment, and which I dare honour by the name of a cure for the disease, when once it has been established. In respect to fatality, we may take phthisis pulmonalis as the malady of maladies of the industrial community of this country.

There is not a single occupation on our list that does not favour the production of phthisis. Thirteen out of the list may be called direct producers of it, and this list represents a part only of the industrial callings which lead to the same result.

The disease called *bronchial phthisis* is next in degree of importance. It differs from phthisis proper, in that the vesicular structure of the lungs is not necessarily involved, and in the fact that tubercle is absent. In this disease the lung does not necessarily go on to destruction from the presence of a persistent foreign irritant, therefore, it happens that some who suffer severely from it recover. In its worst forms, the general symptoms by which it is marked are identical with those of phthisis, and although it does not always kill it often kills. It frequently passes for true phthisis, and the assumed recoveries from presumed phthisis are, as a rule, examples of this disease, bronchial phthisis.

Bronchitis, occurring in the chronic form as it does in the industrial variety of it, is a disabling, without being of necessity a fatal disease. It becomes permanently disabling when it is combined with *emphysema*. Then it is commonly called by the name of *asthma*, in which stage it is relievable, but not curable. It is remarkable for what number of years men will continue at their industrial work while afflicted with this bronchial malady, and some who are engaged in atmospheres of dusts express an opinion that they suffer less from the dust when they are permanently affected with a free and loose cough. In fact the profuse secretion protects the bronchial membrane from irritation. Nevertheless, the majority of industrials who suffer from chronic bronchitis and asthma die in consequence of the disease long before they have attained their natural span of life. They are exceedingly susceptible to vicissitudes of heat and cold, and suffer readily from congestion of the lungs when there is a marked and sudden fall of temperature. Their power for oxidising the blood is limited, and to a large extent, therefore, their vital force is reduced. From this cause, in a secondary way, their digestion suffers; they digest and assimilate food imperfectly, and they are troubled with flatulency, which in turn affects the heart, making its action irregular. They fail quickly under any unusual exertion, and the blue lip and panting breath tell how effectively they are disabled.

If we were to take the whole of the industrial classes at all ages, and were to select from them those who are suffering from some form of disease induced by the occupation, we should find this combination of bronchitis with emphysema, and with or without asthma, by far the most prevailing malady. In occupations where dusts are freely evolved, we should probably be unable to find a single worker of a few years' standing entirely free from such disease.

The peculiar spasmodic affection which is due to inhalation of particles of dust or hemp, and the chest spasm arising from inhaling dust of tobacco, and the simple bronchial irritation arising from first exposures to foreign particles, are temporary conditions of disease, which though severe, need not be fatal.

The diseases affecting the *heart* and *blood*, which have up to this time come before us, as arising from industrial pursuits, are a limited class, which I regret to to say would be seriously extended if we were to carry out researches further along our table of classified injuries. Not one of the five diseased conditions of the heart and blood given in the table need be considered an organic disease. The *palpitation and irregular action* of the heart, and the *intermittent action* also, are nervous derangements of the organ, not diseases of its structure. When they are maintained, however, for long periods of time, the nervous impression which creates them becomes fixed, or at best is easily called forth, so that they remain all but permanent symptoms. When they are present they give rise to an irritable, irresolute, timid condition of the mind, and to an indecision and weakness which are attributed sometimes to idleness, at other times to cowardice. For when the heart which supplies the brain regularly with blood hesitates in its beat, the supply of force which illumines the mental chamber is interrupted. When we are working by gaslight, and the gas flickers, we say the pressure is irregular at the main, and that the illumination, therefore, is imperfect. It is the same when the blood flickers in the brain; the pressure is imperfect from the heart, and the mental light is irregular. The irregularity causes feebleness, and that, in turn, engenders irresolution and fear.

This is the physiological interpretation of a vast deal of that feeble restlessness, quick impulse, unsustained effort, timid exaggeration, and querulous discontent, which, under unfavourable surroundings, so often characterise the manner and behaviour of industrial populations. The members of them are not in danger from structural disease of the heart, but they are deficient in that steadiness of heart stroke and recoil which is essential in order to keep the body and the mind in perfect harmony and healthy tension.

The three diseased conditions of the blood are not of necessity permanent. The *cyanosis* or darkened condition of blood is, in respect to its industrial cause, traceable to one industry alone, the manufacture of the aniline dyes. It is a temporary condition, is the result we may say of accident from sudden exposure to the aniline vapour, and, if recovery from the accident occur, it leaves no permanent mischief in its train.

The two conditions marked as extreme *fluidity* of blood and *anæmia*, though they are both recoverable conditions, are often long sustained. The last one, anæmia, is indeed too often, practically, a permanent condition. It means a thin and enfeebled state of blood in which the combining properties of the blood for oxygen are reduced; in which the constituent parts of blood intended for nutritive purposes; and in which, if I may be allowed such an expression, the sparkle of fully living blood is wanting. This state of the circulating fluid is very general through our industrial community, especially through the female and child part of it, and though it is far from being directly of fatal import, it is indirectly a source of weakness and deterioration. It is fed specially

by many industries, as we have seen in passing from one industrial pursuit to another. It is sustained by many other agencies; by living in an impure atmosphere, by subsisting on unwholesome foods and drinks, such as unlimited tea with bread and butter, and by badly cooked and deficient animal and vegetable supplies of varied kinds. Altogether it is a condition of disease that is incompatible with the claims for efficient manual labour, for increasing intelligence, for production of an advancing race, or for the maintenance of integrity of physical development.

The two diseases affecting the *glandular system*, referred to in our table of occupation and disease, are very different in respect to their importance. The irritation of the salivary glands produced by mercury is a disease extremely painful, and sometimes even dangerous, owing to the extreme inflammation and swelling which occurs. But taken by itself it is temporary in its nature, and leaves as its worst effects a local destructive action on the teeth, and other bony structures which lie in the neighbourhood of the salivary glands, and which with them are involved in the inflammation.

The disease nephrosis, a slow and permanent, structural, sub-inflammatory degeneration of the membranous structure of the kidney, induced by lead, is of fatal import. When this disease is fully established, the excreting organ by which most soluble poisonous matters are eliminated from the body, loses its functional activity, and then there accumulates in the system at large the poisonous agent, which attacks with unflinching severity other vital organs, and so induces a series of structural degenerations that render impossible, first the vital action of individual systems of the organic mechanism, and ultimately the life of the whole organism.

The diseases affecting the *stomach and digestive* organs may all be considered as functional rather than organic maladies; they are therefore recoverable for a long time, and they can none of them be considered strictly fatal in the same sense as phthisis pulmonalis is considered.

One of these diseases, colic, is sometimes fatal in its acute form, but the occurrence is rare. Another of them, gastro-enteric irritation, might be fatal in the same acute manner, but I am myself unable to recall or to find any instance of the kind, and this observation extends also to the choleraic diarrhœa resulting from industrial labour.

The diseases of this class are nevertheless painful and exhausting, and widely extended. In all the occupations we have studied some of these diseases are found amongst the operatives, although they are most common among that list of operatives I have specially described in the third column under this head. Necessarily any one of these conditions of disease, when it is present, exerts a secondary as well as primary effect. It interferes, I mean, with the proper function of the digestive system; it prevents the perfect digestion and assimilation of food, and thus all parts of the body suffer, in turn, from the primary derangement. The old fable of the belly and the members remains as perfect, physiologically and philosophically, as it did when Æsop wrote it, and no physiologist and no physician has surpassed the fable writer in point of scientific illustration.

The diseases affecting the *skin*, which we have introduced into the table, are all disabling diseases, and acutely painful. From the ulceration and exfoliation recovery is slow, and the destruction of parts, before the cure takes place, is extensive and deep, so that recovery is followed by marks and scars, which are indelible, and it may be disfiguring.

The new disease of follicular inflammation is so severe, that in some instances the worker is unable to pursue the occupation that gives rise to it, and it again leaves behind it disfiguration.

The soot ulcer is a formidable disease, and, from what we learn of it in our older authorities, it may be a fatal malady. Happily it is a malady now becoming extinct.

The diseases affecting the *bones and teeth* are, as a rule, confined to the local bounds in which they originate. The osteitis connected with pearl workers appears to be temporary in its duration, presuming, of course, that the worker be removed from the origin of the danger.

The caries of the teeth induced by vapour of nitric acid, by sulphate of iron, or by other corrosive, is confined to the local mischief it inflicts. The necrosis of bone, typically represented in the phosphorus necrosis of the lower jaw, is a more formidable and sometimes a fatal disease, from the exhaustion produced by it. In its mildest forms it is a most painful and loathsome disease. Happily, again, this malady has, I trust, seen its last days. It will remain a singular chapter in the history of extinct diseases.

All the diseases affecting the *brain and nervous system*, and named in our list, are of serious character; for, although some of them, like vertigo and neuralgia, are but passing phenomena, as it would seem even they, probably, never occur without causing some remote impression or injury which is reflected with permanent effect upon other organs, and it may be upon other organisms.

The severer diseases affecting the brain and nervous system, the paralysis which occurs from lead, the cerebral exhaustion and dementia induced by bi-sulphide of carbon, and some other hardly less typical forms of organic nervous change, induced by the industrial labours we have had before us, are, in the present state of our knowledge, one and all fatal maladies. They reduce the body of the sufferer to the most abject helplessness, and they become the roots of progressive physical mischiefs, which extend more certainly than any other into future generations.

The diseases affecting the *muscular system* are closely allied to those which affect the brain and nervous organism. In fact, the nervous supply to muscle and the response of muscle to nervous stimulus are so intimately allied, it is all but impossible to take one into consideration without the other. The muscular paralysis induced by lead may be due entirely to the withdrawal of the nervous stimulus from the muscle. The mercurial tremors are probably dependant upon an intermittent nervous supply to the muscular fibre, and the sharp spasm of muscle and cramp are almost certainly due to a sudden charge from the nervous system, a quick stimulation to which the muscle responds in the same way as it responds to the stimulus of an external prick or irritant. Primarily, I should say the muscular disturbance is developed in nearly all cases through the nervous excitability, so that the unnatural motion of the muscle, or the unnatural failure of it, is but functional in character and for a long time temporary.

After a time, however, the muscle deprived of its stimulus or receiving an improper supply becomes itself organically changed. In the worst cases of lead paralysis I have seen the addition of the galvanic stimulus fail to call forth muscular contraction. The muscle lies practically dead, and then follows that atrophy or wasting which I have noted in the table. The heart itself undergoes this wasting process.

The disease affecting the *organs of sense*, and which appear in the last division of the table of disease and occupation, may be considered, when they are derived from the causes I have named, as temporary in their nature. The ophthalmia is an inflammation dependent upon an external irritant; it disappears when the irritant has been withdrawn. The double vision, produced as we have seen by the action of a preparation containing cyanogen, arises from a nervous disturbance created by the poison, and having its centre probably in the cerebellum or smaller brain. It is in itself merely a symptom, and passes away as the action of the poison ceases.

The impairment in the sense of vision, and the impairment in the sense of hearing which sometime attends the impairment of sight, are both nervous phenomena created in the case of the industrial diseases, which we studied, by the action of the poisonous agent,

nicotine, derived from tobacco. These impairments of the senses, temporary at first, and functional, become, after a time, of greater importance, and occasionally the impairment of vision is so pronounced that the disease amaurosis is established. A process of wasting commences in the retina, that nervous expanse on which the pictures are focussed by the eyeball on their way to the brain. The wasting destroys the power of the retina, either to receive or to send on the impressions that are conveyed to it, and impaired or destroyed vision is the result.

Such, in brief, are the facts relating to the diseases incidental to the industrial pursuits we have followed. I have one remark more to make upon them bearing on their relationship to the general diseases of the community. It is that they introduce into the general list of diseases at least four new diseases which are distinct of themselves, and which, as far as we know, have no precise counterpart in the maladies that occur from purely natural causes. The agents at work in this new production are, specially, bi-chromate of potassa, cyanogen, paraffin, and last, but most importantly, bi-sulphide of carbon. The facts open up a new study for those of us who are employed investigating the courses of disease from their external origins.

In my next and concluding lecture I shall treat on the means of prevention of the industrial diseases that have been before us, with special reference to those diseases that are produced by the inhalation of dust.

MISCELLANEOUS.

BRUSSELS INTERNATIONAL EXHIBITION.

This exhibition, the general scheme and classification of which were given in the Society's *Journal* of the 5th of November last, page 1007, and of which a meeting of the British executive committee was held in the Society's Rooms on the 19th ult., is stated to be finding deserved support from all parts of the world.

In Germany the Prince Imperial gives the undertaking his active support, and the Johanniter Order, which had the entire management of the arrangements in aid of the sick and wounded in the late war, is lending all the assistance in its power. In Austria the Teutonic Order and the Knights of Malta exhibit a deep interest in the subject. In Russia the Ministers of State are members of the committee, and the Imperial Government has taken upon itself all the expenses of Russian exhibitors. In France the governmental departments, and the authorities of the city of Paris are lending aid. Committees have also been formed in Italy, Holland, and other countries. It is hoped, therefore, that the inventions and applications which have been made on the Continent for the saving of life and improvement of the sanitary condition of the people under all circumstances, and in face of dangers of all kinds, ordinary and extraordinary, will be fully illustrated.

In some instances, such as those of life-boats, rocket apparatus, and fire engines, England has long held a prominent place amongst philanthropic inventors and benefactors, and it is expected that she will be well represented. Since the notice which has been already referred to, one important change has been made in the plan of the exhibition, and some moot points definitely settled.

Originally it was intended that each class of articles included in the programme of the exhibition should form a distinct section, but a unanimous wish was expressed by nearly all contributing countries that each should exhibit its contributions *en masse;* this wish has been acceded to, and consequently there will be a distinct British department, as at former exhibitions, an arrangement which will certainly be preferable to most exhibitors.

With respect to the British Section and the medals and other awards, it should be understood that nothing will be admitted from England but through the London committee, and that each exhibitor will receive a commemorative medal, with a diploma; prize medals will afterwards be awarded by international juries. In most countries the beneficent object of the exhibition has been recognised, the heirs to the throne or other exalted personages having accepted the presidencies of the respective committees. H.R.H. the Prince of Wales is the honorary president, and H.R.H. the Duke of Cambridge the honorary vice-president of the London committee; Lord Alfred Churchill, chairman of the Council of the Society of Arts, has been elected chairman to the executive committee. The Belgian executive is presided over by Lieutenant-General Renard, aide-de-camp to the King of the Belgians, and President of the Société des Sauveteurs de Belgique. The exhibition is under the special patronage of His Majesty the King of the Belgians, and the Honorary Presidency of His Majesty's brother, the Comte de Flandre.

The Royal Humane Society, the Royal Life-boat Institution, and other philanthropic bodies, are expected to require considerable space, and a considerable number of individual exhibitors have already applied for space.

Amongst the classes in the programme, the committee is specially anxious to see as large a collection as possible of apparatus, and other means and systems of preventing accidents on railways, roads, rivers, &c., and also in mines and quarries, but the programme of the exhibition includes everything connected with the saving or the preservation of life, whether in the public ways, in factories, workshops, fields, or private houses.

One important element at the exhibition will be the trials of machinery and apparatus, which will take place at Brussels, Antwerp, or Ostend, as may be most suitable in each case.

Lastly, the exhibition forms but a portion of the programme, and is supplemented by a congress, at which the merits of the various systems, apparatus, and other means will be discussed, and the results of which will be printed in the least expensive form, and widely disseminated. The exhibition is announced to open on the 15th of June. Societies, manufacturers, and others who desire to exhibit, are requested to make immediate application for space at the London offices of the Exhibition, 3, Castle-street, Holborn.

NOTICES.

SUBSCRIPTIONS.

The Christmas subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

February 16.—"The Combustion of Gas, and its application to Heating Purposes," by John Wallace, Esq.

February 23.—"Contagious Diseases of Animals as affecting the Health and Wealth of the Country," by George Fleming, Esq., Royal Engineers.

March 1.—"Aquarium Construction and Management," by W. Saville-Kent, Esq., F.L.S., F.Z.S.
March 8.—"Hall Marking of Jewellery," by Alfred Lutschaunig, Esq.
March 15.—"A New Bridge for Providing for the Traffic across the Thames below London Bridge," by Frederic Barnett, Esq.
March 22.—"Railway Couplings," by F. A. Brocklebank, Esq.
March 29.—"Model Dwellings for the Rich," by T. Roger Smith, Esq., and W. H. White, Esq.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

February 15.—"Ostrich Farming and the Ostrich Feather Trade of South Africa." By P. L. Simmonds, Esq., F.S.S.
March 14.—"The Diamond Fields of South Africa, and their Influence on the Native Races of the Neighbourhood." By J. B. Currey, Esq.
March 28.—"The Industries of South Africa." By T. B. Granville, Esq.
April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.
May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following papers will be read:—

February 18.—"The Commercial Aspects of the Suez Canal," by Charles Magniac, Esq. M. E. Grant Duff, Esq., M.P., will preside.
March 3.—"The Land Revenues of India," by Major-General Marriott, C.S.I.
March 24.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.
April 21.—"The Sanitary Progress of India," by Captain Douglas Galton, C.B.
May 5.—"On the Effects of the Depreciation in the Value of Silver, with especial reference to India," by Ernest Seyd, Esq.
May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

Tickets for the meetings of the Indian Section are sent out with this *Journal*.

Chemical Section.

Friday evenings at 8 o'clock. The following papers will be read:—

February 11.—"Sole-Leather Tanning, with some Remarks on the the Import of Hides and Cattle." By Sparke Evans, Esq., of Bristol. J. G. Hepburn, Esq., will preside.
February 25.—"Some Recent Metallurgical Processes." By J. Arthur Phillips, Esq. C. W. Siemens, Esq., D.C.L., F.R.S., will preside.
March 10.—"The Manufacture of Citric and Tartaric Acids." By Robert Warington, Esq., F.C.S.
March 17.—"The Preparation of Dextrine-Maltose (malt-sugar), and its Use for Brewing and other Purposes." By W. Valentin, Esq., F.C.S.
March 31.—"The Methods of Estimating the Illuminating Power and Purity of Coal Gas." By A. Vernon Harcourt, Esq., M.A., F.R.S.

April 28.—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.
May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Widnes.

Cantor Lectures.

Monday evenings at 8 o'clock. The Second Course, "On Iron and Steel Manufacture," by W. Mattieu Williams, Esq.

Lecture V.—February 14th.

The Manufacture of Steel.

What is steel? Steel making directly from the ore.—The indirect or Sheffield method of making steel, and why it has been adopted.—Sheer steel and pot steel.—The Bessemer process.—The Siemens Martin process.—Popular fallacies concerning steel.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Mattieu Williams, "Iron and Steel Manufacture" (Lecture VI.)
Royal Geographical, Burlington-gardens, W., 8½ p.m. "Diary of the late Mr. Margary; from Hankow to Fa-li fu."
British Architects, 9, Conduit-street, W., 8 p.m.
Medical, 11, Chandos-street, W., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Bentley, "Unfermented Beverages." (Lecture II.)

Tues. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. P. L. Simmonds, "Ostrich Farming and the Ostrich Feather Trade of South Africa."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. H. Garrod, "Classification of Vertebrated Animals." (Lecture V.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. William Sugg, "Estimating the Illuminating Power of Coal Gas." 2. Mr. Wilfred Airy, "The Probable Errors of Levelling."
Statistical, Somerset House-terrace, W.C., 7¾ p.m. 1. Sir Charles Dilke, Bt., M.P., "The Municipal Government of Paris." 2. Dr. F. J. Mouat, "International Prison Statistics."
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.
Royal Colonial, 15, Strand, W.C., 8 p.m. Adjourned Discussion on General Bisset's Paper, "South Africa and her Colonies."

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. John Wallace, "The Combustion of Gas, and its Application to Heating Purposes."
Meteorological, 25, Great George-street, S.W., 7 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.

Thurs...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m.
London Institution, Finsbury-circus, E.C., 7 p.m.
Chemical, Burlington House, W., 8 p.m. Dr. Frankland, "Some Points in the Analysis of Potable Water."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. John Saddler, "The Art of Engraving."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. J. H. Gladstone, "Chemistry of the Non-metallic Elements." (Lecture V.)
Zoological, 11, Hanover-square, W., 4 p.m.
Numismatic, 13, Gate-street, W.C., 7 p.m.
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. Magniac, "The Suez Canal."
Royal United Service Insitution, Whitehall-yard, 3 p.m., Mr. T. Brassey, "How Best to Keep Up and Improve the Seamen of the Country."
Royal Institution, Albemarle-street, W., 8 p.m. Mr. C. Wm. Siemens, "The Action of Light on Selenium."
Geological, Burlington House, W., 1 p.m. Annual Meeting.
Philological, University College, W.C., 8 p.m.

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. T. Thiselton Dyer, "The Vegetable Kingdom." (Lecture II.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,213. Vol. XXIV.

FRIDAY, FEBRUARY 18, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

SUBSCRIPTION FOR THE FAMILY OF THE LATE S. T. DAVENPORT.

The following subscriptions have been promised, amounting, with sums previously acknowledged (£1,465 5s.), to £1,583 6s. 6d.

It is requested that members will accept this notice as an acknowledgment of their subscriptions:—

	£	s.	d.
W. A. Adams	5	5	0
H. F. Austin	1	0	0
Edward Bax	2	2	0
Andrew Bell	1	1	0
D. W. Bell	1	1	0
Thomas Brassey, M.P.	10	0	0
William Brookes	3	3	0
Vincent Brooks	3	3	0
Frank Chance, M.D.	2	2	0
B. F. Cobb	2	2	0
John Corbett, M.P.	3	3	0
Arthur W. Ellis	1	1	0
Joseph Firbank	1	1	0
"A Friend" (Oxford)	1	1	0
George Godwin, F.R.S.	2	2	0
A. Gordon	5	5	0
Sir John E. Harington, Bart.	1	1	0
Finch Hill	2	2	0
Edward Holden	2	2	0
Hunt and Roskell	2	2	0
J. F. Iselin	1	1	0
John Knowles	10	10	0
A. McDonnell	1	0	0
Robert Manuel	1	1	0
Peter Martin	3	3	0
D. K. Mason	5	0	0
H. H. Massey	2	2	0
Philip Cunliffe Owen, C.B.	3	3	0
C. J. Peirce	1	1	0
Spencer A. Perceval	2	2	0
Joseph Piltar		10	6
R. Prosser		10	0
Leopold Seligman	2	2	0
James Solly	5	0	0
Archibald Templeton	3	3	0
Silas Tucker	1	1	0
George Turner	10	10	0
Burton H. Vallé	1	1	0
Sir Joseph Whitworth, Bart.	10	0	0
C. J. Womersley	1	1	0
H. W. Woolcott	1	1	0

NATIONAL TRAINING SCHOOL FOR MUSIC.

The Corporation of the City of London have voted the establishment of ten scholarships; Messrs. N. M. de Rothschild & Sons have contributed ten scholarships; the Lord Mayor of London has also contributed a scholarship. The Lord Mayor has summoned a public meeting for Wednesday next, the 23rd inst., at the Mansion-house, to promote the establishment of additional scholarships. H.R.H. the Duke of Edinburgh has consented to take the chair.

EXAMINATION IN DOMESTIC ECONOMY.

The following correspondence on this subject has passed between the Education Department and the Secretary of the Society. It serves to show that the advance made by the Society in this direction is not without appreciation on the part of the Department:—

[Copy.]

Society of Arts, 24th Dec., 1875.

Sir,—I have the honour to send enclosed copies of a Programme of certain Examinations intended to be held by this Society on Domestic Economy, and I am directed to ask if the Lords of the Committee of Council on Education would, on consideration of the importance of these subjects, be disposed to recognise them for encouragement in Classes held in the Evening, in like manner as the other subjects of Science and Art are assisted by grants administered by the Science and Art Department.

I am further directed to point out for the consideration of their Lordships, that the study of the subjects under the head of Domestic Economy, already encouraged by the revised code for girls, would, in the opinion of the Council of this Society, be greatly promoted, if these subjects could be separated, and a grant given to each, and I am to express the earnest hope of the Council that their Lordships will be pleased to give this matter their favourable consideration.—I have the honour to be, Sir, your obedient servant,

(Signed) P. Le Neve Foster, *Secretary.*

To Sir Francis Sandford, C.B., Secretary,
Committee of Council on Education.

[Copy.]

Education Department, Whitehall, S.W.,
7th Feb., 1876.

Sir,—Adverting to your letter of the 24th December, I am directed to state that my Lords have had under consideration the application of your Society with respect to the encouragement of the study of Domestic Economy.

Their Lordships will be glad to hear the results of the experiment which is being made by the Society in this matter, but they are not able at present to give effect to the proposal which you have submitted to them.—I have the honour to be, Sir, your obedient servant,

(Signed) P. Cumin.

To P. Le Neve Foster, Esq.,
Secretary to the Society for the Encouragement of Arts, Manufactures, and Commerce.

INSTITUTIONS.

The following Institution has been received into Union since the last announcement:—

Saltaire Club and Institute, Saltaire, Yorkshire.

HEALTH AND SEWAGE OF TOWNS.

The first meeting of this Committee was held on Friday, the 11th inst. Present—Lord Alfred Churchill (in the chair); R. B. Austin; John G. Barry; M. Blakiston; R. Brewer, Richmond, Surrey; Sir Henry Cole, K.C.B.; F. R. Conder, C.E., Guildford; F. W. Cowan, Horsham; Captain Douglas Galton, C.B., F.R.S.; R. Grantham, C.E.; T. Rowley Hill, M.P., Worcester; C. Higgins; J. C. Mellis, Kenilworth; P. O. Papillon, Mayor of Colchester; W. Shelford, C.E.; Dr. Sutton, Oldham; Seymour Teulon; Charles Tucker, Mayor of Bridport; E. C. Tufnell; Joseph Whitley, Leeds.

Resolutions to the following effect were passed:—

1. "That the 9th of May be the date for the Conference, commencing each day at eleven o'clock, and that the proceedings be continued from day to day so long as may be found needful. Each speaker to be allowed ten minutes."

2. "That the object of the Conference is to obtain and discuss existing information of the results of the various 'systems adopted' and the 'collection of facts.'"

3. "That the introduction and discussion of any schemes which have not been in use in 1875, be not permitted, consequently new projects cannot be discussed."

4. "That the obstacles to sanitation form one of the objects of the Conference."

5. "That information be collected as extensively as possible."

6. "That Town Clerks be requested to furnish a copy of the last reports on the sewage of their towns, and that Medical Officers of Health be applied to for information with a paper of questions to be answered, giving the particulars needed."

7. "That the system of Water-carried sewage and that of Dry sewage be discussed separately."

It was further resolved to appoint an Executive Committee to manage the details of the Conference, such Committee to consist of Lord Alfred Churchill; Mr. F. A. Abel, F.R.S.; Sir Henry Cole, K.C.B.; Colonel Du Cane, R.E., C.B.; and Captain Douglas Galton, C.B.

The Executive Committee met on Wednesday, the 16th inst. Present—Lord A. Churchill, Mr. Abel, Sir H. Cole, and Captain Galton.

CHEMICAL SECTION.

The first meeting of this Section for the present Session was held on Friday, February 11th, Mr. J. G. Hepburn in the chair.

The paper read was—

SOLE-LEATHER TANNING, WITH SOME REMARKS ON THE IMPORT OF HIDES AND CATTLE.

By Sparke Evans, of Bristol.

Previous to the commencement of the present century, the manufacture of leather in England presented no features of particular interest. The tanners for ages drew their own supply of hides from their own city and a few neighbouring towns, whilst the woods and hedgerows in their own vicinity afforded them an abundance of tanning material. The leather thus made was of excellent quality, but the process of tanning was a long one, probably from one to two years, or even longer being required for a hide of ordinary thickness. But in those days the hurry of business was unknown. The tradesman was fond of leaning over the half-hatched door to gossip with his neighbour. The master lived on the premises and strolled from his yard out into his garden or orchard, and the ruddy fruit from the overhanging boughs of the trees dropped at times into his pits.

The trade was then fettered by Excise laws, and under heavy penalties no hide could be taken from a pit as tanned leather without twenty-four hours' notice. On a particular occasion an obnoxious Excise officer, who had the misfortune to fall into a tan-pit, was told that he could not be helped out as the customary notice had not been given.

The duty was taken off about 50 years since, and to the surprise of all who expected cheaper leather the price at once rose. This was of course owing to the increased demand which immediately set in, many buyers having held back from purchasing in expectation that the remission of the duty would lower the price.

The trade hailed the remission of the leather tax with rejoicing; at Uxbridge the obnoxious Exciseman was buried in effigy, but whilst the convivial tanners were rejoicing, some wags unearthed their old enemy and placed him against the door of their supper room, and knocking at the door, the clay-stained effigy was once more amongst his enemies.

With the growth of commerce came a continually increasing demand for leather, which, according to McCullock, ranks third in importance among our manufactures, precedence being allowed only to iron and wool. The demand for both bark and hides thus exceeding the supply, the competition became so keen amongst the trade, that the more thoughtful men endeavoured to supply their wants from foreign countries, so that South American hides and Turkish valonea came into early use, and are now extensively employed in the manufacture of sole leather.

Bristol was one of the first to adopt an important change, namely, in the shape of the manufactured article. Hitherto the hide had been tanned, as indeed it is throughout the Continent of Europe to day, in one piece, that is, with the thick and thin parts unseparated; the effect of which is that the thin part is too much tanned and the thick part too little. Our ancestors in their wisdom failed to perceive that, whilst often twelve weeks are long enough for the thinner part of the hide, it requires twelve months to do justice to the thicker portion. Bristol, therefore, from its use of South American hides and the system of rounding, became specially known for its "Butts" or thick leather.

It needs little experience to find that the hides of well-bred oxen are thin, just as racehorses have thin skins; whilst cattle exposed to all weathers in a semi-wild state, as in the Scotch Highlands, and still more notably as they roam in vast herds over the South American Pampas, produce thick hides. The further south of the Equator the thicker are the hides. Thus Buenos Ayres ox hides rank first in quality.

Homer evidently was not aware that the hides of oxen are thicker in the best part than those of bulls, and furnish leather of a superior quality,

as in almost every mention of a shield* he represents it as having been made of "tough bull's hide."

The first hides sent from South America to Europe were shipped from Brazil to Castile in 1580. Now, the valley through which the River Plate and its tributaries run supplies Europe from its stock. This, in horned cattle, has been estimated to be from 11,000,000 to 15,000,000 head, and in 1872 an export number of, dry and salted, 3,121,758, was reached. It is, however, very doubtful if this number will be exceeded. The hides also are of lighter average, the increased demand having induced the Saladeristas to kill younger cattle.

The annual export of salted hides from South America may be estimated at 2,100,000. Of these three quarters of a million are imported into England.

The herds from which these animals are drawn roam almost at will over boundless pampas. They are recognised by certain marks on the side, the young cattle being branded with a hot iron for the purpose of establishing ownership. This brand unfits the part so marked for ordinary use, and often causes considerable loss.

THE BRAND.

It renders the leather made from it brittle, whilst, unfortunately, the mark, to be conspicuous and easily recognised by the horseman in his chase after the cattle, is placed near the hip, on the best part of the hide; and as brands are added with each change of ownership, hides are, at times, marked with 5, or even 7 brands. Thus in 100 hides tried last year we found 2 without brand; 57 with 1 brand; 14 with 2 brands; 17 with 3 brands; 5 with 4 brands; 4 with 5 brands; and 1 with 7 brands. Averaging the loss to be equal to 1s. each brand, and two brands on each hide, this will be a loss of £300,000 yearly, assuming that 3,000,000 cattle are annually killed. Probably half a-million of money is thus wasted annually.

An Estancieros wishing to avoid this waste branded his cattle on the horn; but an unscrupulous neighbour knocked off the horns, placed his brand on the hide, and claimed the cattle.

About January the cattle are collected and driven to an enclosure, where they are rapidly slaughtered by means of a knife expertly thrust into the back of the neck near the horns, severing the spinal cord. Two men then take off the hide in less than five minutes. Formerly there was a great waste of the meat, bones, hoofs, horns, and hair. All are now preserved and exported, while the hide is carefully pickled and cased, or put in piles for some days, and, when shipped, salt is strewn between each layer of hides. If properly cured there is no risk of heating on the passage home, or of other damage to the cargo in an ordinary passage. But, unfortunately, in men's haste to be rich, the process has recently been much shortened, and in order, it is asserted, to preserve the hides from heating, the captains have been instructed to open the hatches occasionally during the voyage, and pour on the hides a mixture of salt and water. Captains have no objection to this, as they are paid for the cargo by the weight they land; and the merchant finds that the salt, which costs him but little, and water nothing, adds considerably to the weight of the hide. When landed, this sells at, say, 8½d. per lb., a good price for brine, which at times continues to run from the hides months after landing. We have known instances of the mixture being thrown down the hatches when the vessels have arrived at the Azores. In another case this was done at the mouth of the River Avon; and one captain, fancying, probably, he was addressed by the merchant instead of the buyer, replied, "Oh, yes: I gave the hides a good pickling the last time off the coast." For the honour of Englishmen, it is hoped that this disreputable practice will soon cease. This obnoxious clause in the charter party is omitted by our largest Bristol importers.

Recently it has been found that captains have not confined their libations to brine made with fresh water, but have used sea water, the effect of which is to make the hides dark in colour; an additional reason why, if anything be needed, salt only should be applied during the passage.

Hides landed at Antwerp are swept to free them from salt, which, owing to the vexatious revenue laws of Belgium, is thrown into the river to avoid the duty. In England the hides are shaken, and a tare allowed to compensate for salt, &c.

Whilst the foreign hide is deteriorated by the brand, it is superior to the English hide in thickness, is better flayed, and does not suffer from the bot grub to which English cattle are liable. This grub, or bot, lodged underneath the skin of young cattle, is the larvæ of the *Oestrus bovis*, or gad fly, which in sultry weather, during the latter part of June, and throughout July and August, sails buzzing about, inspiring the cattle with intense terror, causing them to gallop madly hither and thither, and eventually deposits its eggs in the skin, generally about the back and loins of the animal. Healthy, thriving beasts are instinctively preferred by the gad fly, as they are more likely to afford sustenance to their progeny. Throughout the autumn and winter the eggs steadily mature, and produce a certain amount of irritation. As the larva grows, it causes the familiar swelling or tumour, in which it lies with its head downwards until towards May-day; its pressure gradually thins and bursts the skin, when the grub escapes, conceals itself in the grass or amongst the litter, and remains five or six weeks in the chrysalis condition, from which it emerges a perfect fly, the constant terror of the cattle, and a source of endless trouble to the herdsman. The only cure appears to be keeping the cattle in the shade when the fly is most troublesome.

The number of English hides tanned in the United Kingdom may be best estimated by the stock slaughtered annually, which, according to the agricultural statistics, would give 2,350,000 ox and cow hides. A very remarkable contrast

* A small circular shield studded with brass nails was shown, copied from some in Drummond Castle, which appear to have been used for the last time in British warfare in the rising of 1745.

At the battle of Culloden the well-known tactics of the Highlanders of furiously rushing on the enemy with sword and shield were skilfully met by the English; orders having been previously given to the troops that each soldier was to thrust with his bayonet at the Highlander nearest his left hand, who by this unexpected movemeot had exposed his side to the thrust of the deadly weapon. It is not pleasant to think of that dreadful day when the bayonet was thus beot and bloody in the strife.

There was also a thick shield from the hippopotamus hide, which was four years in process of tanning; and a thinner shield from the walrus.

occurred in the prices of these hides in the years 1856-57:—

Remarkable Contrast in Price of Hides, the two corresponding periods of Christmas 1856 *and Christmas* 1857.

	£	s.
The two weeks ending 26th December, 1856 (sold 625)	1,281	14
The two weeks ending 26th December, 1857 (sold 531)	664	17

Average per hide of 1856	41s.
„ „ 1856	25s.
Decrease per hide	16s.
Being 40 per cent.	

The first process of the tannery is to free the hides from salt, and subject them to the action of lime for the purpose of separating the hair.

Various new modes of unhairing are being constantly introduced to the notice of the trade. The most recent, and one of the best, appears to be that of Messrs. Conyers and Pullens, who have taken out a patent for suspending the hides in a lime pit. They say three cwt. of lime, if used on their plan, the hides being plunged three times a day, will unhair one hundred hides in two days, a small additional quantity of lime being added the second day. On the Continent many hides are unhaired by subjecting them to heat, whilst in America dry hides are unhaired by the cool sweating process. The right to a patent is, however, disputed.

Throughout France, Germany, and on the Continent generally, and formerly in England, in many yards the hides were allowed to remain in pile, covered up with tan or horse manure, until the heat generated was sufficient to allow the hair to be scraped off. The American plan is a decided improvement; a vault is constructed underground, or covered with earth, the dry untanned hides are suspended in it, and a small stream of water in warm weather, and steam in cold, is allowed to fall from the roof to the floor at the corners of the house; the mist or vapour caused by the falling water and settling on the extended hides gradually causes the hair to slip, and with very much less waste of gelatine than occurs from the old-fashioned heating process, or the present use of lime.

It is said, however, that this plan is not so well adapted for salted as for dry hides. But it is supposed to have the great advantage of producing a far better result in the weight of the hide when tanned.

Mr. Jackson Schultz, who is now writing a series of valuable and interesting articles on tanning in the American *Shoe and Leather Reporter*, February, 1876, holds that warm water should be used to extract all lime from the pelt previous to the commencement of tanning,

Dr. Turnbull, of Ivybridge, used sugar for the same purpose.

There is an undoubted waste of gelatine by the use of lime, therefore sulphide of sodium, charcoal, and other chemical agents have recently been tried in our city, but as yet without permanent success. British tanners are all proverbially slow to move away from the old tracks, as from the length of the process, mistakes often take months to rectify, and a man grows old while watching the effects of a few experiments.

All agree, however, that before the pelt is taken from the lime yard to the tan house all lime should, if possible, be removed. This may be done in a variety of ways. That generally adopted in this country is by suspending the hides in clear water. At Pont Audemer (an old Norman town, fresh with the odour of newly spent tan) one may see the hides fastened by stakes and floating like huge fishes in mid-stream. At Bordeaux the hides are put into a large tub pierced with several holes, and made to revolve for forty minutes, ten minutes with and ten minutes without water, alternately. But the English tanners, generally, are content to allow the weak, sour liquors of the tan yard to cleanse any remaining lime.

In America a weak solution of sulphuric acid is occasionally employed for this purpose, as well as for raising and thickening the pelt, an operation generally considered injurious to the leather. In the process of tanning a great variety of modes have been tried for saving hand labour. The late Mr. Cox, of Edinburgh, suspended his butts to a continually revolving, but not wholly submerged, wheel, the butts as they came to the top falling headlong on the other side; but, as he abandoned tanning, it is probable he did not find this mode profitable. Others have followed in his wake with modifications and with varying success, amongst them Mr. Stephen Cox, of the Clift-house Tannery in our city, who appears, also, to have abandoned the plan. An adaptation of it, however, may still be seen at work in the yard of Messrs. Tremlett and Co., at Exeter. (The reports of their processes were laid on the table.)

Some years ago Messrs. Herepath and Cox, of Bristol, patented a process of making the leather, while tanning, pass as one long strap through a pair of rollers from one pit to another. The theory was that, the old liquor being pressed out, a ready entrance would be made for the new. This, also, was abandoned after a considerable expenditure of time and money.

We have still in Bristol a mode of moving suspended butts on a tramway as far as the pits will allow, but it is of doubtful advantage. The most ingenious contrivance for saving labour was tried by the late Mr. Bede, tanner, of Colyton, East Devon. He, supposing it was cheaper to pump liquor by machinery than to move leather by hand, suspended the butts in pits, and pumped the liquors daily; a pretty fallacy, as the leather became so stiff and dark in colour that it neither tanned well nor worked well. Dr. Turnbull also failed in tanning experiments at Ivybridge. But recently the trade had their attention called to a process which professed to reveal the philosopher's stone, in the shape of running woozes, so that the liquors may be kept up to a fixed strength, the plan being the exact reverse of the old system of extracting the strength from the taps or latches by flowing the woozes through pipes instead of pumping. By this new process the weaker liquor from the top of the old pack flows through a small tube to the bottom of the next pit in succession, and so on to the end of the round, the supply being kept up at the strongest pit, and flowing off exhausted, after traversing each pit until it becomes well nigh spent at the last. This plan appears not only feasible, but profitable, our present process being two steps forward and one

back; for, supposing we shift a pack at ten o'clock this morning into 32° liquor, by ten to night it may be, say, for the sake of illustration, reduced to 31°, and at ten to-morrow it may be 30°, thus, although 24 hours older, it is of less strength. This disadvantage may now be remedied by the flow of liquor, and the strength of the liquor may be increased, if necessary, day by day, according to the age of the leather. As to its being a patent process, the invention seems to have been lost in obscurity, as it is known to have been extensively used by a Devonshire tanner many years since.

On the introduction of *Terra japonica*, an eminent firm in London invented a rapid process of tanning by its use, which it was thought would work a revolution in the trade. The sole leather thus made was tanned in a few weeks or even days. The plan was, to sew the hides into bags with open mouths, by which they were suspended from shoots that kept them filled with a supply of strong terra liquor to replenish the waste, which dripped in an exhausted state through the sides of the bags. To prevent the leather becoming hard, the process was confided to an old pensioner, who every night belaboured the sides of the bags with a stout stick. The secret, however, oozed out through a young fellow, who paid attention to the pensioner's daughter and to the invention as well, he having obtained permission to accompany the old man in his nocturnal rounds.

It seems, then, after all the experience of centuries, and the advantage of recent scientific discovery, almost impossible to shorten the process of making really good leather, such as will be durable, resist damp, and yet be sufficiently flexible to be comfortably worn. In Bristol the very best leather is twelve months in the tan-pits, and in any case a year is occupied in the entire process of manufacture. It is tanned at first slowly in weak woozes, and when finished it most resembles in texture the fine unbroken fibre of the original hide. And if any proof were needed that the best articles, as a rule, are the cheapest, we may quote the experience of various countries. In the late American war the boots supplied to the troops were supposed to last three months. Owing to the low price paid by the French during the Franco-Prussian war, their shoes, in some instances, were said to wear out entirely with a week's hard marching; and a great deal of the failure of the French forces to move rapidly is attributed to this cause; for to provide 500,000 new pairs weekly is no easy task in time of war. Even at the commencement of our own Crimean campaign, shoes of the very worst description were supplied the troops. This, however, led to a thorough investigation, and since that time not even English sportsmen have been supplied with better leather than our own troops. An attempt, it is true, has recently been made, to pass off inferior manufactures for army boots; but, happily, the present Government, like its predecessors in office, are exercising vigilance as to the proper fulfilment of contracts, and have rejected the inferior articles and discharged the guilty parties; so that now a considerable portion of the best leather tanned in Bristol is again used for the army. And Sir Garnet Wolseley says, "the regiment that marches best in an army, is the best in that army."

Small yards are gradually becoming extinct throughout the country, and within a few years some scores have been closed. A village in Wiltshire had seven tanneries at work; now it has only one. At Ashburton, in Devonshire, there were five at work, and they are now all closed. No longer the sound of the tanner's maul is heard across the meadows. The occupiers of the last yards there have removed to Bristol, and now, under one roof, tan four times as much as all the five yards of that country town. Many small tanneries have been closed in Devon and Cornwall within this last fifty years, whilst those placed in more favourable positions are constantly increasing in size.

Kip Tanning.

Kips are the hides of small East Indian cattle, and are imported in a dry state into London in immense numbers.

Owing to the anxiety to buy on a rising market, tanners have recently bought these goods, not only before they were landed, but even before they were shipped; and thus have opened a door to fraud. of which the senders have availed themselves by plastering the fleshy side of the hide with lime or cement to such an extent, that 2½ pounds of this waste has been scraped from one skin. So bad, indeed, has the practice become, that some of the largest kip tanners in the kingdom have temporarily stopped working, until there shall be such an accumulation of these unfairly weighted hides on the market, that they will be sold at their true value. Some lots have already been offered for sale at a considerable reduction, but have not found buyers. The natives appear to have been only too ready to copy from some low class English manufacturers who have exported to India bad linen and cotton goods, injured with lime and size, thus adding false value to their merchandise.

Terra japonica, valonea, shumach, and mimosa are generally employed in the manufacture of this leather, which is afterwards curried and used for the fronts of common boots. The average amount of plaster on all kips in sale 1874-5 to be 1½ pounds per kip.

Duration of process:—Soaking, 2 weeks; liming, 2 weeks; tanning 6 to 7 weeks.

Materials.

The tanning materials principally in use are oak bark and valonea, but, owing to the great rise in the price of the latter article, its place has been supplemented by the use, also, of myrobalans, divi divi, mimosa, terra japonica, and hemlock extract. Formerly the tanners in the South of England used only the bark of the English oak (*Quercus robur*), the annual consumption of which may be estimated to be from 200,000 tons to 300,000. The supply becoming quite inadequate to the demand, it is calculated that without recourse to foreign materials the price would have risen from £8 to £80 per ton. The heavy sole leather made from it is seldom of the very best quality, the greater length of time it takes in tanning not being compensated for by a corresponding increase of price. The leather is, therefore, sold before it is tanned sufficiently to

render it impermeable. The very rapid absorption of water by gelatine accounts in a great measure for cold feet in damp weather when the leather worn is not thoroughly tanned.

Valonea is the fruit of a shrub or small oak tree (*Quercus ægilops*) growing wild in Asia Minor, Roumelia, and Greece, but by far the greater quantity comes from Smyrna. In 1872 the quantity shipped from various ports was 34,000 tons, the largest proportion of which came to England.

A writer in the "Tanner's Journal" asserts that the land of Palestine abounds with the valonea oak, especially at Nazareth, Mount Tabor, and the land of Gilead, and he longs to open up to the blessings of commerce the resources of a country in which are found galls, indigo, and valonea.

In the same journal an able writer from personal observation says respecting valonea :—

The fruit begins to ripen in July, and is ready for the cultivator in August.

Some small portion of it never attains maturity, and either falls off the trees of itself, or is beaten off in the shape of gamata or gamatina. These two trade terms signify those cups that have not opened fully, and remain with the nut stunted and so imbedded in them that it cannot be extracted. The majority of the trees are beaten in August, and the fruit has to be gathered up and taken into stores in villages and towns, often far distant from the hillsides and plains where the plantations grow. This will explain the immense influence exercised on the quality of the crop by the autumn rains. The summer months are very dry, and, as a rule, there is no wet weather before September or October. If, however, as sometimes happens, torrential showers should come down in August and early in September, after the beating of the trees, but before the storing of the fruit, the result is simply this :—The ground gets saturated, the fruit lying there is wet, and before any measures can be taken, the valonea crop of the year is irremediably damaged and discoloured.

The conditions, then, for a crop of fine quality are, a temperate summer, to prevent the fruit being forced on unduly and ripening irregularly and out of shape ; and secondly, a dry autumn up to October, to give the peasants time to gather and store their produce in safety before rains can damage it whilst exposed to the open air.

The acorns which grow in the cup are gathered up with them, but the knocking about which the fruit is subjected to before it is finally despatched to Smyrna, and the mere fact of drying suffice to detach a great number in the meanwhile, and the produce thus reaches our market with only a small portion of them. The valonea is put into sacks, and is then forwarded by camels to the nearest railway station. The cost of this transport by camels is according to the distance; but we can give an idea of the burden imposed on trade by this lack of railways far in the interior by stating that for some districts it is 20 to 50 per cent. of the first value, and in all it exceeds the charge made for the railway journey, although the latter may perhaps be twice or three times as long.

The valonea having reached Smyrna, is emptied into the dry, commodious, and well-aired stores specially built here for the article, and then undergoes the process of picking and cleaning. This is done principally by women, children, and infirm old men incapable of hard work. The smaller, or "spine," is separated from the cups, which are placed apart. The former is always mixed with a proportion of earth and stones collected with the fruit from the ground, and has to be purified of this extraneous substance. The cups are placed in large heaps before the cleaners, who rapidly lay aside all the damaged cups and all the acorns, and push the remainder behind them with their hands after thus cleaning it. At the same time the Trieste cups are quickly thrown into separate baskets, and the valonea thus leaves the workers' hands in three distinct qualities, Mezzana, English, and refuse. The first, however, which consists of the finest large cups, is not picked out of all parcels. In many cases it is allowed to remain in the English quality, which then takes the name of "Natural," from the fact of its thus containing all the sound cups originally produced.

Recent information leads us to think that valonea may be successfully grown in Australia, and thus become a source of wealth to that country, which possessing neither large rivers nor forests, has the more need to cultivate shrubs of commercial value.

The import this year, 1876, promises to be very great; but a large proportion of the best quality has suffered from honey dew; this is apt to cause fermentation, and, therefore, English tanners avoid any samples of this sort. The German tanners, however, who have paid particular attention to this matter, assert they are able to prevent the fermentation without injuring the colour or affecting the strength by the use of salicylic acid, borrowing their information probably from the experience of those engaged in the wine trade, who pay particular attention to the process of fermentation.*

The Turkish Government derives a considerable revenue from this article ; and a law is said to exist which allows anyone to plant this shrub, but forbids the right of cutting it down. So little, however, is this regarded, that the trees are often destroyed wholesale by the natives, and at a small profit converted into charcoal; whilst it is left to the birds to propagate the useful shrub by dropping the acorns into the crevices of the rocks.

For English tanners it would seem better that the Turkish "sick man" had died long ago, if even the strong hand of Russia had ruled in that lawless land.

The total number of tons imported into the United Kingdom is estimated at 25,000 to 30,000 annually.

It may be that some members of this learned association, as they roam over the earth, may have their attention drawn to this, or other shrubs, producing fruits, berries, or roots containing tannin, the necessity for which is specially evident when we see one of our principal tanning imports doubling itself in value for want of adequate supply.

Myrobalans are the dried nuts of an East Indian plant (*Terminalia chebula*), and are largely imported from three principal districts, each sending produce of different appearance, which has led to their being characterised as, dark Madras, fleshy Calcuttas, and lean Bombay. They appear to grow wild, and almost any number of tons can be collected ; but owing to their tendency to make leather soft, only a limited weight can be used with advantage. They vary very much in strength, but are supposed to contain from 20 to 36 per cent. of tannic acid.

Divi divi has from time to time been extensively used by some local tanners, but with variable results. It is the pod of a leguminous shrub (*Cæsalfrinia coriaria*), a native of South America.

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* Messrs. Haycroft and Pethick have favoured me with the following extract of a letter from Smyrna, dated January 8th, 1876.—"We have been considering that the honeydewed valonia could be turned to account by tanners, by using a small percentage of salicylic acid. It is made from carbolic acid and sodium This acid stops completely all fermentation, and would arrest the production of gallic acid. This acid is now manufactured extensively in Germany ; it arrests vinous fermentation completely. This acid has scarcely any taste when applied to the tongue, and it is not corrosive, so that it cannot injure leather ; at any rate, it does not harm the stomach. We know that carbolic acid is sometimes used by tanners in their pits. Italy is the only buyer of honeydew and gets it cheap, as the finest crops are the honeydewed."

It grows to the height of 20 or 30 feet, the pod being somewhat similar in shape to our English pea. It is imported principally from Maracaybo, Rio de la Hacha, and Savanilla. It contains about 50 per cent. of tannic acid, and a considerable amount of mucilaginous matter, which ferments rapidly, especially in thunder weather. This causes, at times, much annoyance and some loss, as one of our Bristol tanners found to his cost, when one day passing through his drying shed he came to a pile of Divi tanned butts, which had been laid down to temper, but through which he was able to thrust his walking-stick, as through a honeycomb. Divi tanned leather feels firm in dry, and soft in damp weather. A fortune is open to anyone who can employ this article in tanning and prevent the dark colour which accompanies its use.

Terra japonica, or catechu, is an East Indian product from the bark, wood, and leaves of the *Acacia catechu*, well known in many tropical countries. From Singapore alone the export reaches annually more than 20,000 tons. When first imported in quantities few persons knew what became of it, until it was discovered that it was used by some of the London brewers to give bitterness and body to their famous London porter. So the story runs. It contains from 35 to 50 per cent. of tannic acid; and, as with the natives of India, who chew it with the betal nut, no doubt it would have ultimately tanned those who drank it, but that the vitality of their skins prevented their being made into leather. About thirty years since this article was extensively used in the manufacture of sole leather in Essex, but it produced a worthless and unsaleable leather, which when worn in very hot or wet weather stained the feet of the wearer. The small quantity now used in Bristol appears to be employed rather for colouring than for tanning purposes. The excessive use of terra produces a white deposit in the interior of the leather. A speculative firm in London, who failed in business, persuaded the Bankruptcy Commissioner that this white deposit was occasioned by the use of the water which came from chalk, and were granted their certificate accordingly.

Mimosa (*Acacia dealbata*) is obtained from New Zealand and Australia, all the trees in the former colony being of this tribe. This bark, from its heavy and dense nature, requires to be finely ground, and even then the whole strength cannot be extracted without warm water. It makes a red leather. Formerly the colonists sent us both their hides and mimosa bark, which we made into leather for them; they now send us leather; and so little of this bark has recently been imported, that it sells at too high a price to be of general use. It contains 24 per cent. of tannic acid. Some of the colonial boots made from this leather are both cheap and durable. Our colonial offspring are proud of their ability to help themselves, and now charge duties on the produce of the mother country.

The American hemlock extract is of comparatively recent importation. Various opinions are expressed as to its value, but, from the fact asserted on excellent authority, that none of the red leather has been shipped to England at a profit by the American tanners, it seems as though the extract is not likely to be a profitable article for an English yard, as the objectionable colour produced by its use necessitates the sale of the leather at a low price. The best extract is that made in vacuum pans, and is free from resinous deposit when used.

Amongst the new tanning principles lately introduced to our notice are "Chesnut Extract" produced from chesnut wood and bark principally in France.

The bark of the mangrove (*Rhizophora mangle*) which is so widely distributed over many tropical countries, produces a cheap red leather. It was largely used in one of our tanneries, but did not answer the expectation of the importer.

Another agent, a brown powder of a gummy nature, which appears to have exuded from trees, by analysis conducted by Mr. Stoddart, has four times the strength of valonea.

Another, about which, like the last mentioned, great secrecy is observed on the part of the importers, has been analysed by Mr. W. N. Evans, and found to contain 23·16 per cent. of Tannin. In outward appearance it resembles the small galls. It is probable that in both these cases the articles cannot be obtained in any considerable quantity.

Waste Products.

The refuse of a tannery is a matter of considerable importance, and consists of untanned, dried pelt, or glue pieces, fleshings, hair, lime deposit, and spent tan. The most important is the first. Glue pieces, dry untanned portions of the hide, or scrolls, are sold for paper-making, the manufacture of peckers, or hammers, for knocking to and fro the ever flying shuttle; though here the pneumatic principle seem likely to supersede the use of pelt. Scores of tons are also annually sold from Bristol for the manufacture of gelatines, portable soups, and isinglass. The best dinner tables of our land are habitually supplied with the refuse products of our tanneries; and little do our exquisites think, as they help themselves or their friends to the shaking and transparent jelly, from what sort of places these harmless luxuries are derived. But as the hide is worth much more per pound than the meat, it will perhaps be a relief for some to know that it is especially well cared for, and the greatest cleanliness is observed in the manufacture of the gelatine in all its multiform shapes. (Some samples manufactured by Messrs. Nelson and Warrick were shown.)

Ordinary size is made from the flesh refuse of the hide, and is extensively used by paper hangers, by cotton spinners (to give firmness to the thread), and carpet manufacturers. Unfortunately for us, the latter have found that excellent size can be made from the pith or interior of horns, and so have abandoned the use of ordinary size.

As to the hair, there has been little demand for it since speculative builders have discovered a mode by which ceilings can be made to retain their position without its use. Unhappily the demand for cheapness has stimulated the makers of inferior clothing and blanketing to mix hair with wool, and many a poor wretch, shivering in his coat, or lying sleepless under his heavy but comfortless blanket, has little guessed that the reason why he could not obtain warmth from either was because his clothing had been made with hair instead of wool. Hair is used also in the fabrication of horse cloths and railway rugs, and ladies may be interested in knowing

that the so-called cheap seal skins are manufactured in the north of England from common plasterers' hair.

The day has not yet dawned on us in which we can find a profitable use for spent tan. Liebig says it is valuable as a manure when thoroughly rotten. Some have tried to turn it into charcoal and light their tanneries with its gas, but with slender success. With us it is consumed in a species of kiln, and the ashes sold at a cheap rate (from 10s. to 20s. per ton). The white smoke that arises from it in burning is of a pleasant odour, reminding us of a Dartmoor or Highland peat fire. The steam from the wet tan, however, causes the smoke to fall in dull weather, and creates some inconvenience, otherwise it would resemble that from a wood fire. A new process for using this refuse instead of charcoal, in the manufacture of tin plates, has lately been tried at Llanelly, and seems likely to be a success.

As to the lime grounds or deposit; it contains a mixture of salt, blood, lime, and gelatine. Nesbit gives as its analysis :—

Moisture	54·05
Organic matter	6·80
Silica	2·55
Iron and alumina	·84
Phosphate of lime	1·85
Carbonate of lime	12·42
Caustic lime	17·44
Common salt	4·05
	100·00

The agricultural mind is so perverse that it refuses to see the excellence of this product as a manure, though hundreds of tons may be had for asking.

Free Trade.

Those who are old enough to recollect the great Free Trade struggle of 1846, will remember that gloom and discontent had for a considerable time spread itself throughout the manufacturing districts, and the heavy autumn rains beating against the windows of the House of Commons naturally helped the vigorous logic of the free traders. Sir Robert Peel was felt to be wavering, and the tanners of England like most manufacturers were loud in their demand for a cheap loaf; but when the news spread that the Government were about to make their first experiment by the admission of leather, duty free, the trade became on this point at least, strongly protectionist. A deputation of tanners from Bristol waited on Sir Robert Peel, laying before him the hardship of their case. Sir Robert listened as one whose mind was made up on the point, and dismissed the deputation by taking up a piece of Bristol tanned leather they had brought with them, and saying :—"Gentlemen, if you can produce such leather as this you need fear no foreign competition."

So free trade came, and one of the first results was, that French curriers bought tanned calf-skins in London, curried them in Paris, and sent them back to Leadenhall-market, where they were sold at a profit. Such a course now is seldom possible, so much has the English currier been educated by foreign competition. It is unfortunate that so many nations fail to see the advantage of following our example. France, for instance, who availed herself freely of our manufactures during the hour of sore trial in her war with Prussia, has now what amounts to a prohibition duty on English leather; and our American cousins, who vainly invite us to display our manufactures at their forthcoming exhibition, are so afraid of the fresh air of free trade, that they, to use the words of one of their distinguished men, Mr. Jackson Shultz, "shoot at us from behind a hedge of more than 30 per cent. import duty."

On the other hand, our working population have profited considerably from the large import of the red hemlock American leather, which was first introduced into England by Zadoc Pratt in 1844, who then sent 1,000 hides to England. Some lots were also shown at the Great Exhibition of 1851, but the importation has now increased so much that in 1874 it amounted to 1,159,815 sides, and Messrs. Nelson's annual circular, published in Manchester, Jan. 12, 1876, says :—

> One of the most striking facts connected with the leather trade of the past year is, without doubt, that of the large import from the United States of America. Receipts from other countries have been insignificant in comparison. By the Government returns, copy of which we annex, it will be seen that the total import is stated as 42,035,795 lbs., being in excess of the previous year 11,612,510 lbs. Probably the importance of this fact will be more clearly seen if it be looked at in comparison to what it is equivalent; thus the whole import from all sources of supply is equal to 2,101,789 twenty pound sides, that being at the rate of 175,149 per month; or it fully doubles the weight produced by all the Salted River Plate and Rio Grande hides tanned in England in one year. We think there can be no doubt of a regular supply of hemlock tanned leather for the future, but with the return of better trade in the States, we believe it most improbable that shipments will be made to the same extent.

The heavy duty of more than 30 per cent., placed by the United States Government on the admission of English leather, is curiously bringing about a protectionist feeling on the part of the English manufacturer, and this feeling will rapidly extend to the trades union societies, whose powerful influence on politics may be exerted ere long in favour of a return to a protectionist policy, or at least to one of equal duties in both countries.

Health.

As to the health of men working in this trade; in a lecture delivered by Dr. B. W. Richardson to the members of this Society in January, he shows, by a carefully prepared list of 70 professions and trades, commencing with barristers and ending with cabmen, that the occupation of tanners and curriers ranks seventeenth in the list for health.—See *Journal of the Society of Arts*, January 7, 1876.

Machinery.

As a rule a very small amount of machinery is employed in tanneries.

The best aid to hand labour for finishing leather appears to be that invented by Mr. Stephen Cox, of the Clift-house Tannery, and the best rolling machine that of Messrs. Barker and Newall, of Warrington; but in neither case can hand labour be advantageously dispensed with.

A machine has lately been invented for splitting a hide into four sheets of leather; as, of course, one part can only have the natural grain on it, the rest are all inferior. The absence of grain on leather may be observed in the common window straps of railway carriages.

Meat and Fresh Hide Supply.

We have seen that the River Plate district alone is supposed to have twelve million head of cattle on its pampas, of which about three million are annually slaughtered for export. The rapid slaughter of so many animals, at one season of the year, is naturally accompanied by a great waste of animal food, whilst even the blood and manure of the cattle finding its way to the river, is at times so pestilential, that orders have occasionally to be issued to stop the working of the slaughter-houses.

It is pitiable that, whilst our poorer countrymen are insufficiently fed, abundance of excellent and cheap meat is ready to supply their need, waiting only means of transit; and that the hide, which would suit us far better if handed to us fresh, should be subjected to the expense and deterioration of a pickling process. Instead, therefore, we say, of sending us hides, hoof, horns, hair, bones, and tallow, and extract of meat, send us the living animal.

Vessels like the *Castalia* could probably be constructed and fitted with every necessary appliance, which in thirty or forty days would land on our shores an almost boundless supply from the River Plate and Texas districts. This is no visionary scheme. An animal costs them, free on board, £5 to £8, and will sell in England for £20 to £30; land them at Falmouth or in the Kingroad, fatten them on the rich Somersetshire meadows, and by an organised system of country abattoirs send to the metropolis an abundant supply of excellent and cheap animal food, leaving us the hides in the country, which we will tan for your benefit, and free you also from the bouquet of odoriferous Bermondsey. Of course this plan is open to many objections. The supply of fresh water we are told required by the cattle during the passage will be enormous; but as steamers are now fitted with means of condensing water, there can be no great difficulty in procuring fresh.

Mr. Charles Taylor, writing to the *Times*, April 29th, 1875, says with reference to the import of cattle from Oporto across the bay, the steamers have the usual 'tween decks, with pens fitted up large enough every way to prevent chafing. The deck is covered with Indian corn stalks, of which this kind of cattle is very fond, making a dinner of their bed. For every hundred beasts shipped, two native cattle men accompany them to attend exclusively to their wants, and it is the captain's duty to see that water is supplied to every beast three times a-day. The result of this careful treatment may be witnessed at Thames Haven or Southampton generally once or twice a-week, when the fine Portugal ox is landed as fresh as when it was shipped. It is not often that large profits and benevolence thus go hand in hand.

At a meeting held in the Cannon-street Hotel August 28, 1875, Mr. Lancaster said he was intimately acquainted with, and deeply interested in one cargo of cattle which was brought from the Argentine Republic. However the public circumstances prevented the development of that trade. But there is no doubt of the fact that animals can be brought from foreign countries, and can undergo a sea voyage of from 26 to 30 days' duration, and be landed in England in a most excellent condition. The cargo was brought here by a steamer; but, unfortunately, owing to the vessel grounding, there was a delay of nine days. Notwithstanding the delays, the cattle were landed at Falmouth in a splendid condition. They were 26 days on board, and only one bullock died. The sheep were in such a good condition—it was in the month of March or April—that they were dressed lamb-fashion, and were sold in London for lamb. The horses which were also brought were likewise a success—they fetched an average of £40. They cost out there a very trifling sum, and the freight was £10 per head. The Falmouth experiment was tried under many disadvantages, but I have reason to know that the buyer of the cattle thus imported wishes the opportunity of repeating the purchase.

In the selection of the cattle, it is not sufficient merely to go into the camps and select haphazard a number of wild or half-wild "Novillos," and then placing them on board ship, expect them to arrive safely at their destination. At the outset, such a plan is undoubtedly the cheapest, for any number of such animals can be bought, say, at an average of £2 to £2 10s. per head, while such beasts as we should select would cost far more; perhaps, as much as £5 or £6 per head, but the final results would be widely different. The wild young cattle, accustomed to roam at will over the rough camps of the province, and placed all untamed on board ship, beat themselves to pieces in their efforts to get free; and if they do not kill themselves before the end of the voyage, pine away to such an extent, that they are landed mere skeletons, and require a long time to recover before they are fit to send to market. In place thereof, we should choose tame beasts, bullocks that have been broken into the yoke in the country carts; or if we did purchase wild cattle, we would establish a grazing farm near the place of embarkation, where they could be tamed before shipment to England. Cattle, so far from deteriorating, would in a majority of instances fatten and improve on the voyage, and be really fit for the butcher on arrival; though it would, of course, be most desirable to turn them out in the marshes for a week or two before slaughtering them, but the expense on this side would be far less than with wild young cattle which would require a good three months before they could be got ready for market. Ship the cattle by steamer; nor would the difference between steam freight and sailing freight be at all appreciable, according to the plan we expect to see carried out. A company formed with sufficient capital should purchase a number of auxiliary screw steamers, which would be fitted with stall and slings especially for the conveyance of cattle, and each of which might be constructed to carry between three and four hundred head. These steamers would load at London or Liverpool with general cargo and passengers for Buenos Ayres and intermediate ports, and the freights, &c., on the outward voyage would go a long way towards paying the working expenses of the vessels on the homeward voyage. On discharging in the River Plate, they would not be detained one day in looking for freights, or in filling up for the return trip, as many ordinary trading vessels are for many weeks at a time.*

* "National Food and Fuel Reformer," November 21, 1874.

Labour.

With regard to labour, as a trade we experience very little difficulty; this arises mainly from the process being so simple that young men from the plough can learn the greater part in a month, and the skilled part in six months. Piece work is now adopted in some yards, which has materially increased the wages of the workman and added much to his comfort, as he can rest or work as it suits him, without the suspicion of a master or foreman's eye ever watching him, whilst he at the same time enjoys the spring or elasticity of feeling that he is working for himself and can do more or less according as his health or strength will allow —whilst the master enjoys exemption from the perpetual harrassment of urging men on to labour. After many years' observation, I feel sure the man who works by the piece finds the hours of labour pass much more pleasantly than the hireling who "watcheth for the shadow," and moreover feels himself less fatigued with his labour, though he has earned considerably more than if he were at day work.

To show how iniquitously some men (who would not perhaps steal a piece of timber) will yet rob a master of time, I can give an illustration drawn from personal experience. Two carpenters were ordered to support a beam. This was very easily done by putting an upright support (which was squared and planed at the workshop, and measured 6 ft. 6 in. long and 6 in. square. If these men had been at work for themselves, or at piece work, the probability is they would have done it in two hours, whereas in what they thought was an unobserved spot they took 27 hours. A pretty illustration of what we may expect when all labour is paid for by day work.

As this subject is now exciting such interest, allow me to add that working men generally, except where the system of long apprenticeships has curtailed the number of workers, are in favour of piecework, it being a difficulty to convince a strong, able-bodied, industrious young countryman, who seeks higher wages in the cities, that it is his duty to restrict the amount of his labour, and consequent earnings, to the capacity of some old or infirm, weak, or incompetent workman by his side.

The mischief of the matter is, that the length of apprenticeship insisted on by many of the trades union societies excludes the young countryman from competing with the town-bred, and often enfeebled artisan, and to cure this will be no easy matter, and will excite the animosity of those who seem to be fast becoming our political masters.

The education the children of the working men are daily receiving in our schools is, at the present time, far better than that possessed by the average class of farmers and small shopkeepers, whilst the continually increasing demand for skilled labour is as continually enhancing its value. Let there be, then, a genuine kind-hearted co-operation between the two classes, so that the labourer may enjoy a share in the profit his skill and his industry creates over and above his weekly wages.

The most desirable results cannot fail to flow from such a course; once more the master may stand by the side of the workman, and ask his opinion and advice as to the best way of accomplishing difficult tasks. The employment of armies of hands in our large factories puts an end to the old-fashioned and friendly feeling between masters and men, and necessarily prevents the division of profits, for "what are they amongst so many?" And where the supervision of labour can be easily carried out, as in workshops, the old pride of the master prevents his accepting, on anything like an equal footing, the assistance of his workmen. But, perhaps, the principle of co-operation may be fairly tested on a farm, where now the smallest amount of labour is scattered over the largest space, say ten able-bodied men to 500 acres of ground. If these labourers had but a very small part of the profit in addition to their ordinary wage, honesty, industry, and carefulness would result, whereas now the man measures his labour by the number of his shillings, and though often too honest to rob for himself, does not feel sufficient interest in his master's property to prevent another doing it, or to prevent the waste of time and materials.

As to the equivalent of labour for the wage, I have known a farmer in the winter (when a man needs more money rather than less) go to a stout young fellow working in a ditch, and say to him, "Ned, I can't afford to give you nine shillings a week, I shall give you eight." "Very well, master," was the reply, "I can do an eight shilling stroke as well as I can a nine"—and we may add, he did not do a stroke over.

This antagonism may be overcome, and labour become happiness to both masters and men, by adopting the principle of co-operation.

In 1851 the census showed 350,000 men engaged in the United Kingdom in different branches of leather manufactures, and its annual value as estimated by Yeats amounts to £20,000,000.

According to Simmonds there are now 770 tanneries in work, with about 400,000 persons directly or indirectly connected with the trade, which occupies a capital of £4,000,000.

Total Import into the Kingdom of Heavy Hides, suitable for sole leather purposes, during the last six years.

1870	1,245,209
1871	1,187,425
1872	1,229,754
1873	1,452,061
1874	1,291,367
1875	1,277,799

Imports into the United Kingdom of Articles connected with the Hide and Leather Trades, during the two past years, ending 1st *December*, 1875.

	1874.	1875.	In 1875.	
Oxen, Bulls, Cows	155,075...	224,347	Increase...	69,272
Calves	36,545...	38,383	Increase...	1,838
Sheep and Lambs ..	759,684...	975,628	Increase	215,944
Bark (cwt.)...........	313,652...	458,315	Increase	144,663 cwt.
Gambier (tons)	18,011...	21,897	Increase...	3,886 tons
Cutch (tons)	4,213...	6,147	Increase ..	1,934 —
Valonia (tons)	25,798...	24.131	Decrease ..	1,667 —
Hides, Dry (cwt.) ..	575,083...	570,357	Decrease ..	4,726 cwt.
Hides, Salted (cwt.)	698,940...	667,409	Decrease ..	31,531 —
Leather (lbs.)...... ...	29,324,172	41,154,853	Increase	11,830,681 lbs.
Leather (value) ...	£2,133.508	£2,768,089	Increase	£634,581
Boots and Shoes, dozen pairs	43,529 ..	80,567	Increase...	37,038 dz. pr.

Exports from the United Kingdom during the two past years, ending 1st *December*, 1875.

	1874.	1875.	In 1875.	
Hides, Dry, (cwt.).....	...298,518	285,160	Decrease...	13,358 cwt.
Hides, Salted (cwt.)	87,811	... 97,737	Increase ...	9,926 —

British Manufacture.

	1874.	1875.	In 1875.
Leather, unwrought cwts.	145,828......	163,036	Increase... 17,208 cwt.
Declared value...	£1,303,748....	..£1,442,215	Increase £138,467
Leather, wrought, Declared value.........	£1,743,636......	£1,871,786	Increase £128,150
Saddlery and Harness Declared value.........	£461,721	£492,472	Increase £30,751

Most unfortunately the study of chemistry has been neglected by tanners generally. Few trades are more ignorant of its application to practical purposes, and no trade is in greater need of its assistance. For instance, we feel sure a great loss is constantly sustained by the change of tannic into gallic acid, but we are not at all sure of the method by which this may be prevented. The old plan was to cover the pits with spent tan, and you may to-day walk over a French yard, without knowing that you are walking over pits filled with leather. Perhaps it may be well for us to return to this old, but somewhat inconvenient method; at present we seem to be like children creeping in the dark. This may seem absurd to scientific minds, but the non-success which has hitherto attended the efforts of chemists generally, makes practical men averse to chemical experiments on a large scale.

All past experience proves that rapidly tanned leather has invariably been of poor quality. It is improbable, therefore, that the process will be hastened with advantage.

Fuller, in his "Worthies of England," published in 1662, says, "The Lord Treasurer Burleigh (who always consulted artificers in their own art) was indoctrinated by a cobbler in the true tanning of leather. This cobbler, taking a slice of bread, toasted it by degrees, at some distance from the fire, turning it many times until it became brown and hard on both sides. 'This, my lord,' saith he, 'we good fellows call a tanned toast; done so well, it will last many a morning's draught, and leather thus leisurely tanned and turned many times in the vat, will prove serviceable."

This old opinion was confirmed by an eminent chemist, Mr. Vernon Harcourt, at the recent meeting of the British Association in Bristol; and this opinion is the more valuable, as chemists generally take quite the opposite view of the matter. Mr. Harcourt said, "That looking at the length of time the hide was on the animal's back before coming to maturity, it was probable the process of making good leather would never be very much hastened;" and this is precisely my own opinion, as a thoroughly good piece of leather ought to be tanned so slowly as not to injure the fine fibres of the natural hide.

Various articles, have, consequently, been used as substitutes, very few of which have stood the test of long trial. Gutta-percha and india-rubber are used in some instances with advantage, but as long as pelt grows on the backs of animals, men will find a use for it, and it is as true to-day as when first uttered, "There is nothing like leather."

DISCUSSION.

Mr. Barrow said he should like to know if Mr. Evans could suggest any remedy for the two defects which he had especially mentioned, namely, the branding of the hides, which injured them to the average extent of 2s. each, and the warbles in the English hides, caused by the fly. There was no doubt of the importance of these matters, and the question was what practical remedy could be suggested.

Mr. Sharpe said the science of chemistry had done very little to improve the process of tanning. Since the days of Simon, the tanner, who was probably the earliest mentioned, the quality of leather had scarcely been improved, for there were some samples in the British Museum, which, allowing for the lapse of time, seemed quite as good as any made at the present day. Chemistry had made gigantic strides in many departments of the arts, such as in the preparation of oils and fats, the discovery of aniline dyes, the Bessemer process for making steel, and many others, but it had done very little for tanners. Possibly that might arise from the fact which had been mentioned that tanning was such a very slow process in itself. He was very pleased to hear, as an old Volunteer officer, that the British army was now supplied with thoroughly good boots, and it was also very satisfactory to him as a person engaged in the leather trade that this subject had been opened, and he hoped as it was a wide field, other papers would, before long, be read on other and lighter descriptions of leather.

Mrs. Amelia B. Lewis thought it was impossible to say anything more than had been said about the importance of importing live cattle, for although she knew pretty well all the methods of preserving meat, and had tried some herself, and possibly had an idea that at some future time she would succeed better than had been done, still she would not deny that it would be preferable to bring over live cattle, because it would not only provide dinners for the poor, but boots and shoes. If there was one article of clothing more important than another to the people of this country it was shoe leather. It was almost impossible to say how much disease was engendered, and how many lives were lost, simply because the lower classes could not buy good boots and shoes. She had taken some pains to investigate this matter, and had taken to pieces shoes in which the soles had bits of brown paper between them. Unfortunately the public were so much occupied with fine buildings, grand palaces, the encouragement of fine art furniture, that these really practical national questions had been at a discount, and she was very much pleased that society was awaking to the necessity of giving time and attention to matters which really were at the foundation of the national well-being.

Mr. Crisp, though he had been amongst leather the greater part of his life, said he had not been practically engaged in the manufacture, and, therefore, could not say much upon the able and entertaining paper which Mr. Evans had read. With regard to the inferior manufacture of boots and shoes, which had just been adverted to, the reason of it was the severe competition between manufacturers, to outstrip each other in price, which led to the use of inferior materials. The only remedy was in price, and in educating people to understand that they could not get a good article at a low rate. If people would go after cheap wares they could not expect to get good ones. Mr. Evans had said that it took nearly twelve months to produce good leather, whilst cheap leather was produced in perhaps as many weeks. Of course the large outlay of capital necessary to keep a large yard going for twelve months before any leather could be brought to market would preclude a great many from entering the trade who were now engaged in it, because a much less capital was required when a quick process was carried on; hence the cheap leather with which common boots and shoes were made. No doubt such leather as that produced by the eminent firm represented by the reader of the paper would prove cheaper in the long run, on account of the extra wear to

be had out of it. In conclusion, he said it would be very advantageous if any scientific man could suggest a means of destroying the insect which caused so much loss to the tanner by making the warble holes in the hides, and also if the branding of South American hides could in any way be put an end to.

Mr. Wills said it very seldom happened that a practical manufacturer had sufficient chemical knowledge to be able to apply it with advantage to his own business, whilst, on the other hand, it still more seldom happened that a chemist, whose studies were principally carried on in the laboratory, had the practical information and experience to enable him to be of much service to manufacturers. One of the great advantages of the Chemical Section of the Society was, that it brought together manufacturers and chemists, and others interested in the subjects brought forward, and statements were heard from the lips of those practically interested as to the special difficulties they had to contend with, and the obstacles to be overcome; in this way the subject was ventilated, and eventually it must be profitable to all concerned. Two or three definite points had been mentioned that evening which stood in the way of the successful working of tanneries, and having been brought to the front, they would, no doubt, receive the attention of those qualified to deal with them, and very probably good results would ensue. The branding of the hides certainly was not a chemical question, but there was, no doubt, great injury being done, and immense loss being incurred through this bad practice, and probably some means could be adopted which would suffice to stamp the animal as belonging to a particular person without spoiling the hide.

Mr. Evans said he should have been better pleased if some gentlemen had taken up the subject from a chemical point of view, and enlightened practical tanners on the nature of gallic acid, and on the value of the various materials for tanning, and also on the use of glucose. He knew but little of this substance himself, but he believed there was a mode of introducing considerable quantities of it into leather. He had in his hand the *Curriers and Leather Sellers' Journal*, which stated that there was a new material—glucose—costing about 2½d. a lb., which could be applied in a melted state to partially dried leather so as to add 10 or 15 per cent. to its weight; and although it injured its quality to some extent, it went on to say that some firms had already consumed from two to three tons per month, which, as it must be assumed they sold the product at 1s. 6d. per pound profit, represented a gross income of from £4,000 to £6,000 per year. The presence of this substance could be detected by chewing a small strip of leather. It was also used to some extent in removing the lime. In answer to Mr. Barrow, he said the subject of the brands was a very difficult one; they were not so bad as they used to be, but they caused great injury. The cattle were branded when quite young, and as they grew of course the brand was enlarged. As a new brand was added every time the cattle changed hands, they sometimes did considerable injury. Something might be done by sending out a strong remonstrance, but he feared there would be no help for it until there was greater honesty in the South American dealers; because, as he had before remarked, if a man did not brand his own cattle, his next door neighbour would be very apt to do so instead, and claim them as his own. The question of warbles was rather an agricultural one, and the only remedy he could suggest was to take great care of the cattle in the summer months when the gad-fly was about, and keep them as much as possible in the shed. Sulphuric acid, strong tobacco juice, and other things had been tried, but the only effectual way here seemed to be plucking out the grub with a fine pair of scissors. Amongst other things used in tanning, he wished to draw attention to a new instrument for testing the value of tanning materials. One of these instruments was on the table, and his friend, Mr. W. Evans, would explain its use.

Mr. W. Evans exhibited the instrument referred to, which was designed for the purpose of easily ascertaining the amount of tannic acid in any tanning material. The tanning liquor was forced through the skin; in fact it did on a small scale what was done on a large scale in the tanyard, and the results had been very surprising. Some large tanners had found that the material for which they paid £20 a ton yielded only from 10 to 15 per cent. of tannic acid, whilst other things which they were buying at the rate of £5 or £6 per ton, had given 30 per cent. The experiment could be performed in about twenty minutes; and those acquainted with the use of gelatine or chemical salts for testing would know the great trouble and unsatisfactory nature of such experiments.

The Chairman, in summing up the discussion, said Mr. Evans had taken such a wide range in his paper, that it was somewhat difficult to follow him in detail. As to the brands, probably a strong protest might be made with advantage, but it seemed to him that the matter rested entirely in their own hands. While they were content to receive the hides branded they would so receive them; and while tanners would give at times 9d. per lb. for salted hides to arrive, it was not likely that the producers would take much care to send them in the best possible condition. Buyers ought not to take hides until they had seen them, but, unfortunately, competition had of late years been so great and hides so scarce, that this seemed impossible. Amongst the methods described by Mr. Evans for taking off the hair was the process of Messrs. Conyers and Pullen. There seemed to be nothing novel in this process, and therefore, if it was successful, any one might use it, notwithstanding the patent. With regard to the sweating in use in America, he considered it was really a process of incipient putrefaction; and though ammonia could scarcely be detected, the water introduced into the vault in which the hides were hung, might carry it off. Still the process appeared to be successful applied to hemlock tannage. Very nearly the same process was used by some leather dressers in this country for removing the wool from lamb skins. Allusion had been made to the very large importation of American leather. As free-traders they could hardly object to this; but, at the same time, he thought there ought to be reciprocity. It was plain that we could not compete with America in the production of the common kinds of leather, and these large importations have driven our home make of the same description completely out of the market. At the same time, our best manufacture, which Americans want, and are ready to buy, can only be sent to them under an almost prohibitory duty. Hemlock extract was, he thought, used in London and other parts of the country, to a greater extent than Mr. Evans imagined, and with a mixture of oak bark, valonea, and other things, it did good service, and made a valuable addition to our list of tanning materials. The slight use of machinery in tanning had been referred to, but it had been more introduced lately, especially in finishing. It must be remembered also that leather was not like many other manufactures, the value of the raw material being so very great compared with the labour required to convert it into leather, and therefore the saving of labour was not of so much consequence. In the iron trade the value of the labour bore a very large proportion to the selling price of iron, whilst in leather, at least in sole leather, it was a comparatively small item. Chaplin's process had been mentioned amongst others for saving time. It was soon abandoned, as it was found that the gelatine was actually forced through the pores of the hide, and thus leather was produced very spongy and of light weight, so that the process, though speedy, was very wasteful. The piece of buffalo leather shown by Mr. Evans looked

very good, but they all knew it did not wear like English tanned ox-hide. However, as it could be produced at something like 1s. a lb., while English leather of similar substance, if it could be found at all, would cost nearly 3s., it came in very well as a cheap material for certain purposes. All tanners would be very glad if chemists would turn their attention to some points on the tanning process. For instance, any cheap substance which would prevent or retard oxidation of tannin, and also prevent fermentation, would be very useful. He should be afraid that salicylic acid, if it possessed this property, would be too expensive, unless a very small quantity were sufficient. He should hardly have thought that glucose, which was nothing but potato sugar, would have this effect. As to the statement in the *Tanners' Journal* respecting glucose, he did not much believe it. Glucose appeared to soften leather somewhat similarly to the ordinary dubbing used by curriers. But if leather, stuffed with glucose, were placed in a stove, it would be found that all, or nearly so, of the extra weight, dried out. He, therefore, did not think that it would be used to any considerable extent. Mr. Evans did not speak very highly of gambier as a tanning material, and he also gave it too great a percentage of tannin. He should doubt if any gambier would show more than 30 to 45 per cent. Still, if used in combination with other materials, it produced very good leather, and was certainly very extensively employed in the manufacture of dressing leather. It is an extract evaporated in open vessels made from the *Uncaria gambier*, a shrub of three years growth. The instrument which Mr. Evans had described was a good testing machine, as he had tried it, but it required some care in manipulation. As the difference in density in the liquid to be tested, before it was forced through the piece of skin and afterwards, was very small, a very delicate hydrometer had to be used, and a small error in reading off the densities made a very considerable difference in percentage of tannin. Still it was a valuable instrument when carefully used; it corresponded closely in results with those obtained by the gelatine process. With regard to spent tan, in London we were obliged to burn it, simply for the purpose of getting rid of it. It is generally partially dried, either by being passed between rollers or by hydraulic pressure, and in this state no doubt saves a considerable quantity of coal. The Americans have a way of burning it quite wet from the pits, in a kind of double reverberating furnace, which is said to be perfectly successful. With regard to the time required for tanning leather, he did not suppose that in the case of best heavy sole leather it would ever be materially shortened, but dressing leather, and sole leather could be properly tanned in a much less time than twelve months; still he agreed with Mr. Evans, that very rapidly tanned leather was generally of poor quality. In conclusion he proposed a hearty vote of thanks to Mr. Evans for his paper, which was carried unanimously.

AFRICAN SECTION.

A meeting of this Section was held on Tuesday, February 15th, Mr. Francis Galton, F.R.S., in the chair.

The paper read was—

ON THE PROGRESS AND PROSPECTS OF OSTRICH FARMING IN THE CAPE COLONY, AND THE TRADE IN OSTRICH FEATHERS.

By P. L. Simmonds, F.R.C.I., &c.

Only those who have looked somewhat closely into the statistics of commerce can form any idea of the demands made upon the animal kingdom for our wants and our luxuries. Animals, large and small, are sought for by the merchant and trader, from the huge elephant and rhinoceros and the carnivorous and other animals in their wild state, to the smaller insects, which contribute colour-dyes, medicine, or silk. The denizens of the air, the creatures of the deep, and the beasts of the forests and the plains, are all made subservient to the increasing demands of the civilised world. We have already acclimatised, tamed, and domesticated many animals which cater to the wants of man, and any fresh step in domesticating wild ones, whose products are useful, is certainly one in the right direction.

Although I have no practical knowledge of the new industry, which has been quaintly termed "ostrich farming," yet, having for many years paid considerable attention to all animal products, in cataloguing and describing the museum collections belonging to the Department of Science and Art, and being thoroughly conversant with the stages of progress in the domestication of the ostrich, when this was mentioned as a fit subject for discussion before the African Committee, I readily agreed to prepare a paper on it.

So far back as 1856, it was suggested by the French that the ostrich might be domesticated in Algeria, and it was pointed out that while the feathers of a bird shot or hunted down, even if they were all of a good commercial character, would sell only for about £5, the feathers plucked twice a year from a male domesticated ostrich would realise at least £9 to its owner. After the discussions and inquiries thus early set on foot, Dr. Gosse, of Berne, published in the Bulletin of the Paris Society of Acclimatisation in 1857 some extended and valuable papers, which helped on the solution of this important question, formerly deemed impossible.

In 1860, the profitable domestication of the ostrich was carried out in Algeria by M. Hardy, who received the offered premium of £80. Prince Demidoff, at Florence, Don Froylam Ayala, at Buen Retiro, in Spain, and M. Noel Suquet, at Marseilles, also followed the same example.

In September, 1864, M. Bouteille, Curator of the Museum of Natural History at Grenoble, submitted to the Society of Acclimatisation at Paris a report of his successful breeding of ostriches in domestication in the Zoological Gardens there.

At the commencement of May, 1864, the female laid two eggs at intervals of six days, these were, however, broken and eaten by her. On the 15th May she again commenced to lay at intervals of two days, up to the 6th June, and produced eleven well-formed eggs. After this the completion of the laying was marked by two small and mal-formed eggs. The male and female birds alternately took their place on the eggs. Of the eleven eggs, two were broken, leaving nine to be hatched, but only two young birds were raised, seven eggs being found either addled or with the fœtus dead. This partial failure was attributable to cold and wet weather, and to a want of practical knowledge for guidance.

I shall proceed to give a short account of the ostrich in the northern districts of Africa before passing to the south.

The ostrich is found to the south of Algeria, where it has fled to escape from the chase, of

which it has long been the special object. The Arabs of the Sahara chase the ostrich by coursing, and destroy so great a number that they are becoming rare, and are likely to disappear altogether from their former haunts. This scarcity of the ostrich, which threatens to become general in all the countries where they were formerly found in large numbers, has attracted the attention of scientific and commercial men. The Acclimatisation Society, of Paris, as we have seen, took up the question, and M. Chagot, a feather merchant, of Paris, offered for some years a prize of £80 for encouraging the domestication and breeding of the ostrich in Algeria or Senegal. Six living ostriches, representing a third generation, were to be raised. The solving of this problem presented difficulties of more than one kind; but these were overcome by M. Hardy, the director of the Acclimatisation Gardens at Hamma, Algeria, to whom the prize was awarded, and this garden now possesses several generations of ostriches born in the gardens. The Acclimatisation Garden at Marseilles, and another private establishment in Italy, subsequently obtained equally successful results.

This domestication, and that in the Cape Colony, has enabled many curious facts to be ascertained. One is that the ostrich subsists exclusively on grain and herbs. It swallows occasionally pieces of metal and stones, and it is this habit which has given the bird the reputation of voracity, and of even being carnivorous, which is not true. It is also well known, of course, that the ostrich forms for itself a nest like other birds, in which it lays its eggs, sits on them, and does not leave them to the sun to hatch, as had been supposed by the older naturalists.

The problem of preserving and domesticating the ostrich has now been successfully carried out both in the northern and southern extremities of the African continent; and, instead of mercilessly hunting down the bird to destroy it for the sake of its feathers, it is now raised and preserved in a state to produce periodically its plumage, abundant and intact, for the benefit of the elevator.

This idea, far from being utopian, has been long in practice, although only of late years prosecuted on a systematic scale, and in a commercial point of view.

In the Middle Ages, according to Marmol, the native tribes of the province of Dara, in Numidia, raised ostriches for their feathers. They were put to graze in troops, so as to secure their feathers in the best condition. Buffon writes on this subject that the feathers of the finest quality were no doubt thus obtained from living birds. Captain Lyons, in his "Travels in Northern Africa," mentions, early in the century, that in some parts of Fezzan they have recourse to the same means. Here are his words:—"At Sockna and its environs they keep ostriches in their yards or enclosures, and collect the feathers three times in two years. From the ostrich skins which I have seen exposed for sale, I fancy that all the best plumes which we see in Europe are obtained from those thus kept enclosed, for those obtained from wild birds have theirs so broken and soiled, that there are often not a dozen good ones found." Various negro tribes in Central Africa also carry on a similar industry; and it is not impossible that the fine plumes called Aleppo, imported into Egypt by the caravans from Sennaar and Darbour, are the result of this practice. Lapanouse (vol. iv, p. 103) tells us that in Sennaar they breed ostriches in their houses with other birds. In Senegal they are also domesticated.

The late M. J. Verraux, the naturalist, made an excellent profit from the feathers derived from the ostriches he raised in his menagerie at Cape Town, and the feathers could be collected without inconvenience twice a year.

Although it is said that children ride on the ostrich in parts of Northern Africa, we have not yet began to harness them, as some of the Roman emperors did. Montaigne, in his curious chapter on coaches (Essais, livre iii. chapitre 6), cites one which was received with great applause by the public. "L'Empereur Firmin fait mener son coche à des autruches de merveilleuse grandeur, de manière qu'il semblait plus voler que rouler." Various travellers record having seen the ostrich ridden by men in Senegal, Gambia, &c.

The ostrich has been celebrated from remote antiquity, its brains being an epicurean dish in old Rome. Like the hog, every part of the bird is utilised. When an ostrich is killed in Africa, the first care is to remove the skin, so as to preserve the feathers uninjured; the next is to melt the fat, and pour it into bags formed out of the thigh and leg, strongly tied at the lower end. The Arabs state the fat yields about 20 litres (upwards of four gallons). The grease of an ostrich in good condition fills both its legs; and as it brings three times the price of common butter, it is considered no despicable part of the game. It is not only eaten with bread and used in the preparation of kooskoosso, and other articles of food, but the Arabs reckon it a valuable remedy in various maladies. It is employed in acute pains by well rubbing in, and then covering the flesh with heated sand. The egg-shells, finely powdered, mixed with various other ingredients, are used to heal alterations in the cornea of the eye, and for sore throat, and the boiling fat applied as a cataplasm is said to afford immediate relief.

The flesh of the ostrich, dressed with pepper and meal, forms the supper of the sportsman. It is said to be delicate eating. Moses, however, prohibited its use as an impure meat.

An ostrich egg weighs on an average about three and a-half pounds, or the equivalent of 30 fowl's eggs, so that an ostrich produces annually in quantity, equal to about 1,100 to 1,300 Spanish fowls' eggs. The flavour of the eggs is somewhat less delicate than those of domestic poultry, but they are, nevertheless, perfectly eatable. A singular fact stated is that the eggs will keep fresh and eatable for two or three months.

The eggs of the ostrich form a considerable item in the Bushman's *cuisine*. Bush girls and Bakahari women, who belong to the wandering Bechuana tribes of the Kalahari district, may be seen coming down to the fountains from their remote habitations, each carrying on her back a kaross, or a net-work containing from twelve to fifteen ostrich egg-shells, which have been emptied by a small aperture at one end; these they fill with water, and cork up the hole with grass. The egg-shells are also frequently ornamentally set and mounted as drinking cups.

In his recently published work on Morocco, Dr. Leared tells us the ostrich is only met with in the south, about Wadnoon and the borders of the Sahara. Birds of the largest size and finest plumage are found in this district. The ostrich is hunted by Arabs mounted on horses. The party advance cautiously against the wind, and with long intervals between each horseman, until marks of the birds' feet are discovered. These are followed up until the birds themselves are seen by the hunters. A dash at full speed is then made after the game, until the ostriches turn and face their pursuers. They do this because their pace, which is accomplished by a combination of flying and running, is interfered with by the action of the wind upon their wings. The gauntlet has then to be run among the armed sportsmen, who either shoot, or maim the birds, by throwing at their legs a short thick stick formed of hard-grained and heavy wood. In the use of this implement the Arabs are extremely dexterous. When secured, the throats of the birds are cut, and the feathers plucked off. These, and the flesh (which although somewhat coarse, is eaten) are then divided among the hunters.

The exports of feathers from Morocco have been as follows:—

Year.	Cwt.	£.
1867	26½	10,500
1868	34	12,200
1869	56¼	17,800
1870	62	23,200
1871	59	17,700
1873	55	18,700

In Tripoli the ostrich feathers are brought from the plateau above the first range of mountains, where the ostriches are hunted down during the hot summer months.

In 1865, the value of the feathers exported was £12,000, in 1866, £7,000, and in 1874, those sent to England rose to the value of £62,000, and to France, £37,600.

Passing now to the British possessions in South Africa, we find that ostrich farming is already an important branch of agricultural industry in the Cape Colony, and promises to become still more so; and yet the breeding and rearing of ostriches dates back only about eight years. Before that a farmer here and there had a few birds on his farm, more as a curiosity than anything else; but few thought of hatching ostrich eggs, rearing young birds, and attending to them as you would a flock of sheep.

When it is understood that the value of an ostrich a few weeks old is £10, and that its value increases rapidly as it grows older, it will be at once apparent that the successful pursuit of this industry is a very remunerative investment of capital. With increased production prices may probably rule lower, but there is a very wide margin, and it will be many years before ostrich breeders need fear the effects of overproduction, or that they will be farming at a loss.

About eight years ago Mr. A. Douglass, of Hilton, in the Eastern Province, bought a pair of birds, and subsequently added to them four more, making in all two cocks and four hens. The idea of an incubator then struck him, and after numerous experiments he succeeded in constructing apparatus admirably adapted for the purpose he required. By this incubator he succeeded in rearing from these six birds 130 young ostriches in one season. The eggs are brought into contact with copper plates, and heated by warm water to a proper temperature.

The following is a description of the incubators generally used for the hatching of ostrich eggs, taken from a handbook of the Cape Colony recently published by Mr. John Noble, Clerk of the Cape House of Assembly:—

"The incubator consists of a wooden box, about three feet square, open from above, and capable of containing twenty-five eggs. It rests upon a copper or zinc pan or cistern, three inches deep, and equal to the size of the box. This is filled with hot water, and has four or five openings through which the vapour ascends into the box. The warm temperature of the water is maintained by a paraffin lamp kept burning underneath the pan; but in some cases this has been found objectionable, as the fumes of the lamp affect the young chicks as they leave the egg, and it is an improvement to have the lamp burning in an adjoining compartment, an extension of the cistern or pan about a foot wide being carried through the partition or wall, and the lamp placed under it. The heat can be regulated as necessary, thermometers being constantly in use. The temperature of the box where the eggs are placed is 102 degs. Fahr. when they are first put in; after two weeks it is gradually reduced to 100 deg., and in two weeks more to 98 deg. The period of incubation is forty-two days. The eggs are turned and aired by opening the box and blanket covering once or twice a day. A fortnight before the expiration of the time, they are held up against the light to examine their condition, and a week after are slightly, but carefully, punctured near the top with a sharp-pointed steel, to enable any of the chicks in weak condition the more readily to break the shell. When hatched, they are turned, kept warm, and fed with cut lucerne, and allowed to run about their inclosures like ordinary fowls."

In natural hatching the average number of birds raised is sixteen out of twenty eggs; in artificial, when properly managed, not more than one out of twelve eggs fail.

A writer in a local paper gives an account of a visit to Mr. Douglass's farm. Hilton is distant about twelve miles from Graham's Town, on the Cradock-road, and appears to be well adapted to ostrich breeding. The greater portion of it is surrounded by a fence, and the enclosed area is subdivided into a number of fields or paddocks, in which the birds are kept. It does not require a very high or very substantial fence to secure the birds. One field contained a brood of chickens a month old, and in the same place a fine large hen which had recently been attacked by a leopard, and severely bitten in the neck. The patient was, however, recovering. Round about the homestead, another brood of fifteen or more, about three months old, were feeding, and flocked round the visitors like chickens when being fed. In one enclosure were twenty fine birds about 18 months old, which trotted up from the farthest end of the field the moment the visitors entered, capered about, and ran after each other in the most playful yet grotesque manner. In one paddock were a savage old cock and two hens. No one dare venture within this until the male bird was secured in a small kraal or wooden stall, into which he was enticed by food. These were the most valuable birds on the farm. The two hens laid eggs all last season; and although he did not pretend it was their market value, Mr. Douglass said it would not pay him to take a thousand pounds sterling for these three birds. The extent to which the occupation is carried on may be judged from the fact that there were then

on the farm upwards of 280 ostriches, and that Mr. Douglass had sold 85 birds. The Acclimatisation Society of Paris in 1874 awarded to Mr. Douglass its first-class silver medal.

Another breeder, near Middlesberg, in addition to birds kept in enclosures, has a flock roaming at large, taken care of daily by two men on horseback. The food which he supplies is, for birds old enough to take care of themselves, Indian corn; the chicks are fed with a mixture of green barley and chicory chopped up fine, and kept regularly supplied by a little boy, whose business it is to be constantly with his charge. This breeder considers his feathers when in season have as fine a gloss as those which are obtained from the bird in its wild state. He attributes this not so much to the character of the pasturage, although this is very favourable, as to the comparatively free range which his adult birds enjoy.

The domestication of the ostrich in the Cape Colony has assumed every year greater importance, and this industry promises to become considerable. It has been attended with such success that many large establishments have been created.

Mr. J. M. Beyers, of Noolbyeducht, near Stellenbosch, appears to be a very successful breeder by artificial incubators.

Mr. Kinnear, of West Beaufort, has given much attention to the subject. His farm is a model of simplicity, and surprises many who were disposed to consider that large tracts of territory were necessary to breed the ostrich with success. On eight acres of land attached to his dwelling, and enclosed with fences, he has thirty ostriches, nearly all raised by him. This enclosure is sown with lucerne, and according to Mr. Kinnear would suffice for the elevation of nearly one hundred ostriches, if his system of irrigation were more extended. A lodge and sheds are constructed for the protection of the young birds during the winter months, and it is here the process of obtaining the feathers is carried on. For this operation two processes are resorted to; some advise the plucking out of the feathers, others consider it best to cut them a little above the roots, and to remove the roots two months afterwards. Mr. Kinnear prefers the latter mode, as he thinks the former is often injurious to the bird. The first plucking of feathers takes place when the bird is about eight months old, but the feathers are then small, and not of much value. The operation is renewed every eight months. Three pluckings of ostriches, when in full plumage, realised to Mr. Kinnear £240, or £120 per annum—that is £8 sterling per bird. In 1874, instead of selling the feathers on the spot, he sent them to England, and by this means each ostrich realised £10, or £2 more. One portion of the enclosure is divided into compartments, in each of which the ostriches are paired. At liberty, in the wild state, five females are often attached to one male, and they all lay their eggs in one nest, and set on them in turn. Mr. Kinnear, however, only assigns one female to each male. They are coupled in July, and commence laying in August, and continue laying for about six weeks, after which they set till October. A month or six weeks later, about December, they recommence to lay for about five weeks, provided the young brood are removed. In the first season the hen will lay fifteen or twenty eggs, but the second is much less. The male sits on the eggs more assiduously than the female, often sixteen hours successively, from four in the afternoon to eight in the morning, the female, on the contrary, takes the greatest care of the young ones. Mr. Kinnear removes the young when they are sufficiently strong to be taken from the nest, that is one or two days after they are hatched. They require a warm temperature, and hence are placed in a deep box lined with sheepskins, taking care to let the air penetrate by the cover. During the severe colds of winter the lodge is heated and kept closed. Their usual food is chopped lucerne, bnt they do not like the stem. Grain is also given to them, and, when they are strong, maize. Trefoil and vetches agree with them as well as lucerne. They neither have iron nails, metal buttons, nor other delicacies of that class, to which many travellers assert they are partial; but they require sand, earth, pulverised quartz, small bones, and plenty of water.

Mr. Kinnear states that, for their usual food, nothing equals lucerne or trefoil, but they also like cabbage leaves, fruit, and grain. Each ostrich will eat about twenty pounds of lucerne a day.

In the district of Colesberg some farmers have enclosed with walls large spaces of ground, leaving the ostriches as it were in a state of liberty. Competent persons think they obtain by this means feathers of a superior quality to those from birds kept in a domestic state; but the rearing of the young ostriches does not succeed so well. On the farm of Mr. Murray, in that district, many ostriches died in 1870 without any apparent cause, their death being attributed to a worm found in their intestines.*

In the districts of Worcester and Graaf-Reinet, the rearing of the birds has succeeded well. The advance which has taken place in ten years, both in the price of the birds and of the feathers, will give an idea of the importance which this industry has already attained in the Cape Colony. In 1860, a pair of ostriches six months old could be bought for 10s.; now, for one bird alone, a few days after hatching, £5 will be given, and for those of three or four months old, £8 or £10. In 1860, the quantity of ostrich plumes exported was 2,297 lbs., valued at £19,201; in 1873 the export was 31,581 lb., valued at £159,677. In 1874, the quantity shipped was even larger. And it may be stated that an ostrich which has obtained its full development will only yield every eight months a quarter of a pound of feathers.

Dr. Mann has favoured me with the following interesting private letter, from Mr. A Burger, giving his experience in ostrich farming, and it appears very desirable to compare the notes of the various breeders. Mr. Burger's farm, Vleyplaats, near Murraysburg, in the division of Graaf Reinet, and adjoining farm, is known by every man in South Africa, and by many a gentleman now in Europe.

"I am sure nothing is more profitable than ostrich farming, the outlay or investment of capital being much less, the expense in farming very much smaller, the extent of property more limited, the risk considerably smaller, and trouble and care not to be compared with any other mode of farming. As is necessary with cattle, the nature of the soil and the seasons must also be studied with reference to ostriches. They may to a certain extent live, thrive and increase on

* Report of Mr. Arthur Lanen, French Consul at Cape Town.

grass or "Zuir veldt," but karoo and "brak" are undoubtedly the best. There they have the natural alkalies, as also the various kinds of bush, herbs and shrubs, besides many kinds of sweet grasses and other things which naturally spring up after rain. There they thrive to the fullest extent, the feathers are so much finer, heavier and more natural, the birds larger and handsomer, increase so much better, and the chickens healthier, and grow up so much quicker; thus the farmer may expect his labour richly rewarded. I hold that from 300 to 400 per cent. can be safely calculated on the outlay, both on birds and other expenses, such as enclosures, plucking stalls, "kraals," and other requirements, land rent, &c., &c. £15 is considered a fair average for the feathers of a full-grown bird, those of one nine month's old fetch £1, and from eighteen months to two years £5, and from thence they give from £10 to £15 very soon. From twenty-five to thirty chickens is a fair average from one hen in a year; I have seen many more. I hold that two hens for one cock is better than three hens, others say three are not too many. The value of young ostriches varies from £20 to £50 a piece, according to size and age."

On one of the "farms" near Grahamstown, where about 170 birds are kept, two males and four females are kept for breeding purposes; the rest are young birds—from chicks to ostriches of two years old—which are destined to produce the feathers that may some day bedeck the royalty and fashion of Europe.

One of the most striking circumstances in connection with the farm is that the old birds are seldom allowed to incubate their own eggs, but "artificial incubators" are used with great success: by this means a larger number of eggs are hatched than is the case if they are left to the natural functions of the parents. Birds hatched by this means are quite as healthy as those reared by the parents.

In forming the nest—which is a huge hole scraped in the sand—the male bird is most assiduous; and when all the arrangements are complete, the laying of the eggs commences. This takes place about June, though the time varies in different parts of Africa. In Algeria it is generally about February. From 15 to 23 eggs are laid, and carefully arranged in the nest, their position being frequently changed by the apparently fastidious parents; and when the number is complete the regular incubation is continued without intermission. The male bird is generally observed to sit at night, the female morning and evening; in a wild state the birds frequently leave the nest untended during the heat of the day. If more than one female is associated with the male they sit alternately, or sometimes both together. The birds are in the habit of ejecting a certain number of eggs from the nest, and allowing them to remain uncovered, and they also throw aside any eggs which, in course of incubation, they find become "addled" and useless. The former are left as food for the ostrich chicks, which, on their first appearance in the world, eat the yolk of the rejected eggs—a wise provision of nature to prevent them dying from starvation, which they probably would do under natural conditions, if, as frequently happens, the nest were situated miles away from a blade of grass, too far for the young birds to travel in search of it.

When the eggs are hatched by means of artificial incubators, the ejected eggs are preserved, and the proportion of spoiled eggs is much smaller. The period of incubation is about 43 days, and the chick on its entry into the world is about the size of a pullet. In the farm of which we are speaking, the old birds are seldom allowed to sit, and the healthy condition of the "chicks" hatched by artificial heat shows that they suffer nothing from this mode of treatment. The first day of their life they are seldom fed, but on the second day—sometimes not until the third—some very tender grass is given to them; even at this early life they swallow pebbles and other hard substances, which serve to digest the food in the gizzard. The young birds are kept at night in a warm place, the weakest ones being placed in an "artificial mother" —a contrivance specially prepared for keeping them warm and out of danger. The others are covered over with coops for shelter. When the birds are a few months old, they are placed in an enclosure, where they are fed at regular times.

All the younger birds are driven under shelter at night, as a precautionary measure; in every enclosure there is a tent or shed, under which they can take refuge from a storm in the day time, and in which, when they are fully grown, they are left to rest at night, but in their early days they are taken in-doors.

Ostriches are comparatively inexpensive to keep, as during three-fourths of the year they require only a little artificial food, the grass produced on the farm being nearly sufficient for their keep; during the remaining fourth they only need some supplemental supplies of green food with a little Indian corn, which can also be grown upon the estate.

The food is generally fine grass and beans, in fields of which they are occasionally "pastured." At other times the food is distributed for them in the yards allotted to them.

Captain Crépu, who has kept ostriches in Algeria, feeds his birds on barley and different kinds of fresh herbs, grass, and the leaves of the cactus or Barbary fig, cabbage, &c., chopped fine. About 3 lbs. avoirdupois of barley a day to each bird, and grass, &c., according to circumstances, is the quantity he recommends. This might be reduced to 2 lbs. a day, except during the winter and breeding seasons, when the supply of food should be plentiful.

The following estimate of possible receipts, which has been carefully prepared by Major Erskine, will give some idea of the enormous profits that are looked for in ostrich farming by sanguine authorities:—

	£	s.	d.	£	s.	d.
First Year.						
Feathers of 20 old birds, at £15 each	300	0	0			
Feathers of 225 birds, of eight months old and under, at £1 each	225	0	0			
				525	0	0
Second Year.						
Feathers of 20 old birds, at £15 each	300	0	0			
Feathers of 375 young birds, of different ages, at £5 each	1,875	0	0			
				2,175	0	0
Third Year.						
Feathers of 20 old birds, at £15 each	300	0	0			
Feathers of 375 birds, at £10 each	3,750	0	0			
Feathers of 375 young birds of 2nd year, at £5 each bird	1,875	0	0			
				5,925	0	0

Fourth Year.

Feathers of 20 old birds, at £15 each	300 0 0		
Feathers of 375 young birds, of 2nd year, at £10 each..	3,750 0 0		
Feathers of 375 young birds, of 3rd year, at £5 each ..	1,875 0 0		
Sale of 225 birds of about 3 years and under at £50 (several pairs would be worth £200)	11,250 0 0		
		17,175 0 0	
Total............		£25,800 0 0	

The fifth year, 375 young birds would be sold, and so in future, except the renewal of stock, which would be small, as the birds live fifty years. The stock on hand at the end of the fourth year would be 20 old birds and 750 young birds, in addition to the above sum realised, besides plant, horses, &c., and lease, goodwill, fencing and improvements; this is without reckoning the purchase of eggs to be hatched by an incubator, which would be done.

This calculation is based upon the assumption that only 25 birds would be reared out of 70 to 80 eggs laid annually by each hen.

In Northern Africa opinions differ as to the longevity of the ostrich; some limit it to from 8 to 15 years, others attribute 70 to 100 years to this bird. The mean average, however, is probably from 25 to 35 years. (*Bull. Soc. Accl.* 4, p. 334.)

For some time before domestication was attempted, the ostrich had become a rare bird in the colony, and the chief sources of the feather supply were hidden away in the far interior, to the north and north-west of the Free State and the Transvaal. Many farmers in the northern and western divisions of the colony now preserve these birds on their farms, and their domestication and annual plucking has proved profitable, since the best feathers range from 30 to 40 guineas a pound in the European market, although those from the domesticated bird are not considered quite equal to those from the wild one.

A curious mode of hatching the eggs was tried by Mr. Thomas Barn, of Wolf's Sprint, Hodder River, Orange Free State. He took eggs from the nest and placed them in the sun in the day-time, covered with sheep-skins. In the night he placed them in his bed with him, so as to maintain the necessary artificial heat, and succeeded in hatching many. At eighteen months he obtained his first crop of feathers, amounting to about ½ lb. for each bird. Later on he succeeded in obtaining annually from some of his male birds about 1 lb. of feathers, worth £30. His young birds of two years old he readily sold for £10, after having obtained two crops of feathers. He has since sold twenty birds for £400.

Who was the first in South Africa seriously to attempt the domestication of the ostrich, will probably remain a matter of uncertainty. About thirteen or fourteen years ago, Mr. Kinnear, of Beaufort West, had a small flock of ostriches well in hand. The idea was probably taken from the French efforts, set on foot by the Paris Acclimatisation Society. The industry has, however, received greater development in southern Africa than in the north, for the farmers of the British colony have taken to the novelty with great spirit. If it is difficult to say who was the first to begin ostrich farming at the Cape, it is more difficult to enumerate all who are continuing it. The occupation is now widespread.

There are but few districts of the colony where there are no ostriches. From the near neighbourhood of Cape Town to the eastern frontier, and from Albany to the Orange River, flocks of these valuable birds are to be found at intervals of no formidable distance. Some breeders have a reputation for their successes. Mr. Meiring, Mr. Raubenheimer, and Mr. Guest, as well as Mr. Kinnear in the west; Mr. Douglass, Mr. Atherstone, and Mr. White, in Upper Albany; Mr. Distin, Mr. Sluiter, Mr. Booysen, and Mr. Murray, of the Midlands; and Mr. Loxton, on the eastern border, are well-known names in connection with ostrich farming. It must not, however, be supposed that the colony, or any part of it, is stocked with the bird.*

The climate of all parts of the Cape Colony, we are told, is alike favourable to the growth and production of the ostrich; when once past their infancy they are the healthiest and easiest cared for stock a farmer can possess; they thrive equally well on the barrenest karroo as in the most fertile region.

The plans adopted by farmers in meeting the first requirement of domestication—that of limitation—have been various. Mr. Kinnear made his compound, not more than eight acres in extent, suffice for thirty birds. It would, however, be misleading to allow this fact to be looked upon as anything but an exception to the rule that the ostrich needs considerable room. Mr. Kinnear was obliged to sow his eight acres with lucerne, in order to provide food for his birds. Even with that provision, and with every allowance made for an unusual aptitude for domestication on the part of Mr. Kinnear, it cannot but be considered that this gentleman was very much indebted to fortune for his success. Other breeders have given their birds the run of their lands, trusting to careful herds, and the attraction of a daily feed of mealies at the homestead. Mr. George White, of Upper Albany, at one time gave an inclosure of 500 acres to 23 young ostriches. Mr. Murray, of Colesberg, had about 90 within 1,000 acres, walled round with stone, and he has now an inclosure of nearly 5,000 acres for his larger flocks. Mr. Douglass, of Albany, has his farm divided into about seven or eight large well fenced paddocks. It may be considered a settled law of ostrich farming, that free space and good fences are essential to success. Sheds, kraals, and houses are also necessary, not only for safe keeping, artificial hatching, and feather gathering, but also for shelter from the cold and wet. Exposure is very hurtful to the birds, if weak or out of condition.

To show the rapid increase of ostriches in the Cape Colony, and the commercial importance attached to breeding them, I may quote from some of the recent Cape papers. Thus, in the *Eastern Province Herald*—"Ostriches for sale, cheap. H. David and Co., offer for sale 52 ostriches, 12 months old; 44 ostriches, 8 to 9 months old; 25 ostriches, 4 to 7 months old. Any number will be

* Handbook of South Africa.

sold to suit purchasers.—Somerset East, September, 1875."

And, later in the following month, the same firm advertised for sale 74 ostriches from 7 to 13 months old. Then, in another paper, we are told, the ostriches of Mr. Bland, sold by Mr. S. H. Roberts, in October last, brought capital prices. They were all young, a year and under. Farmers appear to be turning their attention seriously to ostrich farming. The following are the prices realised, viz., two birds, £38 each; four do., £35 15s. each; eight do., £35 2s. 6d. each; four do., £34 10s. each; two do., £30 2s. 6d.; two do., £30 1s. each; twelve, £25 each; fourteen do., £23 12s. each; four do., £15 each; one do., (injured) £10.

In South Africa, since the recent vast increase in the value of these feathers, and the extension of ostrich farming, ostriches are strictly protected, and a heavy fine is imposed on the destruction of a wild one.

Having now given attention to the breeding and practical part of the subject, let me turn for a few moments to the resulting product, and furnish some description of the general trade in ostrich feathers.

We paid for ornamental feathers, chiefly those of the ostrich, in 1874, nearly £603,000; and the value of imports of the past year (not yet published) was probably more. Of this amount about one-fourth in value is re-exported, but close upon half a million of money is a large sum to pay annually for a trivial article like feathers, to minister to the pretty vanities and dainty whims of the ladies.

The trade in ostrich feathers is an important branch of commerce, which constituted in the 13th century a veritable source of riches for the Pisans and the Genoese, who used to buy them in the ports of Algiers, Bone, Bougie, and Tunis.

The elegance of the feathers of the ostrich, arising from their slender stems and the disunited barbs, has occasioned them to be prized in all ages, and they still constitute a valuable article of commerce. There is a singular feature which distinguishes them. The large wing feathers of other birds have always one side unequally plumed, whilst in those of the ostrich the quill is in the middle of the feather plume. This equal balance was probably the origin of the hieroglyphic of the Egyptians, which represented Justice by an ostrich feather.

The feathers of the male are most prized, being better shaped, larger, whiter, and finer than those of the female bird. White feathers are the most esteemed, but they take dyes readily.

In France, the white feathers are sold by number, in England by weight. The black are also sold by weight in France. France receives in the rough, and prepares, a large quantity of ostrich feathers, which are greatly enhanced in value; for instance, in the seven years ending 1871, she bought about 517,000 lbs. of all sorts, of the approximate value of £112,000, and during the same period exported to different countries 170,000 lbs. of prepared plumes, of the value of £620,000. This commercial industry is therefore of considerable importance, considering the high prices the feathers have reached. Feathers which were worth only about £1, twenty or thirty years ago, can now not be had for £20 or £30. This advanced price is due to the extended use of ostrich feathers for parures and trimmings, hats, &c., and to the scarcity arising from the persevering chase of the wild bird, which has driven it far into the desert regions.

M. Chagot, one of the leading feather merchants of Paris, writing in the Bulletin of the Paris Society, and complaining of the advancing price of ostrich feathers, stated that a good white long feather cost them 11s., one of the second quality 5s. 6d., one of the third quality 3s., and a small tail feather, 1s. 3d. About half a pound of fine black feathers, £5; 600 lbs. ordinary quality, £8 10s.; so that if we estimate 40 wing feathers per bird, and 100 tail feathers, we find each bird yields in value feathers selling for £26 11s., without reckoning the flesh and the fat, which can be also utilised. What other bird can be found which yields anything like this return.

The head and neck of the ostrich are nearly naked, the general plumage very lax; but the quill feathers of the wings—remarkable for the length of the barbs, which, though furnished with barbules, are completely separated from each other—form the well-known ostrich plumes of commerce.

As the trade in ostrich feathers belongs to an industry of luxury—a question of fashion—its importance in the present state of affairs cannot be overrated, when we reflect that the fashion which has made of these plumes an ornament of high price has lasted more than 4,000 years. The forehead of the Pharoahs, among the most ancient dynasties of Egypt, were, in fact, ornamented with these plumes; and in our day they are held in the same favour and estimation among the higher classes of society. The graceful and elegant plumes of the ostrich have thus for centuries been sought after throughout the civilised world, to adorn the head coverings of both sexes. In the middle ages, the beautiful feathers of the ostrich decorated alike the hat of page and cavalier; and in the reign of the second Charles ostrich plumes were universally worn by those of patrician birth, from the king downwards. For the last couple of centuries it has been the rigid law of fashion that ladies going to Court must appear with ostrich feathers in their heads, artificially curled and arranged. As we all know, the crests of the Princes of Wales consist of three ostrich plumes, surmounting the motto, "*Ich Dien.*"

But ostrich feathers are not only required for Court plumes; they are much used, as I have already stated, for ladies' hats, dress trimmings, plumules, &c.

Ostrich feathers dyed black are also required for making funeral plumes for horses' heads, in sets of eleven for the hearse, and sets of six for the lid or coffin board, which is borne on the head of one of the undertakers. These plumes are made of a number of pieces of feathers, fastened on to supports of stout brass wire, which are bent downwards when used, so as to give the graceful fall to the plume. When not in use they are closed up on the centre stem. A full set of these plumes for a funeral is worth £200 to £300, and they are let out by the makers to undertakers. Plumes of white ostrich feathers are sometimes used at the funeral of young females, but such plumes, from their great value, are rarely seen.

But it is not only civilised nations who value ostrich feathers; most travellers tell us that they are the favourite ornament of the savage people of the interior of Africa. They not only adorn their head-dresses with them, but make of the larger white plumes parasols of a remarkable elegance, and with the black feathers a species of plumed baton, which serves the hunter to frighten away furious animals.

In Congo, ostrich feathers mixed with those of the peacock, are employed as ensigns of war. Dr. Schweinfurth tells us that the Donita, the Nueir, and other Negro tribes of the shores of the Upper Nile territory, wear helmets made of cane and grass, garnished all over with ostrich feathers, which are worn as broad hats for protection from the sun.

Subjoined is an account of the total quantity of ostrich feathers imported into the United Kingdom, in the last quarter of a century:

	lbs.	£
1850	3,988	—
1851	11,128	—
1852	8,986	—
1853	7,666	—
1854	10,282	46,285
1855	10,681	13,821
1856	10,797	19,441
1857	14,922	102,132
1858	18,843	56,722
1859	29,672	78,871
1860	25,277	81,425
1861	17,871	42,550
1862	33,642	76,256
1863	28,500	153,059
1864	42,835	194,063
1865	37,811	191,222
1866	42,506	152,447
1867	51,419	136,164
1868	60,712	111,840
1869	64,159	145,257
1870	66,063	176,797
1871	83,977	288,433
1872	73,607	289,518
1873	85,149	347,390
1874	106,919	323,669

In the Board of Trade returns, for the last five years, ostrich feathers are not specifically mentioned, but included under the head of "ornamental feathers." By looking up the sources of supply, I have, however, been able to separate them, although we probably get back some dressed and prepared feathers from France.

Ostrich feathers are now just as much the product of regulated human labour, applied to the art of domestication, as wool, mohair, or silk. The plumes which play so distinguished a part in the pomp of ceremony and fashion, are no longer to be reckoned among the barbaric spoils of the chase. They are the tame products of the farmyard, and are the ultimate results of such commonplace processes as breeding, rearing, herding, feeding, clipping, and sorting. Cape farmers buy and sell ostriches as they do sheep, and they fence their flocks in, stable them, grow crops for them, study their habits, and cut their feathers, as matters of business.

The feathers received from Southern Africa are from a race of ostriches whose stature is the largest of any. They are the largest and longest feathers of commerce, but are at the same time less flexible. M. Jules Verraux, of Paris, informed me that he had seen one which measured over 2 ft. in length by 7 ins. wide; it was at the same time soft, elastic, and its extremity bent like a weeping willow. They rank in value after those of Barbary and Aleppo. M. Verraux states he has seen an ostrich feather sold for £4, and the finest quality of Cape feathers fetch £2. This is somewhat different to the price paid in 1809 to the hunters of them, of 3s. to 4s. for a fine feather, and in 1822 even less than half this price was paid, according to Pringle.

Mr. Layard considers the South African ostrich as distinct from the North African bird, to which probably the name of *Struthio camelus* was originally given. Anderson recognised two distinct species of ostriches in Namaqualand.

Less than half a century since flocks of ostriches were to be seen in almost all parts of the Cape Colony. Preferring the karroo flats and the sweet grass lands of the upper country, where they found the alkalies necessary to their health, they were nevertheless to be found towards the coast, grazing on the sour *veldt*, and making the best of the salt, lime, and such bones as they could find. To obtain its beautiful and much-coveted plumage the bird was hunted down and killed. This practice was not only cruel but also uneconomical. It was, in effect, killing the goose for the sake of the golden eggs. The system of slaughtering the bird for its feathers was fast removing the ostrich from its old haunts, and was surely accomplishing its destruction.

In the time of Kolber, ostriches were so numerous in the neighbourhood of Cape Town, that a man could hardly walk for a quarter of an hour without seeing one or more of these birds.

It is found in the present day thinly scattered over many parts of the Cape Colony, in the Piqetberg, Malmesbury, and Caledon divisions, in Namaqualand, and Clanwilliam, the northern parts of Uitenhage, Beaufort, Colesberg, and Graaf-Reinet, and a few in the dams in the vicinity of Port Elizabeth. In October, 1858, a flock of twenty or thirty were seen in the Koeberg, a few miles from Cape Town. Early in 1857 Count Castelnau, the French Consul, writing to the Paris Society, stated that in a land journey he had made of 125 leagues from Cape Town to Algoa Bay, he had only seen one wild ostrich, although a few were kept by the Boers on their farms, but they did not then breed in captivity.

In 1826, ostrich feathers from the Cape paid a duty in England of 20s. per lb. weight. In 1832 this was reduced to 10s., and in 1845 the tax was wholly removed. In 1846 only 1,327 lbs. of feathers, valued at about £8,000, were exported from the Cape. The amazing increase in this small article of luxury is shown in the following table I have compiled, of the exports from both the Cape Colony and Natal since 1858.

There is a certain fluctuation in the average value per lb. of the feathers, which it is difficult to explain without details of the quality, of the state of the markets, of the season, and other points. That increased production has been followed by diminished prices does not appear to be the case absolutely, though to a certain extent this natural sequence of events may have occurred. A reduced price, occurring contemporaneously with largely increased yield, is most apparent in the

Return of the quantity and value of Ostrich Feathers exported from South Africa in the last 17 *years.*

Date.	From the Cape Colony.		From Natal.	
	Quantity.	Value.	Quantity.	Value.
	lbs.	£	lbs.	£
1858....	1,852	12,688	84	510
1859....	2,972	19,018	70	391
1860....	2,297	19,261	64	465
1861....	3,475	24,142	110	564
1862....	7,462	42,488	600	2,510
1863....	10,275	72,834	1,746	7,255
1864....	17,873	81,755	1,665	6,572
1865....	17,811	66,426	2,025	11,299
1866....	15,144	75,661	2,605	10,921
1867....	18,921	75,221	4,426	11,200
1868....	16,163	63,193	4,191	8,830
1869....	18,920	70,750	2,133	4,757
1870....	29,805	91,229	2,063	6,364
1871....	25,508	150,769	1,706	6,910
1872....	26,993	158,904	1,856	9,745
1873....	31,581	159,677	1,535	5,940
1874....	36,829	205,640	387	3,139

returns for 1870, as compared with those for 1862, the value per lb. being £2·99 in 1870 against £5·7 in 1862.

This may be accounted for by the fact of the increased yield of feathers, under the artificial system of producing them, having so suddenly followed upon a period of scarcity, as to have alarmed the merchants, who feared a general depreciation of the prices. The subsequent rally in prices is sufficient to prove the healthy tone of the market, and the prosperity of the trade, for we find that, after the large crop in 1870, which succeeded a comparatively poor period of production, and which has been followed by an annually increasing yield, prices, instead of falling, rose to an average of 50 per cent. higher per lb. than had been maintained in the years immediately preceding. The average value per lb. previous to 1870, was £3·8. Since then it has been £5·5, as the following table shows:—

Average price per lb.

	Cape Colony.	Natal.
	£	£
1868	3·9	2·1
1869	3·7	2·2
1870	2·99	3·08
1871	5·08	4·05
1872	5·9	5·2
1873	5·05	3·8
1874	5·6	8·0

I have thus endeavoured to trace the commencement and progress of this new and important industrial occupation, hoping that it may lead to further inquiry and discussion, and I cannot but think it will profitably be carried on in some parts of Australia where the Victoria Acclimatisation Society has introduced a troop of ostriches at Wimmera, but they are to be transported to the Murray Downs, Swan Hill, as a more suitable locality, and incubators are to be obtained from the Cape. I have heard it alleged that this industry, like the search for diamonds, is likely to prove detrimental to the permanent agricultural progress and prosperity of the Cape Colony, by withdrawing land from culture, seeing that wheat, butter, and other produce that might be locally produced, have to be imported. But there are many questions which have to be taken into consideration, such as continuous labour, seasons, &c. Moreover, the same complaint was urged against gold seeking in Australia and New Zealand, but this has attracted labour and capital, and gradually settled down, so as to have rather benefited than injured the colonies.

DISCUSSION.

Dr. Mann remarked that one reason why the feathers of birds artificially hatched had an advantage over those of wild birds which had been killed, was that the greatest injury done to the feathers of the wild bird was during the period of incubation, in which process they roughened their tail feathers, and also damaged those of their wings. To Mr. Douglass, he believed, belonged the chief credit for having so admirably developed the practice of artificial incubation, and so great was his reputation in the colony that it was said that he knew a great deal more about the hatching of eggs than the mother bird herself. One point of the greatest interest in connection with ostrich farming was that feathers were removed at stated periods, so that successive crops could be gleaned year after year, and the way in which they were removed was also very interesting. At first the practice was to pluck them, but as this was found to be a source of irritation, it had been superseded by another. The birds were driven up into a small enclosure or shed, where they were so tightly wedged together that they could not move; two skilled men then squeezed in amongst them, who knew the habits of the birds, so that if any one of them should turn vicious they knew how to seize it by the throat, and by partially strangling it, make it perfectly safe. They used a small, delicately made, and very sharp knife, turned to a hook at the point, which was laid flat on the finger of the operator, who passed his hand over the back of the bird and selected the feather he wished to remove, when by a slight turn and backward movement of the knife, he severed it at a short distance from the body, and handed it to his companion. Very commonly the stumps were left to fall out, but sometimes they were removed when they became loose. At first it appeared that certain kinds of pasture only were suitable to these birds, and this still obtained to some extent, and therefore, some local and practical knowledge was still requisite for the selection of an ostrich farm. Above all it was necessary that the birds should have a supply of lime, and the first notion was that lime in any form would do, the object being of course to form the shell of the egg, and also to supply bone earth for the young animals. Common lime, however, did not succeed, and it then became apparent that it was phosphate of lime, not ordinary carbonate of lime, which was required, and it was now usual to grind up a quantity of old bones and add a little sulphur and salt, and this made a compound which the birds readily accepted, and ate greedily. Major Erskine's figures were very interesting, and he knew that whan he was in England he had been at great pains to get information, in order to make an honest estimate, but at the same time he feared it was rather an enthusiastic one. He had now gone out to the Cape to test the value of his figures, and was, no doubt, making arrangements to start an ostrich farm, so that in a few years they might hope to hear how his practice tallied with his anticipations. He feared he had rather overlooked the difficulty of managing animals of this class in large numbers. A large part of Cape Colony was now occupied by small farms of these birds, but the two great centres where most had been done were the farm of Mr.

Douglass, immediately to the north of Graham's Town, and Mr. Murray's farm immediately to the south of the bend of the Orange River. Throughout the whole of this district there was a bird very abundant known as the black crow, and since the ostrich had been brought into the country these birds had acquired a very curious habit of taking up stones and dropping them upon the open nests of the ostrich, so as to break the eggs, which they then proceeded to eat. It was said that as many as one-third of the eggs allowed to be hatched in open nests were destroyed in this way, but until within the last twenty years nothing of the kind was known, though it was possible that the crows in the wild lands had practised it unobserved. The scientific name of the ostrich, *Struthio camelus*, was interesting, meaning the camel bird, and it was very remarkable how grotesquely the foot of the ostrich mimicked that of the camel. The ostrich had two toes of unequal size, which were almost a fac-simile of the camel's foot, as may readily be noticed. It is also a somewhat remarkable and interesting fact that so large and coarse-looking a bird should possess such beautifully fine and delicate feathers. Another fact to be remembered was that the finest feathers belonged to the male and not to the female bird, and therefore it seemed rather curious that men should have allowed these feathers to go almost entirely to the adornment of the ladies, instead of keeping them to themselves, because it was evident that nature intended them for the male sex. In conclusion, he drew attention to a large map of Africa on the wall, which had been prepared for the Section under the superintendence of the late Mr. Davenport, and executed entirely by one of his sons.

Mr. Wm. G. Soper said that having himself visited one or two of the ostrich farms in South Africa, and being a regular importer of ostrich feathers, the subject was not altogether new to him. One important fact mentioned by Mr. Simmonds was that there had been a serious depreciation in the value of ostrich feathers within the last four months in the London market; and another was that some people at the Cape considered that the permanent development of the colony would be more secure were corn, wool, or any other agricultural product made the subject of their care, attention, and investment. Whether owing to these facts or not he could not say, but certain it was that the ostrich farmers of the Cape were now most anxious to get rid of their ostriches and their farms, as he could say, from most trustworthy information, which had reached this country within the last month or two. Another remark made was that the value of the feathers from tame birds was not to be compared with that of those from the wild, and any manufacturer would tell you that the tame feather would not remain in curl so long as the wild one. Consequently, as the development of the tame ostrich feather trade had been partly a question of an increased return for invested capital, immediately that return diminished so would the amount of capital invested. He hoped, therefore, that if there were any gentlemen present anxious to go to the Cape and engage in this branch of industry, they would think twice before investing in the feather farms which would, no doubt, be offered to them. A remark had been made about cutting the feathers instead of plucking them, and this was said to be a more humane process; and no doubt it was so if the feather was immature; but why did they cut the feathers? simply because they could do so twice a year, and so double the returns. The consequence was that the tame feathers were sent to market before they were matured, and thus they did not command anything like the price of the wild feathers. If they would only wait until the feather could be either cut or plucked without inhumanity, and would see the birds had plenty of space in which to roam about and clean their feathers against the bushes, he did not see why the tame feathers should not be as good as the wild. As a rule, however, the birds were kept on a comparatively narrow area, and there was a great desire on the part of the farmer to cut the feathers before they were ripe.

Mr. Hyde Clarke said it was rather curious that artificial incubation, which had been carried out for so many centuries in the northern part of Africa, in the case of the common fowl, should be now practised in the south with these large birds. As a rule, a dead feather did not take a curl so well as one from a living bird, and he should therefore like to ask Mr. Soper, or any other practical man, whether there was any advantage as to the general crispness of the tame feathers as compared with the wild ones, which in many cases were obtained from dead birds. The objection seemed to apply principally to the same feathers cut in an immature state; and if, when allowed to grow their full time, they took the curl as well as the wild ones, it would have an important bearing on the future of the trade.* Another question worth consideration would be whether there was any distinct market for the tame feathers, because it sometimes happened that an inferior article would make a market for itself apart from the superior one.

Mr. Samuel Figgis (Messrs. Lewis and Peat), said he could not claim to have been to the Cape, yet as a great proportion of the feathers which came to this country passed through the hands of his firm, and they had a sale to-morrow, when about £25,000 to £30,000 worth would be put up to auction, he might answer the question put by the last speaker. It seemed to him that the main objection to the tame feather was the weight and thickness of the quill; the quill of the tame feather was much heavier and more inflexible and difficult to manage than that of the wild. He could not help thinking, on hearing the admirable paper of Mr. Simmonds, that he had rather taken some of his figures for granted with respect to the extent of the trade and its increase. For instance, he remarked that in one year France imported £112,000 worth, and exported £170,000 worth, which would leave, it appeared to him, nothing for their own consumption.

Mr. Simmonds said that the latter figure represented the increased value from the feathers being manufactured.

Mr. Figgis said he was aware of that, but being acquainted with the trade in France, he did not think that was sufficient to allow for the enormous consumption of feathers in that country itself. Then again he thought there was a slight inaccuracy with regard to the extent of the trade in 1874, which was represented as being something like £110,000 worth from Tripoli, £20,000 from the West Coast, and £150,000 from the Cape, making altogether about £300,000, but the total was given as £620,000, thus leaving £300,000 odd to be accounted for from Egypt and the Soudan. No doubt the quantity from there was very large, but it was patent to all acquainted with the trade that the estimate of the value of feathers from the Cape must be considerably under-estimated of late years. Major Erskine some time ago visited several people in the city with a view, he believed, of inducing those interested in the trade to help him to get up a company, but he feared he had hardly made himself sufficiently acquainted with the subject in a practical point of view, for no man of business would suppose that such results as he had shown could be obtained. If it were so, and so many thousands, as he represented, could be obtained for the expenditure of a few hundreds, there would be plenty of people glad to take part in it. In his short experience, the trade had grown in such a marvellous way that he

* According to the explanations elicited from practical members of the trade, it appears that the tame feathers have too much stem or stalk, and are, consequently, too strong and stiff for taking a good curl. This is deserving of investigation, as it may arise from defect of food or want of exercise, as compared with wild birds. So likewise with regard to the lustre of tame feathers, which is inferior to wild feathers.—H. C.

feared its future expansion had been over-estimated, and particularly that some of the gentlemen at the Cape were over-estimating the capability of this market to take off the feathers at the prices they put upon them. If there were, as he had heard, 350,000 young ostriches alive in Cape Colony, it appeared to him incontrovertible that lower prices must rule. Ladies would have feathers, and they were also used in large quantities for children, including boys, and with the increase of luxury and greater circulation of money, no doubt the trade would increase during the next five or ten years, but still they must look to a very different result commercially to what there had been of late. He thought the increase of the Cape trade had been much greater then Mr. Simmonds had led them to suppose, and he also thought the produce from the Soudan and from Cairo was largely on the increase. During the last two years there had been an extraordinary weight of feathers from those parts, but the value during the last four months had declined from 20 to 30 per cent., which was only natural considering the enormous supply. As to the difference in the value between the tame and wild feathers, that was found to be in the market of from 15 to 22 per cent., which he attributed mainly to there being a less number to the lb., and to their not having the same brilliancy of plumage, and not retaining the curl as well on the whole as the wild feathers, which were often sought after at high prices when the market was overstocked with tame feathers.

The Chairman said the fact mentioned by Dr. Mann with regard to the black crows was very remarkable, as being one of the few cases in which they heard of animals using weapons. Remarks had been made bearing on the inferiority of tame birds; but it must be borne in mind that attention to the breed of animals was sure to create an improvement in the points which it was desired to develop; and by attention to the breeding of ostriches, no doubt very superior animals would be produced. Another point was the interest which attached to the effective domestication of any new animal. All domestic animals known to the present time had been domesticated from prehistoric times, and the reason, he believed, was this. All travellers had observed that savages reared wild animals as pets, and it was common for chiefs of tribes to receive gifts of animals as presents, and preserve them. For instance, the king on the shores of Lake Nyanza, as mentioned by Captain Speke, had quite a menagerie; those animals which throve in captivity multiplied, which was not the case with all animals, and thus those which were useful ultimately became preserved and domesticated. The ostrich, it appeared, did admit of domestication, and had been reared, to some degree, in various parts of Africa; but, until very lately, no great pains had been taken with it. There was another bird also half domesticated in Africa, the gallina, which was never wholly domesticated because, although these birds were hardy and throve in captivity, they were rather wild, laying their eggs away from the haunts of man. The same difficulty was found with these birds in England; and it was an interesting case of an animal nearly fit for domestication, but not entirely so, which was almost domesticated in savage countries as well as in England. The only point on which he disagreed with Mr. Simmonds was that in which he spoke of the flesh of the ostrich as being delicate eating, for having eaten most kinds of game in Africa, he could only say that the flesh of the ostrich was the hardest, driest, and most sinewy of foods which existed. One point which might be interesting, was the manner in which the hunters carried the feathers after the bird had been shot. One would naturally suppose the hunter would be somewhat puzzled with a handful of delicate feathers, which would be easily injured by the accidents of transport. He got over the difficulty by cutting the gullet of the bird, tying a sinew or thong to the feathers, and pulling them through it; and in this way the feathers were taken to Cape Town, or wherever he wished to bring them. He concluded by proposing a hearty vote of thanks to Mr. Simmonds for his paper.

Mr. Simmonds, in reply, said his object had been served by eliciting practical information from the practical men present. He did not come there as an advocate of this industry, or with the view of inducing parties to embark their capital in it. He had merely put together certain facts, which, he thought, were reliable, even in those cases in which they had been doubted. His figures had been taken from the Board of Trade returns, the Consular reports, and others, and the only difficulty he had found was, that in the last returns, ostrich feathers had not been separated from ornamental feathers generally. Still the ostrich feather formed by far the largest item in the whole. He had hoped that other gentlemen would have been present from the Cape, who would have given more information upon the subject, especially as some of the authorities he had quoted might be rather over sanguine, and he did not altogether pin his faith to what had been put forward.

On the motion of Lord Alfred Churchill, a vote of thanks was passed to the Chairman, and the proceedings terminated.

ELEVENTH ORDINARY MEETING.

Wednesday, February 16th, 1876; Sir FRANCIS C. KNOWLES, Bart., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Anderson, George, 25A, Great George-street, S.W.
Campion, Frank, The Mount, Duffield-road, Derby.
Clark, John, Imperial Gas Works, King's-cross, N.
Green, Thomas Bowden, M.A., F.R.S.L., F.R.Hist. Soc., 14, Argyll-street, Regent-street, W.
Tyson, Edmund John, Hartford, near Huntingdon.

The following candidates were balloted for and duly elected members of the Society:—

Buckle, Captain Charles M., R.N., 3, St. James's-place, S.W., and United Service Club.
Rösing, F., 11, Billiter-square, E.C.
Sampson, Thomas, 252, Marylebone-road, N.W.
Smithers, Alfred Waldron, 24, Brandram-road, Lee, S.E.
Tooth, Robert, 10, St. Mary-at-Hill, E.C.

The paper read was—

THE COMBUSTION OF COAL GAS TO PRODUCE HEAT, AND THE THEORY OF THE STRUCTURE OF FLAMES.

By John Wallace.

Wherever heat is required it is wanted in a certain definable quantity. This quantity is constant for any given purpose; that is to say, whether the object is heating a building, heating or melting metals, cooking, or any of the numberless operations to which we apply it, the same operation, however often repeated under the same conditions, requires the same amount of heat.

The quantity of heat produced in order to perform any operation is always in excess of that actually required, because the whole of it cannot be utilised. Radiation, convection, and absorption are all at work to carry off as much as possible, and the amount thus lost depends in a great measure on the method we adopt in applying it. This is well exemplified in the weight of coal required to evaporate 10 lbs. of water in a steam-

boiler of good, or of bad construction, or in the weight of coal used in different stoves or fire-places to heat a room of a given size. The value of any material as fuel depends principally on its freedom from incombustible matter, and the facility with which it may be burnt in any desired quantity. Coal gas possesses these properties in a very high degree, and the condition in which it is supplied to consumers renders it the best kind of fuel for every domestic purpose requiring heat.

In many manufactures gas is the only fuel suitable for numerous delicate operations requiring a certain heat under perfect control; indeed, the possession of such a means of producing heat has given rise to numerous thriving industries which could not prosper without it.

Ordinary London gas requires to combine with about $6\frac{1}{2}$ times its own volume of atmospheric air in order to be completely burnt. It will not combine with more, but if it gets less, then part of the gas which could not find enough of oxygen will escape only partially burnt, in a condition very injurious to health.

When completely burnt, a cubic foot of gas will produce a definite quantity of heat, and although some makers and vendors of gas apparatus claim for their goods the property of increasing the effect I have just indicated, it is no more possible to do it than to increase a pint of new milk by adding water.

The chief points to be observed in using coal gas are, consequently—1st, to burn it in the most complete manner; and 2nd, to utilise as much as possible of the heat produced.

There are two methods of burning gas to produce heat, each having its own merits. In one case the gas is divided into a number of small jets exposing a very large aggregate surface to the action of the atmosphere. In the other case air is mixed with the gas before burning, so that only a part of the total combining quantity of air has to join the gas at the surface of the flame. This allows the surface to be greatly reduced, and the bulk of the flame to be increased, and consequently renders it possible to burn a greater quantity of gas than before in a given space.

The latter method, which is due to Professor Bunsen, is the one almost invariably adopted in burning large quantities. The gas can not only be burnt in much less space than formerly, but it gives off no smoke, and consequently deposits no soot on any surface which it may be required to heat.

I light the gas issuing from a tube half-an-inch in diameter, and you see a long straggling smoky flame. As it is only by contact with the atmosphere that combustion can be supported, the gas has to expose a considerable surface to the air in order to get its supply. There is a hollow space in this flame extending to at least two-thirds of its height and full of gas which can only burn when it meets the oxygen. The sheath of flame surrounding this hollow space represents that part of the gas already under the influence of the oxygen, and the thickness of the sheath may represent the distance to which the oxygen penetrates before it is completely combined with the gas. If a vessel of water or other cool substance were placed over this flame a coating of soot would soon be deposited. But the moment I admit air to mix with the gas below the flame, the flame contracts to at least one-sixth of its previous size, the illuminating power disappears, and all the heat the large flame gave out is now produced by the smaller one. This flame deposits no soot, but on the contrary, will burn it off a coated surface.

Returning to the smoky flame, I coat a piece of tinplate with solid carbon which has suddenly been changed from the invisible and gaseous form into a wonderfully fine black powder; and now admitting the air, the flame shrinks and intensifies, the carbon is again transformed, and is now carbonic acid gas.

Bunsen, or atmospheric burners, no matter what their form may be, all possess certain essential parts in common. There is a gas-jet orifice, and, in close proximity, one or more air openings. There is a chamber where the gas and air mix, and there is an outlet where the mixture burns.

Here is the simplest known form of Bunsen burner. It consists of a straight upright tube with a gas-jet orifice at the bottom and holes at each side of the jet, through which air is drawn by the inductive force of the gas. On removing the tube and lighting the jet the gas burns in a long pencil from the orifice, but, when the tube or mixing chamber is put on, the gas must burn at the top.

If the gas should light inside, then combustion is interfered with, and partially burnt gas begins to escape, producing that sickening smell which has brought the Bunsen burner so often into disrepute. The Patent-office bears witness to scores of inventions devised to obviate this defect, and it is my purpose to exhibit to you several forms of apparatus designed to avoid this most inconvenient tendency.

I shall now direct your attention to the appearance of the flame, as it is in all cases an unfailing index of the value of the burner for practical purposes. Not only must the proper proportion of air be mixed with the gas, it must be mixed intimately, otherwise the flame will be irregular, produce a roaring noise, and be liable to light within on a slight change of pressure. The roaring appears to be caused by certain parts of the column of gas and air having explosive proportions which ignite and burn more readily than the rest. These explosions are so rapid as sometimes to produce a musical note. This irregular mixture may be cured in the common burner by lengthening the tube and by other methods.

Here is a burner one inch in diameter, with a flame which shows all the peculiarities of good combustion. The flame has a hollow space within represented by a most brilliant emerald green cone resting on the tube. Above and around this is a clear amber coloured flame. The cone has a sparkling irregular surface, and the flame shows a strong disposition to "light down," indicating an imperfect mixture of air and gas in the tube. To render the admixture more complete I shall put into the tube a piece of sheet metal folded in such a manner as to divide the tube into several flat passages. The flame is now quite steady, although the air openings at the base of the tube are full open, and the gas may be turned up and down within wide

limits with perfect safety. In this case the surfaces against which the gas passes give it a rolling or eddying movement which thoroughly mixes the gas and air before they reach the flame. A mass of loosely twisted wire will produce nearly the same effect, but it reduces too much the velocity of the current.

Another, and a more complete method employed to adjust the proportion of air is exemplified in the "cam" burner.

At the base of the tube is a gas cock, having an eccentric fixed on the plug or key, which lifts the air slide in such a manner as to adjust the gas and air at one movement. The curves on the cam or eccentric are so made that on one side the maximum amount of air is admitted, producing an oxidising flame, while on the other side the curve allows a less amount of air, producing a deoxidising flame. By quickly reversing the cock, the air slide is closed, and pure gas burns at the top of the tube. In addition to this, the burner tube is hinged so as to incline to any angle, making on the whole a very useful laboratory burner.

To illustrate the intensity of the heat of the flame, I shall expose to it a piece of stout copper wire. It becomes rapidly red hot, then a pale golden colour, and now it has fallen in molten drops into the vessel of water placed below the flame. Copper is estimated to melt at 2,245° F.

It is not always convenient to use a burner of this description, because if the pressure were to be suddenly lowered independent of the gas cock and cam, it would light down and cause the usual nuisance.

In order to have a burner which shall be absolutely safe and reliable under all variations of pressure and quality of gas, another form of burner must be used, of a class represented by the tangent burner.

It consists of a circular chamber, into which the jet of gas enters at a tangent, drawing with it the air necessary for pre-admixture. The compound eddies round the chamber escaping finally at the tube a perfect mixture. A diaphragm of wire gauze below the tube prevents the flame from getting into the chamber, and a covering of the same material protects the jet orifice of the gas.

This burner may be made of various sizes, of which I have here an example with twelve flames.

It is now time to inquire how much air is mixed with the gas previous to combustion. The Tables I. and II. contain the desired information. They were made upon Newcastle coal gas, combining with about $6\frac{1}{2}$ volumes of air, and as the same coal is used to make London gas, they will serve to represent the results of burning London gas under the same circumstances. They show how much air may safely be mixed previous to combustion in a burner of a given size.

The burner used for this purpose had a tube seven-sixteenths of an inch inside diameter. The consumption of gas was maintained as nearly uniform as possible. The tables indicate the changes in the appearance of the flames as the pre-admixture of air varied. The result showed that one and a half volumes of air was the maximum limit of pre-admixture with a seven-sixteenth inch burner; if the air exceeded that amount, the flame would go down the tube and burn within. If, on the other

Experiments on the Proportion of Gas and Air, Mixed previous to Combustion, in Wallace's Burner.

Table I.—*Pressure of Gas and Air six-tenths of an inch.*

Experiments.	Height of Inner Cone.	Height of Outer Flame.	Volume of Gas Per Hour.	Volume of Air Per Hour.
	Inches.	Inches.	Cubic feet.	Cubic feet.
No. 1 ..	·29	2·75	6·00	8·22
No. 2 ..	1·00	2·55	6·00	6·00
No. 3 ..	1·55*	3·30	5·82	3·66

Table II.—*Pressure of Gas and Air fifteen-tenths of an inch.*

Experiments.	Height of Inner Cone.	Height of Outer Flame.	Volume of Gas Per Hour.	Volume of Air Per Hour.
	Inches.	Inches.	Cubic feet.	Cubic feet.
No. 4 ..	·55	3·30	8·84	12·72
No. 5 ..	1·00	3·30	8·88	10·92
No. 6 ..	2·40*	4·30	9·00	6·96

hand, less than 65 per cent. of air were mixed previous to combustion, the flame began to burn imperfectly and deposit soot. There must always exist a certain proportion between the diameter of a burner tube, the quantity of gas passing through it, and the quantity of air mixed with the gas. A well-made burner will be equally efficient with gas at all pressures, from three-eighths of an inch up to any number of feet on a water column; and it is difficult to say how much gas may be burned through one tube. We have already observed that as the pre-admixture of air increases, the flame becomes smaller and more intense. Bearing in mind, then, that the nearer a substance to be heated is placed to the source of heat, the more rapidly the heat passes into it, we find that a vessel of water may be placed nearer the centre of the flame without interfering with combustion. There is also less risk of the flame being fouled in its own products when the amount of air it takes up while burning is reduced to a minimum.

In Table III. are the results of three trials made with the illuminating burner against the Bunsen burner. A vessel of tin-plate, containing one pint of water, was placed over an illuminating burner of the batswing form at a height above the flames chosen out of three trials as the best position. The same vessel and quantity of water were placed over the Bunsen burner with like precautions :—

Table III.

Gas burning at the rate of 4·5 cubic feet per hour.

Experiments.	First. min. sec.	Second. min. sec.	Third. min. sec.	Average. min. sec.
Batswing.........	12·43 ...	12·45 ...	12·48 ...	12·45
Bunsen	9·32 ...	9·32 ...	9·33 ...	9·32

The results of this experiment serve to confirm what has just been stated. With gas burning in both cases at the rate of four and a-half cubic feet

* Cone almost imperceptible, with short white tail.

per hour, the water was boiled in 9 minutes 32 seconds by the Bunsen burner, whereas the batswing required 12 minutes 45 seconds. The balance in favour of the former is, therefore, 3 minutes 13 seconds, or 25 per cent. As the diameter of the Bunsen burner is increased it becomes more and more difficult to obtain a good and steady flame. Increase of length gives the air and gas more time to mix and produce a regular flame, but the slightest disturbance causes it to strike down. The experiment with the folded plate and the twisted wire as slight obstructions made a certain improvement, but could not be called a complete remedy. The rose top is the best known appliance, but when made of large size the combustion in the interior of the flame becomes imperfect, and, after all, it will not bear turning low without striking down. Another necessary condition also presents itself, increasing the difficulty of obtaining a good large flame. The proportion of air mixed previous to combustion must be greatly augmented, because the surface of the flame (which takes up the remainder of the air to render combustion complete) does not increase in the same ratio as the volume of the flame. If the flame be long and straggling, although giving off no unburnt products, it will certainly deposit soot when applied to the cold surface of a vessel of water; it therefore becomes a matter of the greatest importance, that the burner be of a form that is free from the risk of striking back when lighted. To meet this difficulty the perforated cap has been devised, which, by reversing the usual principle of construction, gives the most remarkable results. Instead of regulating the admission of air from from below by partially closing the air orifices, it is done at the top by back pressure.

A cap of perforated metallic plate is fitted over the top of the burner tube and made to slide up and down, so as to adjust the number of openings through which the air and gas are to escape into the flame. The cap offers more or less impediment to the upward passage of the gas, and thus controls and regulates its power of drawing in air at the bottom. This burner has been found capable of burning every kind of coal gas with equal facility. When lit, and adjusted to the maximum amount of air, the cap is studded with brilliant green beads forming the base of the flame; each bead corresponding with one of the perforations, while above you see a flame which is solid to the centre, and without that hollow inner space which has hitherto been considered a peculiar feature of all round flames.

A piece of fine wire put across the flame close to the cap is incandescent along the whole length enveloped in the flame coming from a burner two inches in diameter, and consuming forty feet of gas per hour. When I partially close the air openings, a hollow conical space immediately appears in the flame, and the wire cools to blackness. On again admitting the air the wire becomes immediately incandescent, and the flame is solid as before. In order to make the appearance of the beads more distinct, I shall use a cap, with much coarser perforations, which, if carefully lighted, makes a flame of marvellous beauty. The cap is now studded with an array of gems whose brilliancy would pale that of the brightest emeralds. Their colour is entirely on the surface, for they are hollow, and filled with the unburnt mixture of air and gas, and they fade and merge into each other on the slightest interruption of the air supply at the base of the tube.

These experiments all indicate that a great increase must have taken place in the amount of air mixed previous to combustion. This supposition has already been confirmed by measurement, proving that a burner two inches in diameter will burn safely a mixture containing 4·6 volumes of air per volume of gas.

Spectrum analysis has not yet thrown much light on the peculiarities of this flame. The carbon lines are exceedingly brilliant in the spectrum of the green beads, but the condition of combustion indicated is not clearly defined. It was at first thought possible that the increased temperature of the flame might cause a combination with the nitrogen of the atmosphere mixed with the gas, but a mixture of pure oxygen and coal gas gave the same spectrum as before, so that the nitrogen may be supposed to pass through it unaffected.

The application of coal gas to cooking seems to have had a fair amount of attention from competent men, and good and useful apparatus are easily obtainable; but it is otherwise with the gas stove, which shows scarcely any improvement for the past twenty years. It has been much ornamented, and that is all. The largest burner put in the smallest case that will hold it without becoming too hot seems to be the *ne plus ultra* of a gas stove. If a chimney is used, it is put at the hottest part of the stove case, so as to carry off the heat as well as the products of combustion, or still worse, the burner is put in a common fireplace, and at least seven-eighths of the heat go up the chimney. There is no more extravagant method of using gas than this.

Every one who has seen the coal stove in use on the Continent must be aware that its great heating power is due to a large radiating surface, and nothing else than a large radiating surface would give such a result. The same rule applies to the gas stove, which should be at least six feet high, and so arranged internally that the products of combustion should pass over the whole surface before escaping.

The diagram shown represents a section of a gas stove six feet high and fifteen inches diameter, with a partition dividing it into two parts from the bottom to within six inches of the top. The products of combustion from the burner, pass up to the top of the division, and then down the other division, escaping on a level with the burner, after having travelled nearly twelve feet over a thin iron plate forming the radiating surface of the stove. The hot spent gases not only pass over a large heating surface, but they travel slowly, allowing the greatest time for the heat to pass through.

The speed of the draught (being regulated by the difference of temperature of the two columns) is always in proportion to the amount of gas being burnt, and the result is a balanced draught which never requires the control of a damper.

Let me show you by experiment the advantage of this arrangement.

A syphon of stove piping represents the stove case with its two divisions, and a small burner is placed below one end. The pro-

ducts of combustion pass up one half of the syphon and down the other, escaping at the level of the burner. To render this apparent I pass some smoke up from beside the burner, and you presently see it emerge at the outlet, showing that there is a continuous current through. The products of combustion are losing heat through the sides of the pipe as they travel along it, and the thermometers fixed half way along, and at the end, will give us an idea of the rate of radiation. The thermometer at the bend of the syphon stands at 220 degrees Fahr., and that at the bottom or outlet indicates 95 degrees Fahr., so the difference between these two temperatures represents what would be the loss from a gas stove, if the chimney were put at the top instead of at the bottom, and shows the absurdity of placing the outlet at the top.

The disposal of the products of combustion is the next matter for attention, for, although they may be carefully turned into a chimney, they may be unable to ascend by reason of down draughts. This difficulty often occurs in heating conservatories having low chimneys, and situated frequently in places where the force of the wind accumulates. There is the risk of extinguishing the gas which may afterwards escape, causing serious risk of explosion, and there is also the danger of having the products of combustion blown in among the plants, which would soon kill them.

The problem then is, how to prevent the down draught without closing the chimney, and thereby arresting the products.

The disturbing force of the wind down the chimney must be met by another equal force acting at the same time in an opposite direction. These two forces will meet and neutralise each other, and the products will continue to escape, as in calm weather.

I shall again have recourse to experiment, to show how this may be done.

Here is a box representing the stove case, which is placed below the syphon pipe. A flame burns in the box which is air-tight with the exception of a small tube supplying air to the flame. The outlet of the syphon is extended so as to terminate close to the air supply tube. Both these tubes open in the same direction, and the orifices may be at any distance from the burner. We have now the outlet and inlet terminating so nearly together as to receive the force of the wind at the same time, and, although I make a violent current of air pass against these openings, you see through the glass window of the box that the flame suffers no material disturbance.

A gas heating stove cannot be said to be complete until it is fitted with an automatic regulator, which will only allow the gas to be burnt at such times and in such quantity as will ensure the desired temperature.

I shall now show you an apparatus designed for this purpose, which owes its movement to the expansion and contraction of air confined in a closed vessel. Air is remarkable for the small amount of heat requisite to change its volume. An increase of one degree Fahr. will expand 491 cubic feet of air into 492 cubic feet; and, if it is not allowed to expand, by being confined, it will exert a pressure equal to a column of mercury one-sixteenth of an inch in height. A difference of a very few degrees, therefore, can easily accumulate sufficient force to close or open the gas orifice of a stove.

The second diagram is intended to show how this may be put into practice, and such a regulator will work on a difference of two degrees Fahr., lighting, adjusting, or extinguishing the burner as heat may be required, for weeks or months together.

The mode of action is as follows:—A thin copper cylinder of a certain capacity contains the air which is to regulate the gas by its expansion. This vessel is painted a dead black to render it the more susceptible to absorbtion or radiation of heat, and it has on it a small valve, the purpose of which will presently be described. A small pipe leads from the expansion chamber to one end of an invented syphon, containing mercury. The other end of the syphon has within it a tube suspended over the mercury, with its mouth at about one-eighth of an inch from the surface.

The gas to be burnt enters the cup at one side, and passes over the surface of the mercury into the central tube, up which it passes on its way to the burner in the direction of the arrows. In addition to this a tube takes a supply of gas to a small flame burning constantly beside the burner. As the air is confined in the vessel, the tube, and the cup, any increase of volume will depress the mercury in the cup, raise the level in the tube, and decrease the space below the central tube by which the gas escapes to the burner; and if the air continues to expand, it will close it completely and cut off the gas. Then the surface of the mercury around the centre tube is acted on by the pressure of the gas while the surface within the tube is free, so the mercury within rises to a height proportionate to the pressure of the gas.

When the mercury begins to fall by reason of the cooling of the air in the expansion chamber, it still retains a higher level within the centre tube until its gravity overcomes the pressure of the gas, when it falls clear of the tube, allowing a free rush of gas to ignite the burner immediately by the aid of the constant flame. All that is necessary to set this regulator is to open the valve in the expansion chamber, and light the burner. When the desired temperature is obtained, the valve must be closed, and a sample, as it were, of air at the desired temperature is shut up in the expansion chamber. Any alteration of temperature outside the chamber will affect the volume of the air within, causing a corresponding adjustment of the gas. If the gas were turned slowly on and off, there would be an escape each time it was lit and extinguished, but in this case the supply and cut off are sudden, while the adjustment is gradual.

With an apparatus of this kind a conservatory, for instance, may be heated with the greatest nicety. As sure as the thermometer falls below a given point, the gas will be turned on and lighted, and when the sun affords sufficient warmth, it will be extinguished until the temperature falls again.

That absence of sufficient heating surface, which has already been noticed in speaking of the ordinary gas stove, is equally remarkable in most of the hot-water apparatus, where gas is the fuel used. Twenty-four inches is the maximum distance the heat is allowed to travel in contact with

the boiler, and from eight to ten inches may be regarded as a fair average distance when speaking of the small apparatus of which the greatest number are sold. Is it any wonder that gas heating has been tried and condemned a hundred, nay, a thousand times; or that the public at large should be thoroughly satisfied that it has in it no element of true success.

I know of only one manufacturer whose hot-water apparatus shows any sign of thorough appreciation of the fuel he has to deal with. The apparatus is shown on diagram No. 3, which has been kindly lent by the inventor, Mr. Ezard, of Bradford, near Manchester.

The diagram represents a double range of hot-water pipes attached to a small boiler under which the burner is placed. Instead of carrying the chimney away from the top of the boiler, it is made to pass along the upper range of pipes, emerging at the return bend.

You will at once see how greatly the heating surface is increased, and this is not the only important advantage gained. The time of contact is extended in proportion, and the result is that the products of combustion escape at a temperature only slightly above that of the water. When we remember that water contains 3,234 times the quantity of heat which an equal bulk of air contains at the same sensible temperature, it will be evident that very little of the gas heat is going to waste.

No real progress can be made in the application of gas to heating until the following facts are fully recognised. No apparatus made to burn coal fuel is fit to be used for gas fuel, the condition necessary to ensure good combustion being totally different. Gas fuel requires a large heating surface, and a very slow chimney draught, barely enough, in fact, to carry off the product; and this draught must not be disturbed.

Gas at 3s. 9d. per thousand feet costs 1½d. per lb., and yet it is now well known that cooking may be done with it not only better but more cheaply than with coal.

I shall now proceed to make a comparison between gas and coal as fuel for heating, and the figures will require very little to be added by way of comment.

Let us assume, as a basis, that coal costs the user 26s. per ton, and gas at 3s. 9d. per thousand feet in London, and on these data examine the cost of obtaining an equal amount of heat from the two substances.

In 1866 Dr. Letheby and Mr. F. J. Evans demonstrated that 1 lb. of coal completely burnt would produce the same amount of heat as 13 cubic feet of coal gas.

From the estimates of Dr. Neil Arnott, Mr. Edwards, author of "Our Domestic Fireplaces," and other authorities on this question of the heat utilised for warming a chamber by burning coal in a common open fireplace, it appears that on an average, one-eighth, or 13 per cent. of the total heat of the coal is really available for the desired purpose. Eight pounds of coal would, therefore, be required to produce as much heat in a room as would be given off from a three-light chandelier burning 13 cubic feet of gas in one hour.

Their relative prices would be as follows:—

	d.
8lbs. of coal at 26s. per ton............	1·112
13 cubic feet of gas at 3s. 9d. per 1,000..	·585
Difference	·527

In other words, the cost of the same amount of heat in the two cases would be as 11d. to 6½d., which is tantamount to saying that the coal heat costs 90 per cent. more than gas heat. As it is not wholesome to allow the products of combustion from a gas stove to escape into a room, a liberal sacrifice might be made to get rid of them by means of a chimney, without bringing up the cost of the gas to that of the coal.

There are certainly many methods of using coal which render it more economical than gas, but most of them are expensive to apply, and none possess all the advantages of gas fuel. If the figures just quoted are to be relied on, gas is no longer to be regarded as a luxury for the wealthy alone. The poorest classes have generally the worst constructed fireplaces as regards heating power, and buying their coal in small quantities, they pay a higher price for it than do those who buy by the ton. It should be an inducement to the public to know that the use of gas in the daytime is more likely than anything else to reduce the price of it by giving uniform and complete employment for the apparatus at the gasworks, and it is neither impossible nor even improbable that at no very distant date coal or other gas may almost entirely supersede the fuel at present used in the dwellings of all our large towns.

There is one other application of gas heat to which it will on the present occasion be possible only to refer briefly. It is the raising of steam to drive small engines of not more than four horse-power. The demand for engines of this class is already very great, and a good substitute for the coal furnace is much needed, not only because it affects the insurance of a building, but also because a small fire requires much more vigilant attention than a larger one. There are already many gas-heated boilers in London and elsewhere, but they appear to be all constructed after the pattern of the coal-fired boiler, and the inevitable consequence must be a considerable waste of gas. The rules already detailed for the construction of heating apparatus apply equally to steam boilers. There must be the balanced draught, the large heating surface, and the greatest possible distance for the heat to travel before leaving the boiler. There must also be high steam pressure, and an automatic regulating valve on the gas-pipe, actuated by the boiler pressure, so as to turn the gas down as soon as the steam approaches the blowing-off point, and thus use fuel only as the rate power is required.

Such a boiler is already in the hands of a well-known firm of engineers, who intend to manufacture it in conjunction with small sizes of the already famous Willan three-cylinder engine. Results of the most satisfactory character have confirmed the experiments already made, and an exceedingly useful and compact apparatus may be expected.

There are various facts among the foregoing remarks which, if summarised, may lead to some useful conclusions regarding the constitution of

the solid flame. Let us take the well-known Bunsen flame as a basis of comparison. There is the conical space within the flame, then a sheath or envelope of flame described by Faraday as the zone of partial combustion, and outside of all a second sheath or envelope, the zone of complete combustion. Although air has been mixed with the gas before it reached the flame, it is not sufficient to render the gas combustible. The mixture of air and gas ignites first around the edge of the tube, because there it meets the oxygen most readily, but the centre of the rising column of gas and air has to travel to the top of the hollow cone before it can meet the oxygen of the air, which rushes into, and combines with, the flame, with extraordinary rapidity. The thickness of the flame surrounding the hollow cone represents the distance the oxygen travels before it is combined with the gas, previous to escaping upwards as carbonic acid at a temperature which greatly increases its volume. Part of the oxygen is arrested in the outer sheath or zone of perfect combustion, and part presumably passes into the zone of partial combustion, producing a carbonic oxide flame, which, as its material passes into the outer part, receives its complement of oxygen, and becomes carbonic acid.

It has already been observed that small flames require less air pre-admixed than large ones; this is due to the greater surface which they present to the air in proportion to their bulk. The oxygen has consequently a less distance to travel into them.

In Table No. 1, a 7-16th of an inch burner would only bear $1\frac{1}{2}$ volumes pre-admixed before becoming solid, whereas a 2 inch burner would require a mixture of 4·6 volumes to solidify it. If the small burner received more than $1\frac{1}{2}$ volumes, the flame immediately descended and burned within the tube, its position in the tube depending on the excess of the pre-admixture. Before the flame descended, it exhibited the bright green film across its base, indicating the best state of combustion, and it retained the green film even when burning half way down the tube.

Now, when we remember that it requires nearly $6\frac{1}{2}$ volumes of air to consume the gas completely, it is evident that the amount pre-admixed is not enough even to produce a carbonic oxide flame, which requires just one half of the total amount. If, then, the combustion is complete, the flame must receive its complement of oxygen through the top of the tube, making its way through and against the current of products of combustion, whose velocity is increased by expansion into six or seven times their original volume.

Leaving the small flame, let us turn to the large one. The primary conditions are here very different. In the first place it has only one tenth part of the surface in proportion to its bulk that the small flame has; and in the second, the amount of air pre-admixed is 4·6 volumes, or about 40 per cent. more than that necessary to produce a carbonic oxide flame. The flame is perfectly solid, from the green beads where it commences, up to the top. There is no apparent difference in the temperature of the flame from the centre to the outside, and the green beads (those most delicate indexes of any change in the proportion of oxygen in any part), are exactly the same in colour and size at the centre as at the outer edge. The platina wire when suddenly placed across the flame heats apparently at the same rate in every part immersed, so there is much reason to suppose that this is a carbonic acid flame having neither the zone of no combustion nor that of partial combustion.

It must not be regarded as a group of separate flames, as the beads have no separate supplies of air; besides, a solid flame can be produced without the perforated cap, by making a sufficiently intimate mixture of the air and gas, as in the case of the smaller flame. Since the green beads are so uniform in size and colour, we may reasonably conclude that they are burning under the same conditions, and one of these conditions is that the two and a quarter volumes of air necessary to combustion of the gas must pass to the very centre of the flame, giving every bead a uniform and equal supply.

It would be interesting to learn whether the nitrogen of the two and a quarter volumes of air accompanies the oxygen into the flame, or whether it is partially or wholly dissociated before combining.

The subject has been treated throughout from the point of view of an engineer rather than that of a chemist, and more with a view to getting at the simplest and best modes of burning coal gas rather than of analysing the phenomena of combustion.

The work of the chemist has been a good deal limited by the apparatus with which he has experimented; and it is with a hope that an improved form of burner may assist in the further analysis of a most important subject, that the matter has been brought before you.

DISCUSSION.

The Chairman, in inviting discussion, said it must have been noticed that this was a process for producing heat; when light alone was to be produced, the particles of carbon which were thrown up above the flame might be collected on a tin plate, those particles being really heated by that portion of the carbon which was thoroughly burned, and, like the particles of any other body, highly heated, evolved light. As the quantity of light was reduced greater heat was produced, and, therefore, the less light, the more heat there would be. With regard to the colour of the flame, it struck him that a kind of separation took place, and that the exterior flame, of a faint reddish hue, was the hydrogen flame, and that the interior flame, of a bluish green colour, was due to the combustion of the carbon. There was a sharp line of demarcation between the purple and the blue flame, and that it appeared to him was the precise measure of success in the burner. In the centre of the flame the particles were being burnt which in an ordinary flame escaped into the air, and thus a greater heat was produced. If you wanted light you must sacrifice heat, and *vice versâ*, and, in accordance with this view, he thought most stoves had far too much light to be successful.

Mr. Wallace, to illustrate the Chairman's remarks, here showed that the light of a candle was sufficient, and when the gas in the room was turned down, even the light of a match, to throw the shadow of an opaque object through the flame of his improved Bunsen burner on to a sheet of paper.

Mr. F. W. Hartley had listened with great interest to the paper, more particularly as he had made many experiments with Mr. Wallace's burners, which he thought were far in advance of the ordinary Bunsen burner. Still, he must in some measure dissent from some of his conclusions in respect to the applicability of

gas for heating purposes as compared with solid fuel. Unfortunately he had not the figures with him, but some time ago he read a paper before the British Association of Gas Managers on this very subject, wherein he instituted a comparison between the heating power of coal gas and of solid fuel, and was obliged to come to the conclusion that gas, either applied to warming or to boiling water, would be from three to four times as expensive as solid fuel. The data with which he started were nearly identical with those Mr. Wallace adopted, namely, that 13·32 cubic feet of gas were equal to 1 lb. of coal. Mr. Wallace had spoken of the heating power of gas flame in a chandelier, but when burnt openly in that way, the whole of the heat given off by the flame was present in the room, but when it was burnt in a stove of ordinary construction which must be ventilated, the great part of the heating power given off by the gas must pass away, even with the stove recommended by Mr. Wallace, though that, he believed, might be equalled by some others in the market. With regard to stoves for boiling purposes, he could not accept the heating surface mentioned of 10 to 12 inches as a fact, and he knew that in the Jackson boiler, Mr. Goddard, of Ipswich, succeeded in getting practically about 9 lbs. of water evaporated for every 13 cubic feet of gas employed. Then, with regard to the Bunsen burner itself, he did not know whether they were coming to the conclusion that that kind of burner gave off more heat than any other in which gas was properly consumed, but if so, he could not agree to it. If you could supply the gas with the full amount of oxygen necessary to its combustion, it mattered not what burner was employed, you would get the same amount of heat; the only advantage was that you intensified the flame, so that objects placed in it were raised to a higher temperature. The flame might be concentrated, but the total quantity of heat evolved was the same in either case if the gas were completely oxidised. All chemists would acknowledge that whether a body were oxidised slowly or rapidly, the same amount of heat was given off from it, whether it was sensible thermometrically or not. Hence he was at issue with some people as to the application of Bunsen burners for cooking stoves. For boiling, or for laboratory purposes, no doubt they were admirable, but for ordinary purposes it would frequently happen that a simple jet burner was more advantageous, particularly in cooking stoves. Mr. Wallace had got rid of some of the disadvantages of the Bunsen burner in preventing the return of the flame, but it must be remembered that in cooking and heating generally, an enormous advantage was derived from the radiated heat, which, in these burners, was very little. It had been stated, on the authority of Dr. Letheby, that the radiant heat from a Bunsen burner was only 12°, whilst from an ordinary burner it was 30°, and from an ordinary burner with a spiral of platinum in it, it was 85°, thus showing that if you could get solid matter into a flame, you got an enormous increase of radiating power. The quantity of heat given off from an ordinary fireplace had never been determined, the estimate varying from one-third to one-eighth of the total quantity produced, but he believed the latter figure to be much too low. In making these remarks, he by no means meant to detract from the value of Mr. Wallace's burners, which he much appreciated.

Mr. A. G. Southby thought all must admit that they were much indebted to Mr. Wallace for his improvements in Bunsen burners for heating large objects to a great heat, but he must differ from him in his conclusion that the only way of using gas economically for heating was by means of a Bunsen burner. When the heat was to be applied to boiling water, or warming a room, or any domestic purpose, a comparatively slight heat only was required, and he had come to the conclusion that water could be boiled rather more economically by an ordinary batswing or fishtail burner, in an apparatus constructed for the purpose, than by any Bunsen burner in the market. A little stove, which was sold for 1s. 6d., would boil a larger quantity of water with the same amount of gas than any Bunsen burner as ordinarily used, though if applied to the same apparatus it would give equal results. If carbon and hydrogen were totally consumed they must give out exactly the same amount of heat, however it was accomplished, but the effect of the radiant heat in boiling was commonly very much underrated. In an ordinary steam boiler, one-fourth of the heat which went into it came directly from the fire. With regard to the amount of heat wasted in such a stove as Mr. Wallace had exhibited, he had shown that in one constructed on the same principle it was only two per cent., and even less than that if the pipe which carried off the products of combustion was used for heating the ventilating air as it came in from outside the building.

Mr. Branson said the last two speakers seemed to have rather fogged the question of heating by gas by introducing the word "if" rather too freely, saying that an ordinary burner would produce as much heat as the Bunsen if properly arranged. But hitherto it had always been the question how to do it properly. Mr. Wallace had shown pretty conclusively that the flame of an ordinary burner impinging upon metal left its own carbon there, which, being a great non-conductor, would tend to neutralise the object of using gas at all. For many years past he had used the largest gas furnace in London, or probably anywhere else, and he could only say that a properly constructed Bunsen burner, where the flame had to impinge upon the metal, was simply invaluable. It gave you complete control of the temperature, which was not the case in a coal furnace, and in many processes which required delicate treatment it was an inestimable advantage. The only drawback was that which had already been mentioned, viz., the expense of the gas, which, whether burned with or without air, certainly cost three times as much as coal, and probably four times, and he did not see how that could be prevented, unless the operations were large enough to permit the user to make his own gas. The great difficulty he had found in the use of gas was that unless you had utensils upon which the flame could directly impinge, a great deal of heat was dissipated.

Mr. Riley had been much interested in the paper, but must agree with what had been said by the first speaker, that if the carbon and hydrogen were completely oxidised, you must get the same quantity of heat whatever burner were employed. As to the cost of gas and coal, there could be no comparison. Mr. Wallace had taken the cost of coal when a very small portion of it was utilised, as in an ordinary firegrate, which was the most wasteful way possible of using it. He had tried to distil water with gas, but found the cost enormous as compared with coal. Some years ago he was foolish enough to trust some one to put up a gas bath in his house, but it filled the place with the smell of partially burnt gas, and proved a complete failure, though he managed to improve it somewhat himself. One difficulty was that you always got a large deposit of moisture, which condensed on the surface of the pipes, and tended to check the draught; this was a great obstacle where you wished to heat water by circulation. The best and most economical mode of heating water by gas which he had seen was that called the Geyser, made by some one in the Goswell-road; and a friend of his had used one for a bath, and spoke most favourably of it. The principle was that there were a series of very small jets of gas at the bottom of a cylinder two or three feet high, and the water was made to trickle from the top over a number of copper tubes, which were heated by the gas.

Mr. Wills said the questions which had been mooted all depended upon certain scientific principles, and must be decided by them. In a common luminous gas flame you had the heating of particles of carbon; and the

reason of the luminosity was not that there was carbon present, but because there was a sufficient space of time during which the particles were raised to incandescence. If this time were appreciable you got luminosity, but if not you lost it, and this was the case when the separation of the carbon and its conversion into carbonic acid took place simultaneously. When a gas flame was fed with air there was no luminosity, but what would have existed in the form of light was converted into heat. This was one gain; but there was another also, in the concentration of the heat into a smaller space. A luminous flame was of considerable length, but the moment air was introduced the flame was shortened, and consequently gave an increased temperature. One or two speakers had slightly confounded two different things—calorific value and calorific intensity. It was quite true that you could only get a certain amount of heat out of any given fuel, whether you burned it slowly or quickly, and this was the value, but the intensity was a very different thing. You might get out of a piece of wood a temperature of 2,000° Cent., or only 10° Cent. if it decomposed slowly; and this depended on two conditions, the space and the time in which it was burned. When air was introduced into a gas flame, more of it would burn in a given time and in less space, and the temperature rose correspondingly, the degree depending in great measure on the class of apparatus you used. He thought Mr. Wallace was in error in describing the Bunsen burner as having three zones, as he believed there were only two, the interior cone in which there was simple gas, and the outer one in which the gas was burning. He had a little difficulty in accepting the Chairman's suggestion that hydrogen was burning outside, and carbon inside, because the hydrogen mixed with the air much more rapidly and energetically than the carbon, and hence the combustion of the hydrogen would be more likely to take place near the supply of air than the carbon. The absolute temperature of hydrogen uniting with oxygen was something like 34,000° whereas that of carbon and oxygen was about 80,000°, and therefore the probability was that the greater energy of combustion took place nearest the point of contact with the air. The principle of the Bunsen burner depended on this fact, that the speed of gas and air issuing from the tube must be greater than the speed of combustion of the mixture. Oxygen and hydrogen, when combined, formed water, and in doing so produced the greatest amount of heat and force with which we were acquainted; such a mixture was found by practical experiment to burn at the rate of about 38 feet per second; and with a tube 8 feet long, it would take about one second for the flame to traverse the whole length. If, therefore, you wanted thom to burn at the extreme end, the mixture must pass along it at a greater speed than 38 feet per second, or else the flame would go back, and an explosion take place. The same thing occurred in the case of gas and air, though the mixture was not quite so explosive; they would burn down the tube at a given rate, and it was necessary to have the gas passing out at a greater rate than the gas would burn backwards. All the appliances Mr. Wallace had introduced, were for the purpose of retarding this backward flow. The most intense heat, no doubt, would be found at the point of the inner cone, where the most energetic combustion took place, and it would have been noticed that the platinum got brightest just at the top of the blue flame.

The Chairman, in proposing a vote of thanks to Mr. Wallace, said he did not understand that he proposed to supplant ordinary fuel by gas in all cases, but only to show the best mode of utilising it for heating purposes; otherwise there would be such an enormous amount of coke produced, they would not know what to do with it.

Mr. Wallace, in reply, said he was much pleased at the full discussion which had taken place, and assured Mr. Riley that no one could express an adverse view more agreeably than he had done. At the same time he must repudiate the error of supposing that gas gave out more heat when burned in one manner rather than another, supposing it to be completely oxidised in each case, and it would be found that he had expressly guarded himself in an early passage in the paper from countenancing such an idea. With regard to the velocity of combustion, or the rate at which the column of gas rose in the tube, and the rate at which it was burned, the total area of the openings in the cap might be considerably less than the total area of the tube, and therefore the speed of combustion was in the inverse ratio of the two areas; so that although the speed of the gas passing through the holes might be greater than the rate of combustion, yet the rate of the ascension of the column within the tube might be considerably less; and that was one of the advantages of the perforated cap. This view was that in a small flame there were three zones, that in a larger one the second zone disappeared, and that in a much larger one, with a greater increase of air pre-admixed, the hollow space disappeared. A small flame more resembled that of a candle, and a very small flame gave no light, although no air was mixed with it previous to combustion, because its surface was such in proportion to its bulk that the oxygen could unite with it with sufficient facility to prevent any luminosity.

MISCELLANEOUS.

GRESHAM COLLEGE.

At a recent meeting of the Court of Common Council, Sir Charles Reed presented to the Court a resolution of the Committee for Managing the Gresham College Trusts, of which he is a member, and of which Lord Selborne is chairman. The resolution is as follows:—"That it was desirable that the Gresham Lectures, and the funds applicable to their support, should be placed, with the assistance of the Charity Commissioners, on a more satisfactory footing." Sir Charles explained that during last year the committee had resolved to take steps to remove the reproach which had fallen upon the college, in consequence of the discredit attaching to the arrangements made for the delivery of the lectures under the will of Sir Thomas Gresham. Upon the resignation of the late Lecturer on Astronomy the committee had abolished the Latin lecture, increased the number of English ones, and made the appointment, not one for life, but during pleasure. These changes were made to secure the power at some future time to deal with the trust by a new scheme, if it was thought well to do so. While these matters were under deliberation a letter was received by the Lord Mayor from the Charity Commissioners, calling attention to the lectures, and offering to confer as to "a plan for placing them on a more satisfactory footing." The letter was forwarded by the Court to the Gresham Committee, and it was in answer to that letter that he now brought up a unanimous recommendation that the committee should be at liberty to agree to such conference. In order that the grounds of this recommendation might be fully understood, he proposed to refer briefly to the origin and history of the Trust. Sir Thomas Gresham gave to the Corporation and to the Mercers' Company, by his will, in 1564, two properties, one, the Royal Exchange, the other a mansion, called in his own words, "Myne now house in the parish of St. Helen's and St. Peter's the Poor, for the maintenance of four persons to be appointed by the Corporation to read lectures in Divinity, Astronomy, Music, and Geometry in the said house." The Mercers' Company, on their part, were

to appoint "three persons to lecture in Law, Physic, and Rhetoric." The appointment to these lectureships, it would be observed, were made independently, but secondary duties, including the management of the Exchange, devolved upon the two bodies in their joint capacity. Thus constituted, the Grand Joint Committee adopted in 1597 certain regulations in these words—"It is thought good for the credit of the place, for the increase of learning, and for the honour of the founder, that there be certain several solemn lectures publickly read and performed in such manner as may best tend to the glory of God and the common benefit of the people of this City, and for that the greatest part of the inhabitants understand not the Latin tongue, whereby the said lectures may become solitary in a short time, if they shall be read in the Latin tongue only, they shall be read also in English; and yet withal it is very likely that divers strangers of foreign countries who resorteth thither, and understandeth not the English tongue, will greatly desire to hear the reading of the said lectures, whereby the memory of the said founder in the erecting of the said college for the increase of learning may be divulged to the good example of foreign nations and the honour and credit of this honourable City." Following this declaration the arrangements for the delivery of the lectures in Latin and in English were set out. Laudable as were the intentions of the early managers, there was abundant evidence that abuses gradually crept in, which rendered the administration of this magnificent educational endowment a scandal and reproach. The records of the Corporation bore some early references to such a state of things, but in 1706 a memorial was presented setting forth grave charges against the professors, who, it was alleged, had evinced "an unwillingness and reluctancy to perform their work, because it required some pains and attendance, and were so far from the ambition of being crowded with auditors, that they seemed rather to desire to have none at all." Pursuing this policy thoroughly by refusing to read on holidays, the professors reduced their duties to "next to nothing, and together with the affronts of some on those that come to demand their lectures, the uncertainty of the times and days when they were to be read, the meanness and indifferency of some of them when they did read, being often without method, design, or regular handling a subject, not confining themselves to their proper province, but passing in a desultory manner from one subject to another, without that order and connection as might have been wished, so far discouraged and baulked the expectation of the auditory that they almost gained their point." Dr. Johnson, mourning the fallen fortunes of a college, frequented in its palmy days by all the literary celebrities of London, and in which the Royal Society was founded, says: "Gresham College was intended as a place of instruction for London, able professors were to read lectures, but they so contrive as now to have no scholars." To remedy these abuses the Court in 1719 instructed its committee to take steps to enforce obedience to certain stringent regulations; it required the professors to give bonds for the due performance of duty; it refused to allow reading by proxy, and made residence obligatory. All this, however, was of no avail, for the jurisdiction of the Court was denied, and the professors claimed absolute independence of all authority. Following the downward history, it was lamentable to state that in 1768 the college property was alienated to the Crown, and a splendid prospective income was bartered away for a paltry £500 a year, to which sum the lecture fund was thenceforward limited. Thus denuded of its ancient renown, and deprived of its observatory and laboratory, the Gresham lecture was consigned to an obscure apartment in the Royal Exchange until the fire of 1858, when the building in Gresham-street was erected. Of the lectures in the old Exchange it is enough to say that, owing to the incapacity and irregularity of the lecturers, the numbers had dwindled down to a score of persons on the average. Between 1800 and 1820 he found the returns showed thirteen auditors at the Latin and ten at the English lectures, other than music; and frequently there had been no lectures at all for want of an audience of three persons. In 1837 the Corporation ordered that in "the event of any vacancy occurring in either of the Gresham professorships, which are in the appointment of the Corporation, that the same be not filled up until the Gresham committee have reported to this Court, so that steps may be taken for making the lectures connected with such professorships of immediate utility to the citizens of London, and worthy the memory of Sir Thomas Gresham." Again, on the 13th July, 1848, the committee was instructed not to elect any gentleman to a vacant lectureship "who will not undertake to express his willingness in writing to enter into such arrangements for the delivery and better development of the lectures as this committee may think fit from time to time to make." And again in 1850 the Corporation required the candidates selected by the committee "to give a probationary lecture at the college, due notice being given to every member of this Court." These resolutions, while they all mark the earnest desire of the Corporation to restore the venerable trust to a position of honourable usefulness, reveal at the same time the secret of its decay and humiliation. He felt it a disgrace to admit that the enlightened design of the founder was utterly frustrated, and must so continue to be until ample powers were given to an undivided authority to adapt the lectures to the wants of the time, to act as one body in all appointments, and retain full control over the learned persons appointed under the trust. In 1867 counsel's opinion was sought upon these points. He would not trouble the Court with the case, but the committee was advised that the only satisfactory solution of the difficulty would be found in the agreement of the Corporation and the Mercers' Company to propound a scheme for the sanction of Parliament. That agreement had now happily been arrived at, and it appeared to the members of the Gresham Committee representing the Corporation that the present was a fitting time for effecting so desirable an object. The proposed conference would be under the presidency of the Lord Mayor and Lord Selborne, and it was not too much to predict that the result of the deliberations would be a scheme which, while it preserved to the citizens the direction of an ancient trust, would cause it once more to represent the wishes of the founder, in making it what he originally designed it to be, a college for the furtherance and advancement of learning in London.

In the report of the discussion on Mr. Shirley Hibberd's paper last week, Mr. Smartt is made to speak of "transplanting young seedlings into pots." His suggestion really was to "graft them on to stocks."

Statistics relative to the use made of the post-office in the principal countries of the world, show that Switzerland occupies the first place with 31 letters annually per inhabitant; England comes next with 20½, then the United States with 19. France only ranks ninth. With respect to telegraphic communications Switzerland also takes the lead with 81 messages per 100 inhabitants; next follow England, 54; Holland, 51, Belgium, 47, the United States, 32, Germany 31. France has the tenth place in the thirteen chief states; Russia the last, with one telegram only per 100 inhabitants.

It is stated that a week's work in Birmingham comprises, among its various results, the fabrication of 14,000,000 pens, 6,000 bedsteads, 7,000 guns, 300,000,000 cut nails, 100,000,000 buttons, 1,000 saddles, 5,000,000 copper or bronze coins, 20,000 pairs of spectacles, six tons of papier maché wares, over £30,000 worth of jewellery, 4,000 miles of iron and steel wire, ten tons of pins, five tons of hair-pins and hooks and eyes, 130,000 gross of wood screws, 500 tons of nuts and screw bolts and spikes, fifty tons of wrought iron hinges, 350 miles length of wax for vestas, forty tons of refined metal, forty tons of German silver, 1,000 dozen of fenders, 3,500 bellows, 800 tons of brass and copper wares.

MÉKARSKI SELF-PROPELLING TRAM-CAR.

This tram-car, worked by heated and compressed air, has been tried with success on one of the Paris tramways. The framing is supported on two axles rather near together to facilitate the passage round curves; and the body, after the stylo of the Northern Tramway Company of Paris, contains seats for sixteen passengers, while standing room is afforded for fourteen more on the hind platform. In front is another platform of smaller dimensions reserved for the driver, and carrying the heat chamber and regulator, the use of which will be explained further on. Air-tight cylindrical reservoirs for the compressed air are connected together by copper pipes, and are dividod into two series, the larger constituting the principal motive agency, and the smaller, of one third the volume, constituting the reserve. On leaving the reservoirs the compressed air passes through a column of hot water in which it becomes saturated with steam at a high temperature; this water, which is introduced before starting into the heating chamber at a temperature of 338 to 356 degrees Fahrenheit, gradually parts with its heat during the journey, so that its temperature becomes reduced to about 212 to 248 degrees Fahrenheit at the end of the course. In the upper part of the heating chamber, therefore, is contained a mixture of air and steam at the pressure of the reservoirs. Instead of discharging this gaseous mixture directly into the working cylinders at a pressure which is necessarily variable and continually decreasing, it is made to pass through a special appliance by which the pressure is regulated automatically to a given degree, variable at the will of the driver, notwithstanding the variations of pressure in the reservoirs. On leaving the regulator, the gaseous mixture enters the cylinders where it acts upon pistons similar to those of a locomotive.

The distinguishing feature of M. Mékarski's system is the use of air saturated with steam whereby a long run may be made with a comparatively small quantity of air. The action is noiseless, for the steam, instead of exhausting, is condensed in the cylinders as completely as possible, in order to restore to the air all the latent heat absorbed by the vaporization. The tram-car is so well under hand that it can be stopped suddenly, again started, and the speed increased or slackened with tho greatest ease. At one end of the line, air-compressing machinery must be erected, with powerful expansion and condensing engines working pumps for forcing the air, compressed to 25 or 30 atmospheres, into the reservoirs of the tramcars while they are at rest, and the excess into fixed reservoirs; each car, after its double journey, receives its charge of air, while at the same time steam is introduced into the heating chamber to restore the amount of heat lost on the journey.

A new tramway locomotive has been constructed at Nivelles, where it has been with such success, on the tramways connected with the works, that a second of smaller size is begun. The boiler is on the Belleville system, the fire-box is arranged for burning coke, and the combustion is intensified by a Korting ventilator. A three-cylinder Brotherhood engine turne an intermediate shaft which engages in the driving axle by means of an endless screw and worm-wheel.

Herr Hirn has been conducting a series of experiments on the comparative strength of wood and cast-iron in their different applications, and finds that, in a great number of cases, the former has the advantage. The strength of the wood was found to be in direct ratio to its density; and this strength was increased by immersing the pieces of wood in linseed oil heated to between 80° and 100° Centigrade (185° and 212° Fahr.) for two or three days.

TYPE-WRITING MACHINES.

The idea of substituting a writing machine for the pen is a sufficiently obvious one, and has occurred to a great number of inventors. It is, however, only lately that any real success has been attained in this direction, and even yet it is probable that the invention is hardly in as perfect a condition as it will certainly attain, should its theoretical advantages be at all realised in practice. It is quite certain that a machine must have very great advantages over the pen before it can—except in a few special cases—rival it. Even the simplest machine must be costly compared with a pen, it cannot well be very portable, and it requires a special training besides that which has already been undergone in the case of all who have learnt to write. Then there are also the inherent defects of machinery, such as liability to get out of order, necessity of repair, and the like. Against these may be set, in a thoroughly satisfactory machine, the greatly increased legibility of type over manuscript, the fact that any person who can operate the machine at all can produce perfectly legible matter, instead of the hieroglyphics of a bad writer, the increased speed of production—which should be quite double that of the pen, the economy of space from print as compared with manuscript, and lastly, but by no means least important, the avoidance of injury to health and eyesight from long-continued writing. It should be added that a good machine would also do work that could not be done by hand at all where "manifolding" is required, for it would produce some sixteen or eighteen copies in much less time than a writer could produce half-a-dozen. On the whole it may fairly be said that if a good writing machine can be produced at a reasonable cost, there will be plenty of demand for it. It must be tolerably cheap, for the clerks' work which it would chiefly supersede is not very highly skilled labour, and can be supplied in any amount required, at a cheap cost. How far the acquirements of a perfect apparatus have been fulfilled by any machine now before the public, or likely to come before them, may be left to be decided by experience. Several machines have been made which more or less completely answer the purpose intended. Sir Charles Wheatstone constructed more than one, though he never made public the result of his experiments, and there are two now practically in the market, one brought out by the "Remington" Machine Company, and the other the property of Mr. S. Holten, and known as the "writing ball." The author of this sketch is not aware that there are any other machines actually before the public at the present moment, and even these two have only been so recently introduced that they have not had time—whatever their merits or demerits—to have proved their value by the test of experience.

The nearest approach to anything of the sort is to be found in the printing telegraph instruments. Of these there is a considerable variety, but it will be sufficient to refer to tho one which is the best known, that invented by Professor Hughes. This has been used to some extent both in this country and in America, indeed, it is now in use at some of the postal telegraph offices, the instruments having been taken over by the Government from the companies originally making the lines. For present purposes it is sufficient to notice that the type is set on the periphery of a wheel with a horizontal axis. This is kept continually in motion by clockwork, and is stopped at the letter required while the impression is being taken. The impression is taken on a long slip of paper continuously fed through the machine. It is obvious that an apparatus of similar character might be used for writing, but—except per-

haps for the use of blind persons, or persons unable from physical deformity to write—it would be too costly and inconvenient for such a purpose.

Among the earlier attempts at the production of such a machine the following may be noted as serving to show the various plans adopted. Some of these are more fully described in a paper read before the Society in 1867, by Mr. J. Pratt.* In 1855, M. Foucault showed at the Paris Exhibition, a machine for the blind. In this the types were formed on the end of the pistons, sliding in grooves in a metal plate. On the piston being depressed by the finger, the type was forced against carbonised paper laid over the paper to be written on, and an impression produced. The pistons all converged to the same point, and the paper was moved along by a rack as the writing progressed.

Later than this a machine, also for the blind, was exhibited in the South Kensington Museum, the invention of Mr. Hughes. The types were mounted as in Foucault's, on the ends of sliding pistons, but the plate containing them was arranged to rotate on a vertical axis to which all the pistons were parallel, and the type was brought over the proper spot by the revolution of the plate before being depressed to make its impression.

In 1866 a machine was patented in England, intended for making stereotype moulds as well as for writing. It was invented by Mr. J. E. Sweet, an American (Patent No. 1448, A.D., 1866), and had a type-wheel on a vertical axis, with the type set parallel to the axis. This wheel was moved by clockwork or otherwise, and stopped at the required letter by a catch actuated by a key like that of a piano. The principle of the apparatus is therefore much like that of the printing telegraph.

In March, 1867, a paper was read by Mr. Hall, before the Polytechnic Institution of New York, in which he described a machine with a type-wheel and piano-keys, acting much on the telegraph principle.

Several other machines have been patented in England and America, but it does not appear that any of them were really brought to practical perfection.

We now come to what appears to be really the first type-writing machine of any practical value, that of Mr. J. Pratt, of Alabama, patented in England in 1866, and described before the Society of Arts, in the paper above referred to. A model of this machine is in the possession of the Society, and though it is not now in working order, it is in sufficiently good condition to show perfectly the principle of its construction. It used to work satisfactorily, but being principally of wood, and very fragile, it soon got out of order, and some of the slighter parts were broken. In his paper Mr. Pratt gave a very full description of the machine, and it will therefore be unnecessary to do more here than note its principal features. The types are all fitted on the face of a small plate, about three-quarters of an inch square. This is supported vertically before a frame carrying the paper by an arrangement of levers capable of giving it both a vertical and a horizontal motion. By a proper combination of the two movements, the plate can be shifted into any position, and consequently any type required can be brought opposite the point where the impression is taken. As this is done, the same mechanism which moves the plate sets in motion a small hammer, which strikes on the paper on the opposite side to the plate, and strikes the paper against the type, thus producing an impression. Carbon paper is, of course, used in this as in the other machines above mentioned, and therefore several copies can be taken. In order to limit the number of keys required to operate the levers for shifting the type-plate, the inventor had one set of keys for giving the vertical movements, and another for giving the horizontal movements. Thus, for each letter it was required to move two keys, but as each key of one set could be used with each key of the other set, a much smaller number of keys was required than if one key were required for every letter. It may make it appear clearer to say that the depression of one key brought into position the vertical line containing the type required, this depression of the other, the horizontal line containing the same type, and consequently the intervention of the two lines, where the special letter needed was to be found, was brought into the proper place for the impression. Then, if K be the number of keys, T the number of types, it is obvious that $K = 2\sqrt{T}$, *e.g.*, for 64 types 16 keys would be wanted. The paper was carried in a small frame, traversed after each letter by a rachet-wheel and pall. At the end of a line the frame was raised by a rack worked by a separate key, and at the same time thrown back to the proper side of the machine for commencing a fresh line.

Sir Charles Wheatstone devoted a good deal of time to the construction of a writing machine, and he succeeded in making several, all capable of producing tolerably clear and legible writing, and one at least which may fairly be considered complete. Still he was not satisfied with the performance of any of the machines, and therefore they were none of them patented. He went on modifying them in different ways up to the time of his death. There are now in existence certainly four finished machines, all working in different ways. These are in the possession of Mr. R. Sabine, of the British Telegraph Works, and are now at the Society's House, where they can be inspected by any of the members who are curious in such matters. As no description of any of them exists, it may be worth while to give a short account of each of them. It may be premised that the mechanism is in all the models closely boxed in, so that without pulling them to pieces, it would be impossible to give a minute and accurate description of the method in which they work. The following, therefore, only purports to be a general description of the method in which each apparatus works. For clearness sake, the machines may be denominated each by a number, Nos. 1, 2, 3, 4.

No. 1 is in its main features somewhat like Pratt's above described. The paper is held in a vertical frame sliding in guides across the machine, and the impression is produced by the blow of a small hammer on the type, the paper being interposed between the hammer and the type, and the type moved to its proper place each time. The difference, however, in the method of mounting the types, and in actuating the mechanism is very great. The type is set in three rows on the periphery of a small wheel on a vertical spindle. Thus by shifting the wheel up or down (in the direction of its axis) the line containing the letter required is brought to the proper point on a level with the hammer, and by rotating the wheel, the letter itself is brought round. Both these motions are effected by depressing the same key, there being a key corresponding to each letter on the type wheel. The spindle of the type wheel is (apparently) rotated by a spring, the same spring which gives the traverse to the paper, and which therefore is wound up by drawing the frame back to its original position after the completion of each line. The depression of the key, acting through an arrangement of levers, raises the type wheel to the required height, and at the same time sets free a catch, so that the wheel is turned round by the spring till it is caught by the second catch, the position of which corresponds with that of the letter required. The hammer is worked by an arrangement something like that used in the piano, and so mounted that the blow is given after the type has been brought into position. The model now in the Society's House works with very fair precision, and would probably enable a tolerable speed to be attained after a little practice. The action is somewhat heavy, and unless the key is depressed sharply, and with a little jerk, the hammer is not operated, and consequently no impression results. Possibly a second machine might have worked better than this first and only specimen of its kind, but their

* *Journal*, vol. xv., p. 384.

is no doubt that, even as it stands, this machine is capable of very satisfactory work. It would probably be rather costly in construction, but the mechanism, though intricate, is not delicate, or apparently likely to get out of order. Its inventor, however, was not satisfied with it, for he made no further attempts to perfect it, but went on to the entirely different principle on which the other three machines work.

These are all rather alike, though with modifications. No. 2 may be taken as the typical machine. It is by no means easy, without the aid of diagrams, to give a clear idea of its action. The types are set each on the end of a small lever, and these levers are arranged side by side in the form of a quadrant, each lever being pivotted freely. The whole set of levers is connected to a sliding plate, by shifting which to the right or left a suitable distance, any one of the levers is brought over the point where the impression is to be taken. The type being thus held over the proper spot, a small hammer strikes it down on the paper below. The sliding plate extends along the front of the instrument parallel with the row of keys, which resemble piano keys. It has in it a number of slots, into each of which a pin slides, the arrangement being such that each pin and slot moves the plate a certain distance, differing from that to which any other pin moves it, and corresponding with the distance necessary to bring the letter required into action. Each pin is actuated by one of the keys of the keyboard. Thus, by depressing the proper key any required letter is brought under the hammer. The types are charged with ink by being brought against an inking pad at each side, as they move. The paper on which the impression is to be received is fitted on a cylinder, which is revolved continuously. The writing is consequently carried round and round the cylinder. As soon as it reaches the spot where it began, the cylinder is shifted longitudinally, so that a fresh line is commenced. There seems no reason why a reciprocating plate, with suitable means for shifting it at the end of the line, should not be substituted for this obviously inconvenient cylinder. With this improvement, perhaps, a machine of this character might be brought into practical use. In its present form the arrangement which prevents the use of paper of any other than a certain size and shape is a considerable drawback.

Machine No. 3 is, in effect, the same as the last mentioned, with some modifications.

Machine No. 4 is on the same principle as No. 2, but is very considerably modified. It is much smaller and more compact. The keys are like those of a concertina, and are placed at the top of the machine. The slotted plate is quadrant shaped and pivotted near the top of the apparatus. The pins move in slots which occupy the whole face of the plate, instead of their being arranged along the edge only.

It will thus be seen that Sir Charles Wheatstone had gone a long way towards the construction of a typewriting machine, and it is certainly a question well worth the consideration of those interested in the subject, whether the ideas he never quite worked out to his own satisfaction may not afford a basis on which some other inventor may work more successfully. The description above given of Sir Charles Wheatstone's machine is very meagre and incomplete, but it may suffice to show that there are points of novelty about them which render them very distinct from other inventions. As no patent has ever been taken out for any one of them, these inventions are open to be used by any of sufficient mechanical genius to develop them. Though it is a matter of regret that the author should not have lived to perfect his invention, it is better that they should thus be open to the world, free from the monopoly of an unworked patent.

The machines described above, whatever may have been their actual merits, were never really before the public. With the two we now come to, the case is different. The first of these machines was brought into rather prominent notice some few years back, under the name of the "writing ball." It was invented by Mr. R. M. Hansen, head-master of an institute for the deaf and dumb, at Copenhagen, and was patented in England in May, 1870. Since that time several patents for improvements have been taken out, the last being dated May 7, 1875. The chief peculiarity of the invention is that the keys are all arranged over a semi-spherical surface, which, to a certain extent, conforms to the shape of the hands. The keys are formed of pistons, set as radii of the sphere, so that each key strikes to the same spot. The keys are depressed directly by the fingers, and are raised by small springs. The paper (carbonised and white) is carried either by a cylinder or a plate under the "ball." In the original machine the paper was moved continuously by clockwork, or a small electrical motion, but in the more recent forms the paper is traversed by a movement derived from the key, which is depressed. This slightly depresses the bed on which the paper is supported, and by suitable apparatus this movement is caused to carry the paper forward a single space. It is stated that with practice, great rapidity can be attained by the machine, and the direct action of the keys on the paper enables considerable force to be applied, and consequently a large number of "manifolded" copies obtained.

The second of the two machines alluded to above is that known as the "Remington," from the company which now manufactures and sells them. This was exhibited at the Wednesday evening meeting of the Society on December 15th last, and a short description appeared in the *Journal* of the Friday following. It will not, therefore, be needful to say much about it here. It may be mentioned that the chief points of difference between it and those noticed above consist in the types being mounted on levers which are strung on a circular wire, so that they hang in a sort of cone, and all strike on the same spot when set in action by a suitable arrangement of mechanism operated from a key-board. Carbonised paper also is not used, but a ribbon saturated with a thick ink—presumably glycerine and aniline—is placed between the type and the paper. The type-levers strike upwards, so that the ribbon hangs away from the paper which is above them. The paper is carried by a roller, which moves a space in the direction of its axis after each letter, and is brought back to begin each new line by a treadle. The work of the machine is very rapid, and it seems easy to learn its use.

A principle quite different to any of the above is introduced in a machine patented last year by Mr. A. Barlow. A vertical cylinder carries the types, and is raised or lowered to bring the required letter opposite the place on the paper when it is to be impressed. This raising or lowering is affected through the action of one key, which being raised or lowered to a certain height acts through suitable mechanism to raise or lower the type cylinder likewise. The key is slotted with a number of slots corresponding to the number of letters, and the finger being placed over the slot, and the key depressed, it descends until it reaches the level of a pin which enters the slot and is stopped by the finger. All the other pins pass freely through their slots.

Such are some of the different machines which have been employed for the purpose of superseding the pen. It remains to be seen how far any of them will be successful, but from the accounts given by the proprietors of the Remington apparatus, as to the numbers they are selling, it seems likely that an extended use may be found either for this particular machine or some other like it.

Messrs. J. M. Johnson and Sons, of Castle-street, Holborn, have been appointed sole European agents for the Official Catalogue of the Philadelphia International Exhibition, 1876.

COFFEE DISEASE IN DOMINICA.

At page 958, Vol. xxiii. of the *Journal of the Society of Arts*, for October 15th, 1875, appeared an article from the *Gardeners' Chronicle*, on the coffee disease in Dominica. It was there stated that Mr. H. Prestoe, the superintendent of the Trinidad Botanic Gardens, had been commissioned to visit Dominica, and report on the capabilities of the island for coffee culture. This report has recently been published, and it contains a great deal of interesting matter, not only on the immediate subject of coffee planting, but also on other plants of economic value. With regard to coffee, it seems that the disease which has been referred to the insect, *Cemiostoma coffeellum*, has not been the sole cause of the failure of the Dominica coffee crops. It is said to be not at all improbable, that so long ago as when the coffee plantations were seriously injured by a severe hurricane, the ravages of the blight were for a period more apparent, and really helped to induce abandonment, which, at that time, occurred so extensively, but at no other time does it appear to have had that effect. At the present time, although traces of the insect are apparent throughout the island, its presence does not affect the trees to any serious extent. The general decline, therefore, in the cultivation of coffee, seems to be mainly attributable to causes which are to be traced without difficulty, in the social and political history of the island, and to a system of agriculture which seems to have been never unattended with pernicious effects, varied in their character, but always powerful and persistent. These effects are described as follows:—

1. The unsettled and turbulent character of the proprietary body at the end of the last and beginning of the present centuries.
2. The reckless clearing of forests from 1780 to the present time, but especially up to 1830.
3. The high price of sugar.
4. The sudden abolition of slavery.
5. The acquisition of land, chiefly in coffee, by persons without means and without a knowledge of agriculture, or of the coffee cultivation as it was carried on formerly.
6. Extensive squatting on Crown lands, abandoned or partly abandoned estates.

Mr. Prestoe says: "The restoration of the coffee culture obviously depending less on the destruction of the coffee blight than on the removal or neutralisation of the effects of these causes, together with the adoption of other remedial measures suggested by the very great agricultural capabilities of the island, I am induced to frame this report on a consideration of the various points involved in this conclusion, and to suggest certain remedial measures which appear to me likely to promote the restoration of the coffee cultivation and simultaneously the general welfare of the island." To promote this end it is suggested—1st, that persons of means desirous of embarking in any branch of tropical agriculture, especially coffee and cocoa, should be attracted to the island by careful publication of its great agricultural capabilities and other advantages. 2nd, assisting under Government auspices or direction deserving small proprietors in the island by a system of advances on their properties, and by verbal and printed instructions as to their cultivation. 3rd, measures to educate the peasantry and the numerous class of squatters to a sense of the use and value of money, and to a knowledge in common things, such as a rigid suppression of squatting and misappropriation of the forests, compulsory education in schools, and special provision for promoting the exportation of fruit and vegetables.

Three varieties of coffee are commonly met with in Dominica, and of these the Moka is the most liable to attacks from the moth referred to; a fourth variety, however, which is not common, but which was noticed for its robust habit and prolific character, had no trace of being attacked, though trees of the ordinary kind and of the Moka near them were considerably affected. The insect is described as being very susceptible of wood smoke, so that the wood or grass fires in the plantations would to a great extent destroy them. The facts as stated show that an experienced and practical coffee planter has really nothing to fear from the *Cemiostoma coffeellum*.

With regard to the causes of the decline in the coffee cultivation in the island, it is shown that political and other disturbances have from time to time seriously affected the prosperity of the colony. Towards the close of the last and the beginning of the present centuries the island had reached its greatest prosperity, the export of coffee alone amounting to four or five millions of pounds annually. The greater part of the western side of the island, the south-west and north-east quarters, were then under luxuriant fields of coffee, and conspicuous amongst them were the plantations of the Coulihaut district, now, in great part, together with many square miles north and south of it, an arid barren waste. Besides the disturbances and the consequent frequent changes in the ownership of the plantations, another and very powerful influence in the decline of coffee wealth must have operated simultaneously. It has been said, and truly, that the soil of the earlier coffee plantations soon became exhausted, and this rapid exhaustion of the soil was doubtless due much less to the exhaustive power of the coffee plant to extract the nutritive elements of the soil (although that is known to be considerable, and it does not appear that any attempt was made to manure), and to the original poverty of the soil, than to the diminished moisture occasioned by the injudicious clearing of the country, and especially so when the plantations occur on steep hillsides, as exists in all the old coffee districts.

Besides the clearing of the forests, effected for establishing coffee plantations, there was a very extensive denudation, occasioned by a large exportation of the satin wood and other fine woods so long as they could be got within easy distance of the sea coast. At a time when this influence was most powerfully at work, and when the energy and skill of the proprietors were most needed for adopting measures to obviate its effects, they were leaving the country in numbers. No returns of produce are to be found for the years between 1792 and 1823, but from this latest date to 1837 a steady decline is shown in the coffee produce from 2,177,559 to 386,315 lbs. Subsequently, under the calamitous spirit of avarice which has long been too common in the West Indies, the high price of sugar induced many coffee planters to root up their coffee trees and plant sugar canes, and not a few found that where they grew coffee successfully they failed to grow sugar. At the present day there is seen here and there patches of sickly looking canes, still bordered by the lively green fence of the *Pois doux* tree (*Inga Burgoni*), originally planted as a shelter to the coffee. At the same time, also, with the view of acquiring greater profit with less trouble than accrued in coffee cultivation, the smaller coffee plots were extensively planted over in cocoa. Simultaneously with all these injurious influences, which were steadily at work to undermine the agricultural stability of the island, existed in its lowest form that great curse to the West Indies in former times, the design of realising fortunes rapidly, at no matter what cost to the future prospects of the colony; and in no other island in the West Indies, probably—prior to the abolition of slavery—was this design more extensively carried out.

The land being parcelled out to squatters and small holders, it follows that their aim is to get as large and as quick a profit from the soil as possible, scarcely anything being expended on its preparation, so that it becomes quite exhausted and impoverished. The influence of the mode of life of the squatters and the garden holder in a moral sense, is described as being simply deplorable. The

majority appear to have relapsed under this system to a state of semi-barbarism, especially about the hills in the north of the island, where they have located themselves most distantly from civilising agencies. Their houses are mere huts not more than six feet high, and inferior in all respects to the sheds which the coolies in Trinidad put up to protect their cattle. The whole family of occupants appropriate the floor in company with, and in the same manner as, their more than half starved dogs. The fire is made on the floor, and thus all within the hut is blackened by the smoke. The place of honour for the night is a narrow blackened board. The stock of utensils consists of a round pot or pannikin one or two broken calabashes, an old axe, cutlass or hoe, all looking too much like rejecta from some other party better off. Here and there one sees a piece of damaged crockery, but more commonly an old rusty gun. They are altogether negligent in their persons, what clothing they have consists of scanty rags, and of no particular colour. The children are not clothed at all, but here and there they may be seen with their hair tied up into little bundles with strips of the mahoe bark, and delicate stems of climbing plants. Their ignorance and mental dullness is excessive. The forests around them swarms with agoutis and manicons, and the streams with crabs.

After careful consideration of the capabilities of Dominica for coffee cultivation, Mr. Prestoe says that even with the existing trees, if they were judiciously pruned and relieved of bush and weeds, together with their obnoxious neighbours, the plantains and yams, the present yield of coffee in the island might be doubled the first year, and quadrupled the second. No island of the West Indian group is said to be so highly favoured as Dominica, in respect of its river system for purposes of irrigation, and for working machinery. The roads also consist of a grand coast road, completely encircling the island, and three hill roads across the island centres, north and south. Besides these there are numerous minor roads, rendering the valleys and estates accessible from the coast road. The climate is described as being truly delightful, the nights invariably cool. It is much to be hoped that the publication of this report will be the means of restoring the cultivation of coffee to an island so eminently suited as Dominica has proved to be in every respect. The practical advice given in the report on the management of the plants is such as to make it valuable to planters themselves, or intending planters. The report then should be freely distributed by the authorities, not only in Dominica, but in the other West Indian islands.

Some experiments were made a short time back with some new hydrants which have been supplied to the Inner Temple for extinguishing fire. Plugs have been sunk to the number of between thirty and forty in various parts of the Inner Temple, to each of which a hydrant can be fixed and set to work in less than five minutes. The experiments were intended to test the power of the apparatus, and its force was proved by the hose being turned upon the clock tower of the library, over which the water was carried very easily. The condition of each plug was tested in succession, and the results were deemed highly satisfactory.

The number of volumes of classified abridgments, published by the Patent-office, has become so large that a "Key," or index, has been prepared, giving the name of the volume in which any special class of inventions is included. This is published as part of the circular issued by the Commissioners of Patents in order to supply information to applicants to the Patent-office.

During the year ending December 31, 1875, 4,561 applications for patents were received. The number in 1874 was 4,492, that in 1873, 4,294. The number now reached is far in excess of any previous year. The increase has been continuous since 1870, in which year there was a fall below the numbers of the year before (3,405 in 1870, as against 3,786 in 1869). In 1872 the numbers (3,970) were again in excess of any previous year.

JAPANESE LACQUER WARE.

The export of lacquer ware, though not attaining to any very high figures, is a somewhat prominent feature in the productions of Japan. Mr. Robertson, the Consul at Kanagawa, states that the lacquer ware that finds a sale in foreign markets is, as a rule, that description into which a preparation of gold powder enters, and known to Japanese as "makiyé;" but, as many articles of daily household use in Japan are of plain lacquered ware, that is, without ornament, the material of wood with a coating of plain lacquer or varnish, the industry, whether looked at as affecting the export trade, or regarded as a permanent industry in the country, and one giving employment to many hands, cannot fail to commend itself to those interested in Japan and its productions.

The groundwork of lacquer consists in the sap of the "urushi" tree, the fruit of which produces the vegetable wax. The Japanese distinguish between the male and female tree, the former bearing no fruit. The trees attain to a height of from 36 to 42 feet. In those parts of the country where the trade in lacquer is of any importance, the varnish is taken from the tree when it has attained to an age of from four to eight years. On attaining the latter full age the tree is cut down. Where the tree is cultivated for the sake of the wax, the sap is not extracted; and in Aidgu and Yonegawa, where the trees are specially reserved for wax, they will be seen to attain to no inconsiderable height. The "urushi"—lacquer varnish tree—is cultivated in two ways; either by sowing or by cuttings. In following the former, the front of the tree is lightly pounded in a mortar, so as to remove the rind from the seed. These are then mixed with wood ashes, moistened with water, and afterwards put into straw bags, over which liquid manure is poured, other bags are then left to soak in water until the close of the winter. Just before the commencement of spring, on a day duly noted in the Japanese farmer's almanac, the seed is sown broadcast over the ground, and slightly covered with earth. In respect to slips or cuttings, they are planted out in rows, and thinned as soon as a leaf or two appears. Sowings, are, however, preferred, as it is found very difficult to rear from cuttings. The amount of varnish obtainable from any one tree depends on the vigour of the tree and the quality of the soil. A good vigorous "urushi" will, after four or five years' growth, have a stem of about six inches in diameter. The sap is generally drawn off on the tree attaining its fifth or sixth year of growth, and this is done in the following manner:—A lateral incision is made with a knife in the trunk of the tree, and four days later the incision so made is punctured. The sap that exudes is then carefully removed with a small spatula, and put into a wooden jar. One incision is made at a time, commencing from the root upwards, and the trees are taken in turn. This is continued until each tree exhibits a series of cuts all up the trunk. The tree is afterwards felled. The drawing off of the sap is begun in the middle of the summer and continues to about the month of November. The very first and last sap drawn is not considered of good quality. The best is that which is drawn off late in the summer. From spring to summer the sap ascends the tree, and afterwards descends. The expert is therefore guided by this fact as to where the incisions should be made. When the sap is descending in the trunk it is considered inferior. The bark of the larger trees being somewhat thick, the ordinary instrument in use sometimes fails to make the proper incision, in which case the bark is first removed prior to making the incision. The "yamo urushi," on wild varnish, grows plentifully, and in leaf and flower resembles closely the "urushi," but it meets with little attention, as its yield of sap is very small. There is also a species known as the "tsuta urushi," or ivy lacquer tree, which attaches itself to trees after the fashion of ivy, but yields even less sap than the lacquer

tree. Lacquer is obtained largely in the eastern portion of the empire, but to no great extent in the western provinces. The wood of the "urushi" tree being exceptionally good, is applied to many uses, and notably to the making of floats for fishing-nets.

Having thus given a brief description of the manner in which the lacquer varnish is obtained, Consul Robertson furnishes a few additional remarks upon the preparation of the lacquer ware. The Japanese, it seems, give the year A.D. 724 as the date when the art of lacquering was first discovered, but those amongst Japanese who have given attention to the subject fix the date at the year A.D. 889 or 900. It would appear to have attained to some perfection in the year 1290, for the name of a distinguished painter in lacquer who lived at that time is still handed down as the founder of a particular school of art in lacquer painting. From that time it developed until it attained its present perfection. The following is a brief general description of the mode in which designs in lacquer are worked:—The first thing is to trace out on the thinnest of paper the required pattern or design, and the tracing is then gone over with a composition of lacquer varnish and vermilion, afterwards laid on whatever it is proposed to impart the design to, such as the facing of a cabinet, or other piece of work, and well rubbed over with a bamboo spatula. On the removal of the paper the material below will be seen to have received the outline. This is now gone over with a particular kind of soft lacquer varnish. When this industry is pursued in hot weather the varnish speedily dries, and consequently, where the pattern is a good deal involved, such as one representing bunches of flowers or flocks of birds, a small portion only of the pattern is executed at one time, and the gold powder, which enters largely into most of the lacquer ware for the foreign market, is applied to each part as it is being executed. For this a large and very soft brush is used, and by its aid the gold powder is well rubbed in with the lacquer or varnish. The work is then left to dry for the space of about twenty-four hours, after which the pattern is lightly rubbed over with charcoal made from a particular wood, this process securing evenness of surface. The work is then rubbed with polishing powder, and afterwards carefully wiped.

There still remains a good deal of finishing work, such as the tracing of leaves on trees, the petals of flowers, the wings of birds, &c., and so on, according to the particular subject in hand. Into all of these gold powder largely enters, the working in which requires a light brush and skilful hand, so as to preserve an even mixture of the powder and varnish. After this has well dried, a particular kind of lacquer varnish, known as "yoshinô urushi," is well rubbed in, and the whole then polished with horn dust. The polishing process is done with the finger, and is continued until the gold glitter shows out well. A beautiful polish is said to be thus obtained. Briefly, then, the designing on lacquer ware is done thus: supposing the subject is to be a flower, it is traced out on the paper and imparted to the groundwork of wood. Gold powder is then sprinkled over the work from out of a bamboo tube, well rubbed in with a brush, and then allowed to dry, afterwards polished, and a coating of varnish applied. This is repeated several times, until the work assumes a rust colour. The veins or tracery of the leaves are marked out with lacquer varnish. Before this dries gold powder is again sprinkled over, and then rubbed in with a brush. When the surface has dried, it is rubbed over with a piece of charcoal, so as to tone down any irregularities. After that it is polished, when the flower will appear in due form.

A communication has been received from the Secretary of the Franklin Institute, to the effect that the institute will, during the continuance of the Philadelphia Exhibition, extend the free use of its library and reading-rooms to all members of the Society of Arts who may be properly accredited.

CORRESPONDENCE.

THE MALT TAX.

Sir,—The following letter has been sent to the Right Hon. the Chancellor of the Exchequer, and as it may be interesting to the members and the public generally, I shall esteem it a favour if you will find room for it as soon as convenient.—I am, &c.,

T. Briggs.

The Homestead, Richmond, Surrey,
February 16th, 1876.

To the Right Honourable Sir Stafford Northcote, Bart., M.P., Chancellor of the Exchequer.

The Homestead, Richmond, Surrey.
11th February, 1876.

Sir,—In a letter you have addressed to the Secretary of the Essex Chamber of Agriculture, dated the 25th of January last, in reply to a memorial from that body, a copy of which has made its appearance in the *Times* of the 10th instant and other newspapers, on the question of the Malt Tax, you state that "You will not fail to give the representation they have put before you your full consideration, and in the meantime you beg to call the attention of the parties interested to two Acts of Parliament which touch the matter in question. The first (27 Vic., cap 29) allows malt to be made duty free for cattle feeding, on condition of its being ground and mixed with 10 per cent. of linseed meal; the second (33 and 34 Vic., cap 33, sec. 6) allows farmers to germinate barley for the said purpose."

May I venture to bring to your notice the fact that these two Acts of Parliament are well known to the great majority of the farmers through the length and breadth of the land, as containing provisions which, in their very essence, render them utterly useless for the purpose for which they were passed, and, in fact, a dead letter; so much so, that it has become a by-word amongst the farmers to style the ground malt and linseed as "Gladstone's mixture," in a spirit of ridicule.

What the farmers require is liberty, not the interference of such conditions as those imposed upon them by these Acts; they simply ignore the two Acts of Parliament, and go on as usual, pleasing themselves as to what they grow, and under the influence of the present restrictions of the Excise laws, barley is a crop that, with few exceptions, is seldom grown, and, of course, it is unnecessary to tell you that if a thing is not produced, it cannot be used either in the way the Act states, or in any other way; therefore the supply and demand being interfered with by the fiscal laws of the land, the natural consequence is that malt cannot be used for food for cattle, inasmuch as it would raise the price to a figure that would not pay, more especially since the country has been deprived of more than four-fifths of the malt kilns, by the monopoly created by the malt duty: hence the dearness of butchers' meat.

It will, perhaps, occur to you that the discontent of the farming classes generally has recently been somewhat modified on this question, but my experience as a member of the Farmers' Club enables me to explain this fact. In the first place their only organs for the expression of their opinions at all, are the Chambers of Agriculture and the farmers' clubs throughout the country, the councils of which institutions are composed principally of large or gentlemen farmers, and a few land owners, farming their own land, and they were silenced by the good barley harvest of 1874, inasmuch as they, not being stinted of capital, had plenty of good malting barley to sell when it was at a high price, while the majority of small holders were condemned to have nothing but wheat to sell in the same season, when it was at a very low price; but the latter have practically no means of

expressing their opinions plainly, whilst the high class farmer, finding his barley pay him so well, erroneously fancies he would be injured by the repeal of the malt duty, and this, in my opinion, explains the silence of the farmers under the present difficulties of the subject.

You are doubtless aware that British grown barley, from the nature of the soil and the climate, is superior to any imported barley for malting purposes, and this is proved by the fact that it also commands a higher price in the market then imported barley, and you are also aware that on the other hand, British wheat is generally sold at a lower price in this market then imported wheat. This will probably present itself to your mind as a proof that Providence has formed physically this country as a barley producing country rather than as a wheat producing country, and it certainly appears, therefore, to me, plain that the malt tax is one of those taxes which inevitably tends to frustrate the designs of Providence.

You will find in the last issue of the Society of Arts *Journal*, of February 14th, at page 178, a paper on "Condensed beer," read by Dr. Bartlett, and discussed by a respectable audience, leading up to this fact, which I would beg to recommend for your perusal, and I send you a copy by this post.

Trusting that you will find this subject a paramount one for discussion in the House of Parliament, in the present session.—I am, sir, your obedient servant,

T. Briggs.

MEDALS AND SOCIETIES GRANTING MEDALS.

Sir,—In the article entitled "Notes on Medals, and Societies Granting Medals," by P. L. Simmonds, in No. 1,181, July 9, 1875, of the *Journal* of your Society, which a friend has sent me, there is the following sentence:—"In the reign of Elizabeth many medals were struck, but none which deserve special mention, except one to commemorate the defeat of the Spanish Armada, having the device of a fleet scattered by the winds, and the legend *Afflavit Deus et dissipati sunt.* This, however, is not extant."

It will, perhaps, be interesting to the writer of the article to know that part of this statement is, I believe, incorrect, as I have in my possession a medal which answers to the description. I bought it some years since, at Batavia, at an auction of unclaimed articles, where the articles disposed of appeared to have remained for a very long period. I have not got the medal with me at present, as it is packed up in England, but on my return there I shall be happy to send you a more minute description of it, or a cast of it. As far as I recollect, the legend on it, quoted by Mr. Simmonds, does not contain the word *Deus*, but merely *Afflavit et dissipati*, and on the obverse side another legend, *Ledor non alidor.*

Hoping this may interest some members of your Society,—I am, &c.,

D. F. Pryce.

Haarlem, Holland, 29th January, 1876.

[Mr. Simmonds' statement was taken from the Mint Report of last year.—Ed.]

During the last American fiscal year there were over 7,000,000 acres of public lands disposed of in one way or other in the United States. But a trifle over one-tenth, or 745,091 acres, were sold for cash, the gross revenues of the Land Office from every source having been less than 2,000,000 dols. Railway grants are now the great absorbents of the public lands of the United States.

The authorities of Reggio, Calabria, offer a prize of 2,000 lire (francs) for the best apparatus for extracting the essence of Bergamot. The conditions are strength and cheapness in the apparatus itself, combined with capacity for producing the largest quantity of essence in the shortest time, without detriment to the colour, purity, and fragrance of the extract.

GENERAL NOTES.

Schools of Cookery.—The following extract from a letter from Leamington gives an account of the success that the school there has met with:—"Our school is very successful. Plenty of scholars for practice, and the artisan and labouring classes have taken it up warmly. We have abundance of pupils. Sanguine as I was, I had little idea how very interested all classes would be, but we have worked very hard to make the cookery school known and popular."

New Flooring.—A communication has been made to the North of France Industrial Society as to a new system of parquet flooring invented by M. Briffaut. The squares are composed of slips of oak or other wood, or a combination of woods forming patterns; the pieces are held together by a layer of bituminous cement laid hot on their underside; and this cement is in turn covered with a paving tile, so that the three substances are intimately united. In order to obtain a more perfect adherence, conical iron pins are driven through holes left in the tiles and into the wood while the cement is still in a liquid state. The squares are laid in mortar or cement over a layer of sand, and are joined together by very fine iron tongues fitting in grooves. This system is applicable where marble and ordinary pavements are employed, and the inventor has the intention to apply it to cabinet-work.

Preservation of Meat.—A communication has been made to the Paris Academy of Sciences, to the following effect, by M. A. Reynoso. The means employed are compressed air, oxygen, nitrogen, hydrogen, &c. M. Reynoso says he has succeeded in preserving meat, fresh and with the blood in it, in the case of beef, in pieces weighing 63 kilogrammes, for periods ranging from one month to three and a-half. So long as it remained in the apparatus it remained fresh and full of blood, and when taken out it kept a longer time than fresh meat from the butcher. In the case of mutton, he notes the remarkable fact that the meat, after having been subjected to the action of compressed gases, and being taken out of the apparatus and exposed to the air, dried slowly, and then kept good for an indefinite period. The inventor says that meat preserved by the method in question is equally fit for making soup or for roasting, and that the blood has flowed from a piece of beef which had been preserved for forty days. When carbonic oxide is employed the meat undergoes a change, and the colour changes to bright rose, but the other gases produce no such alteration. M. Reynoso says that his experiments have been pursued for two years on a very large scale with constant repetitions. Another communication has been made to the same academy by M. de Herzen, the inventor, who has applied his process at Buenos Ayres. It consists of steeping the quarters of meat in a pickle composed of 8 parts of biborate of soda, 2 of boracic acid, 3 of saltpetre, and 1 of salt, in 100. The meat is packed in barrels, which are filled up with a little of the pickle, and is ready for use after soaking in water twenty-four hours.

NOTICES.

SUBSCRIPTIONS.

The Christmas subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

February 23.—"Contagious Diseases of Animals as affecting the Health and Wealth of the Country," by George Fleming, Esq., Royal Engineers.

March 1.—"Aquarium Construction and Management," by W. Saville-Kent, Esq., F.L.S., F.Z.S.

March 8.—"Hall Marking of Jewellery," by Alfred Lutschaunig, Esq.

March 15.—"A New Bridge for Providing for the Traffic across the Thames below London Bridge," by Frederic Barnett, Esq.

March 22.—"Railway Couplings," by F. A. Brocklebank, Esq.

March 29.—"Model Dwellings for the Rich," by T. Roger Smith, Esq., and W. H. White, Esq.

April 5.—"The Cultivation in India of Caoutchouc-yielding Trees," by Clements R. Markham, C.B.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

March 14.—"The Diamond Fields of South Africa, and their Influence on the Native Races of the Neighbourhood." By J. B. Currey, Esq.

March 28.—"The Industries of South Africa." By T. B. Granville, Esq.

April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following papers will be read:—

February 18.—"The Commercial Aspects of the Suez Canal," by Charles Magniac, Esq. M. E. Grant Duff, Esq., M.P., will preside.

March 3.—"The Land Revenues of India," by Major-General Marriott, C.S.I. Sir G. Campbell, M.P., K.S.I., D.C.L., will preside.

March 24.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

April 21.—"The Sanitary Progress of India," by Captain Douglas Galton, C.B.

May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

Chemical Section.

Friday evenings at 8 o'clock. The following papers will be read:—

February 25.—"Some Recent Metallurgical Processes." By J. Arthur Phillips, Esq. C. W. Siemens, Esq., D.C.L., F.R.S., will preside.

March 10.—"The Manufacture of Citric and Tartaric Acids." By Robert Warington, Esq., F.C.S.

March 17.—"The Preparation of Dextrine-Maltose (malt-sugar), and its Use for Brewing and other Purposes." By W. Valentin, Esq., F.C.S.

March 31.—"The Methods of Estimating the Illuminating Power and Purity of Coal Gas." By A. Vernon Harcourt, Esq., M.A., F.R.S.

April 28.—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne.

Cantor Lectures.

Monday evenings at 8 o'clock. Second Course, "On Iron and Steel Manufacture," by W. Mattieu Williams, Esq. Concluding lecture.

Lecture VI.—February 21st.

Cast Steel, Tool Steel, and Tools.

Cast or pot steel—The Bessemer process.—The Siemens Martin process.—The Uchatius process.—Popular fallacies concerning steel.—The composition and properties of the best steel.—The welding of iron and steel.—The hardening and tempering of steel.—Case hardening.—The hardness, tenacity, and toughness of steel.—Steel rails and tyres.—Steel ships.—Steel bridges and the use of steel for structural purposes generally.—Theory of the constitution of steel.—Edge tools, the general principles of their construction and the quality and hardness of steel required for them.

The Third Course, on "Wool Dyeing," by George Jarmain, Esq., will commence on March 6.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. W. Mattieu Williams, "Iron and Steel Manufacture" (Lecture VI.)
Royal United Service Institution, Whitehall-yard, 8½ p.m.
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned Discussion on "Agricultural Holdings Act."
Medical, 11, Chandos-street, W., 8 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Mr. F. A. Allen, "Traces of early Phœnician, Jewish, and Carthaginian intercourse with the British Isles."
London Institution, Finsbury-circus, E.C., 5 p.m.

Tues. ...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "Classification of Vertebrated Animals." (Lecture VI.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. Wilfrid Airy, "On the Probable Errors of Levelling, with Rules for the Treatment of Accumulated Errors."
Anthropological Institute, 4, St. Martin's-place, W.C.

Wed. .. **SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. George Fleming, "Contagious Diseases of Animals as affecting the Health and Wealth of the Country."
Geological, Burlington House, W., 8 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Prof. Zerffi, "Hans Sachs, as Poet and Reformer."

Thurs Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Prof. Clifford, "Sight, and what it Tells us."
Civil and Mechanical Engineers Society, 7, Westminster-chambers, S.W. Mr. C. H. Driver, "Aquaria and their Construction."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gladstone, "Chemistry of the Non-metallic Elements." (Lecture VI.)
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Philosophical Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Mr. J. Arthur Phillips, "Some Recent Metallurgical Processes."
Royal Institution, Albemarle-street, W. Weekly Meeting, 9 p.m. Rev. S. J. Perry, "Transit of Venus."
Quekett Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. T. Thistleton Dyer, "The Vegetable Kingdom." (Lecture III.)
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,214. Vol. XXIV.

FRIDAY, FEBRUARY 25, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

SUBSCRIPTION FOR THE FAMILY OF THE LATE S. T. DAVENPORT.

The following subscriptions have been promised, making, with sums previously acknowledged, a total of £1,619 10s. 6d.

It is requested that members will accept this notice as an acknowledgment of their subscriptions:—

	£	s.	d.
Dr. A. Burn	1	1	0
J. Oldfield Chadwick	1	1	0
Baron Dimsdale, M.P.	2	2	0
Percy S. Easton	2	2	0
William Evill, jun.	2	2	0
John France	2	2	0
Sir John Hawkshaw, F.R.S.	10	0	0
Henry Hensman	2	2	0
William Holland	2	2	0
J. B. Leishman	3	3	0
W. E. Newton	2	2	0
John O'Hagan	1	1	0
W. Payne	1	1	0
Henry Port	1	1	0
Dr. David S. Price	1	1	0
Eugene Rimmel	1	1	0
John Shields	1	0	0
William Smith, C.E.	1	1	0
W. W. Strode	2	2	0
George Wallis	1	1	0
H. J. Woodhouse	1	1	0

FOOD COMMITTEE.

A meeting of this Committee was held on Monday, the 21st inst. Present—Lord Alfred S. Churchill (in the chair), J. J. Manley, Edward B. Savile, Benjamin Shaw, and E. C. Tufnell, with P. Le Neve Foster, Secretary.

INDIAN SECTION.

A meeting of this Section was held on Friday evening, 18th February, M. E. Grant-Duff, M.P., in the chair.

The Chairman briefly introduced Mr. Magniac, who had kindly undertaken to give some much-needed information on the commercial aspects of the Suez Canal, on which he was a most competent authority.

The paper read was:—

ON THE COMMERCIAL ASPECTS OF THE SUEZ CANAL.

By Charles Magniac.

The saying that history repeats itself was never more truly or perhaps more unexpectedly exemplified than in the case of the Suez Canal.

For five hundred years an arid tract of sandy desert, not more than fifty miles long, separated the east from the west. A thousand millions of people allowed a paltry strip of ground, which looked at relatively to the distances involved is no more than a stone in the high road, to divide them as effectually as an impassable wall. So effectually that each, requiring the products of the other, rather than overpass this barrier, was content for five hundred years to face an unnecessary sea voyage of 7,000 miles.

And more astonishing still, the ancients, of whose condition of civilisation the nineteenth century speaks with such patronising approval, had effectually neutralised this barrier by engineering works at least 3,000 years ago. Truly, the saying, "that every wise man has forgotten more than he knows," may be applied to the world.

I will not take up your time by referring to the historical accounts of the various waterways which have undoubtedly existed between the Red Sea and the Mediterranean.

The earliest date assigned to these works is the time of Abraham, roundly, 2,000 years B.C., when the canal is said to have been made for the purpose of communicating with Mecca. However incorrect the date may be, the sequence of oral and recorded tradition is unbroken, that more or less for 2,000 to 3,000 years previous to our time a water-way united the two seas. What is not so clear is that this way was direct, and the concurrence of testimony seems to show that for one-half of the distance the Nile was made use of. I shall here drop the less certainly recorded historical facts, with one exception, which is so apposite to our present subject that I think I shall be excused for referring to it.

No one who meditates on the future of India, but must, more or less, be guided in his deductions by the teachings of the past, and of that eventful past probably no one circumstance is more pregnantly suggestive than the famous military promenade into India of Alexander the Great. He put up with no such delay as a sea voyage of 15,000 miles round the Cape of Good Hope. Straight to his goal he marched, until his onward progress ended on the Hydaspes.

There a fleet was built, and these ships under the command of Nearchus traversed the Persian Gulf and the Red Sea, crossed the Isthmus of Suez, and terminated their voyage in a Mediterranean port, if the dates are correct, and if we can believe the story that has been handed down to us.

What was there 2,000 years ago great authorities declared impossible ten years since!

I shall not refer to history further than absolutely necessary for our present purpose, which is the consideration of the Suez Canal in its particular reference to its effect upon the trade of India.

In the proper consideration of this subject one historical fact stands out predominant from all the rest, and it is not the less serious, perhaps even

more so, because it involves a sentiment. This fact is, that for good or evil every Frenchman has persuaded himself that Egypt is the Naboth's Vineyard of the French nation. However unreasonable, however great a delusion, however childish, the fact remains, and in dealing with Egypt, and with matters connected with Egypt, we must lay our account to this, that whatever we do and whatever we wish to do, we shall either openly or secretly be opposed by France. We shall urge in vain that our interest in respect of India is so vast that no other nation can compare with us, that our merchantmen occupy the canal in a continuous line, and that their sails whiten the waters of the Red Sea. All this they will concede, but until compelled by the inexorable logic of events, which it is our business to bring about, they will not concede that France has not a divine right to play the first, second, and last fiddle in Egypt.

It will require much temper, much patience, much time, and above all an inexorable will, to conquer this idea, but it must be conquered or evil will ensue. We have lately been told on authority that the purchase of our shares in the canal is itself to prevent complications and preserve peace. I hope it may be so, but it certainly will not be the case unless we bring the collective judgment of the nation to bear upon the whole question, and in order to do so the nation must be informed, and I know no better way than by such free discussions as these, where the unrivalled knowledge which so many of our countrymen possess of the East can be brought to light.

The canal, as everyone knows, was projected with the desire and intention of transferring from England to France the trade of the East. It was shown with perfect accuracy that by its means Marseilles and the Mediterranean ports would be brought nearer than London by some five or six days to the shipping ports of India. Hence it was inferred that the time wasted at sea would be saved to commerce, and that in consequence France would gain the maritime and commercial supremacy now possessed by Great Britain. Alongside these more prosaic considerations, the political aspirations of France were flattered by the expectation that French supremacy in Egypt would become so in fact as well as in name by the completion of this canal, the management of which was to be entirely in the hands of Frenchmen.

Is it surprising that under such circumstances the scheme was received with more than coldness in England; and that the Government of the day declined to help it, because in the words of Lord Palmerston—"it was evidently intended to further the separation of Turkey and Egypt."

Still less surprising is it that the public declined to subscribe their money for an object which, in the words of the same statesman, "was physically impracticable, except at an expense which precluded all hope of a remunerative result."

This opinion, as I shall show you presently, has been amply justified by events. And while upon this subject, let me say a few words on behalf of one of the greatest engineers that this country has ever produced. I mean Robert Stephenson, whose conduct in this matter has been so grossly misrepresented.

He has been accused of saying that the canal was impracticable. What he did say I will give you in his own words:—

"I said that I concurred with Lord Palmerston in opinion. I referred to his statement that money might overcome almost any physical difficulties, however great, but that the undertaking, even finished, would not be commercially advantageous."

The fact is, that Stephenson's great engineering fault was his inexorable conscientiousness.

His estimates are an imperishable monument to his fame. He knew—none better—that unlimited money could overcome, as he said, "almost any physical difficulty." What he did not know was that behind the estimates for the construction of the canal there was an unlimited purse to be dipped into, and that twice the amount of the original estimate of £8,000,000 for the construction was to be squeezed out of the Khedive himself or a confiding public.

The canal was made. Most people now know how the first funds were raised. As M. Lesseps has told us himself with "patriotic eagerness." "For what purpose?" said one. "No matter, provided it be against the English."

I do not desire to weary you with figures which have been published before, but as the real cost of the canal is a subject of material consideration in our future dealings with the company, and as some guide to the consideration which the shareholders are entitled to, and as they are apt to omit what has been done for them, I desire to place this before you as briefly and succinctly as possible, to serve as a record for reference.

It is not possible, without giving a detailed account of the expenditure of the company, which would be unsuitable for this occasion, to specify the cost of the work, except under general headings.

In consequence of the early difficulties of the concern irregular receipts had to be obtained, and although the capital and loans of the company are clearly set out, the original estimate proved so inadequate that resources had to be extracted from the Khedive or from the Government of Egypt, without which the works must have been stopped. Some of these resources were derived from financing expedients, others from a source which, I am proud to think, amply justifies the abstention of our countrymen from partaking in the original undertaking—a source which I do not hesitate to say has tainted the undertaking with an indelible stain. I refer to the system of forced labour, under which the works were commenced, and which was pushed to an extreme, never, I feel sure, contemplated at the outset. The extent of this I shall enable you to judge of by a very significant fact, which I shall come to presently.

I should mention that the latest officially published accounts of the company are to the 31st December, 1874. Up to that day the outlay for works and expenses, was as near as may be, as shown by the account, £19,750,000.

You will be interested to hear whence this large sum has been derived. It may be specified as follows, and the necessary explanation shall be given presently.

The account is thus :—

	Cash Capital.
Original Share issue—	
400,000 shares of 500 frs. each (200,000,000 frs)	£8,000,000

	Cash Capital.
Loan of 1867—	
333,333 obligations of 500 frs. each, bearing 5 per cent. interest, issued at 300 francs each (99,999,000 frs.)	£4,000,000
Loan of 1871—	
Bons Trentenaires, 200,000 bonds of 125 frs. each, bearing $6\frac{4}{10}$ per cent. interest, issued at 100 frs.. of these 120,000 only issued (12,000,000 frs.)........	480,000
Bonds for arrears of unpaid interest, 7 Coupons of 1st July, 1871, to 1st July, 1874, inclusive, 400,000 bonds of 85 frs. each, bearing 5 per cent. interest (34,000,000 frs.)	1,360,000
	13,840,000
Receipts during construction of canal ..	5,920,000
	19,760,000

Besides which the company has had the benefit of certain works, for the most part essential to the traffic, costing 2 to 3 millions sterling, paid for by Egypt.

And now a word in explanation of the chief of the above items.

Receipts during Construction.

To this is due the existence of the company, without which it must have collapsed.

I referred at the outset to the original estimated cost, which, I will remind you, was £8,000,000.

During construction it was found that this sum was wholly insufficient for the purpose, and borrowing at that stage being out of the question, the ingenious plan was devised of selling back to the Khedive the privileges and property which were granted, on condition of the canal being constructed.

In this sum of nearly six millions is included five millions derived from this source, and I will confine myself to reference to two items comprised in it—one of £1,520,000. This sum represents the advantage the company expected to derive from what in Parliamentary language has lately been termed "labour on cheap terms," otherwise what the world in general would call "forced labour," and even if we said "slavery," I do not think the term would be too strong. The other item is one of £1,200,000, which particularly interests us.

Having wrung out of the Khedive £1,500,000, £400,000, £300,000, and such like sums, on various grounds, his patience and his purse were at last alike exhausted. Like the daughters of the horse leech the company still asked for more, and the Khedive, by a wise stroke, put an end to further demands. Money he had none to give, but such as he could borrow at 10 or 12 per cent. in Paris and Alexandria. So he stopped all demands by handing over as payment in full the coupons for twenty-five years on his shares. These, as is well known, are now ours.

I have shown that the original estimate was £8,000,000; that Palmerston and Stephenson denied the possibility of making the canal on such terms.

That it really cost directly in money twenty to twenty-one millions, to which indirect expenditure by the Khedive of two to three millions more must be added, making a total, with interest, exceeding twenty-five millions sterling. At 5 per cent. only the interest upon that would be £1,250,000, and I shall show you immediately that the gross receipts, including a larger charge than is warranted by the concession, the canal having been open six years, do not amount to that sum.

I think, then, we are entitled to ask as regards the past, whether Palmerston and Stephenson are justly liable to the vituperation which has been so freely passed upon them? and as regards the future, whether shareholders who, to use an expression printed in large type in the *Times*, are "speculators in an investment," have a right to expect that, after all that has been done for them, they are to have, as they seem to expect, a right to tax commerce to an extent only limited by their own expectations of profit.

Before I leave this portion of the subject I will record the actual capital upon which interest and dividend has to be paid, and the annual charge.

	Capital.		Interest and Sinking Fund.
Loan 1867—			
Obligations	£6,000,000	..	£402,000
Loan, 1871—			
Trentenary Bonds	600,000	..	51,000
			Interest.
Interest Bonds	1,360,000	..	68,000
			Dividends.
Shares.....................	8,000,000	..	400,000
	£15,960,000		£921,000
Charges for stamps, &c.........			8,500
			£929,500

Delegations secured only by the dividends on the Khedive shares—

	Interest.
120,000 each, 500 frs., £2,400,000	£120,000

Any surplus to be applied to the sinking fund to repay the above nominal capital of the 1st July, 1894, and the further surplus to be divided as bonus.

I have endeavoured to show what the canal is, and I propose now to direct your attention to the subject from a commercial point of view.

I think it better to say at once that I fear you will be disappointed, and if you are, you will only be in the same position as every body connected with the canal. The only people that I know of who are pleased are the shareholders, and their conversion only dates from a couple of months back, when our Government made their purchase, and sent the shares up in consequence. It is a very curious thing that few, if any, of the particular expectations formed have been realised, yet the effect of this canal upon trade has been most momentous; indeed, it may be said that the Suez Canal, in conjunction with steam and ocean telegraphy, has revolutionised the Eastern trade, to the great present loss of all concerned.

Although I assert as I do that the change has been disadvantageous to trade, I by no means wish to say that it will be permanently so. I have sufficient faith in general principles to feel satisfied that in the long run more rapid communication must prove beneficial to trade in general, however much individuals may suffer; at

the same time, I am inclined to think it will be less beneficial to this country than to any other.

We had an unexampled geographical position. A variety of circumstances combined to make it advantageous that there should be one spot in Europe where consumers of the produce of other countries could, within a few days or weeks, supply themselves with any article they required. That spot was our own country; and that advantage no longer exists, or does so only to a limited extent. I will instance the case of an Italian or an Austrian cotton spinner. Formerly, he could so arrange his business as to get the raw material he wanted from London or Liverpool in a fortnight. Now, he can do the same from India in less than a month. The difference is not sufficient to make it worth his while to remain on his old lines.

Then, again, there is another consideration. The length of operations in produce has been, I will not say shortened by a half—it would be nearer to say five-sixths. Upon that point I shall presently give some details. In consequence of this the advantage which England derived from her immense capital and credit has been very much lessened.

Again, when, as formerly, trade toiled slowly and uncertainly round the Cape, it was necessary for Europe that a sufficient stock of goods should exist in some easily available locality. Now that places of production are practically as near the consumer as England, stocks of produce are, or ought to be, held there—another serious loss to this country. But the greatest loss of all has been the loss of profit, and I do not exaggerate in asserting that this has been universal.

It might have been expected that if the seller lost the buyer would gain. It certainly would have been supposed that if the producer lost the consumer gained. But buyers buy to sell again, and it is no consolation to a consumer to be able to buy below the cost of production if he has curtailed means to buy with. And that, I fear, has been the case with the Eastern trade. Unsatisfactory all round, due in a great measure to the state of transition in which it is at present.

The change has been so rapid that all the old machinery—warehouses, sailing vessels, capital, six months' bills, and the British merchant whose occupation is gone—still exist alongside of the new era. The consumer deals direct with the producer, and until trade accommodates itself to the change, the result cannot fail to be unsatisfactory.

I will now, with your permission, refer to some specific facts. When the canal was projected certain expectations were held out, the most of which have not been realised. Among them was the idea that sailing vessels would use the canal, and that the distance being nearly a half less, the number of voyages would be increased in the proportion of at least five to three, at a great saving in the cost of freight. This has not been so. It was found in practice that, although the distance was shorter, the time consumed was not sufficiently lessened to benefit a sailing vessel in any appreciable degree, bearing in mind that the charge for the canal has to be superadded. And in the result sailing vessels have practically ceased to exist in the trade. I hold in my hand a return of the vessels using the canal during the past four months. It is most suggestive. The list contains four to five hundred vessels, each with S.S. (screw steamer) after its name, each of the huge size of from 1,200 to nearly 3,000 tons, and the large majority hoisting the British flag. In all that long list there are but three sailing vessels, and these are Egyptian, belonging to the expedition for the conquest of Abyssinia.

In effect, then, the canal trade is entirely conducted by steam, and of that steam, in 1874, out of 2,400,000 tons, 1,700,000 were British.

The preceding remarks made about loss, I am sorry to say, particularly apply to this section of this trade also. For two years it has been very unremunerative. Freights have been most irregular, varying from £3 10s. to £1 10s., sometimes higher via the Cape than through the canal, at other times equal. The reason of this will be plain on examination.

There is but one mode of making a steamer pay—ceaseless activity. The daily expense is so great that it cannot afford to be a moment idle, consequently, whereas sailing vessels in the old times would lay a month or two on the berth for better rates, a steamer is compelled to take what is going and be off. And a very moderate supply of tonnage at a port in excess of immediate wants causes the undue depreciation in freights. As an illustration of the incomprehensible nature of the changes going on, I was quite lately informed that at one port, three miles of steamers were laid up, while at others 400,000 tons are being built. It is probable that both are exaggerations, but experience enables me to give a partial explanation. Improvements in machinery are continually being devised, which enable steamers to be sailed at very much less cost, particularly as regards consumption of coals. The consequence is that many built two years ago are selling at half what they cost, because they cannot compete with those continually being constructed with the most recent improvements.

I shall show presently the amount of tonnage used in the Indian trade.

A considerable saving was expected on insurance. Disappointment again. I will hazard an explanation. Steamer losses have been losses indeed. Although less frequent, the results have generally been more disastrous. The loss of a ship generally presumed some salvage; by a steamer, the loss is generally practically a total one.

I will now explain why I have found it utterly impossible to furnish you with figures satisfactory to my mind. The statistics published by the Government are probably unequalled for arrangement and accuracy, but they have the unpardonable fault of being so much deferred as to be, in many respects, valueless. The latest official figures I have been able to procure are only to the 31st March, 1874. And even these I had the greatest difficulty in procuring. We are now in 1876. And I cannot think that in these days of canals and steamers it is too much to expect that completed tables should be published six months after date, with supplementary tables even three months later.

I have endeavoured to supplement these statistics by private information, but as their value lies in comparison, it is utterly impossible to obtain a

sufficiently close connection to make them entirely reliable.

Bear in mind that my figures relate to India only, and I hope you will not be disappointed if you find them rather bald, for the reasons I have given.

I compare the year 1869, before the opening of the canal, with the year 1874, and as I believe the strongest impression is made by the fewest and broadest facts, I shall confine myself to one or two lines in each case.

The total registered tonnage of all vessels employed in Indian trade, except native craft, was:—

1869.	1874.
6,750,000	8,140,000

This shows an increase in 5 years of 20 per cent., or one-fifth due in the main to Canal influences, but here generalisation requires to be modified by experience. You must bear in mind that it does not follow that this addition of 1,500,000 tons was used. Many steamers may, and we know do, leave without full cargoes, and I think we may take it as a rule that steamer tonnage fills up less completely than ship tonnage, for the reason I gave that steamers cannot wait.

I will now give you another figure fact, the proportion of British and British Indian tonnage to foreign:—

	1869.	1874.
British and British Indian	5,850,000	7,150,000
Foreign................	1,000,000	1,000,000

From which you will see that our own tonnage well holds its own. Here again it may have been a doubtful advantage, for if worked at a loss it might have been better to let others do it.

I now take the total trade of India with foreign countries, exclusive of coasting:—

	1869.	1874.
Exports	53,100,000	55,000,000
Imports	36,000,000	32,500,000
	89,100,000	87,500,000
Treasure	16,400,000	8,000,000
	£105,500,000	95,500,000

From the above Table it will be gathered that, notwithstanding the opening of the canal, the total trade, which in 1869 was of the value of £105,500,000, in 1874 was reduced by 10 per cent. From this it would naturally be inferred that so large a reduction in value as ten millions sterling would indicate a reduction in quantity. This by no means follows, and the proof may be found in more places than one, and particularly we may judge from the amount of tonnage required to carry the goods in the respective years—

1869.	1874.
4,400,000 tons.	4,650,000 tons.

Showing that although the value of the trade had decreased, 250,000 tons additional shipping were required to convey it.

This bears out the opinion I had formed that the trade has not been satisfactory. The producer has evidently got less money, the consumer complains he cannot pay, and the seller complains that he loses.

An interesting fact may here be examined, and as it is likely to become a thing of the past is worth recording, viz., the relative amounts of steam and sailing tonnage. I will give you the result only of a careful analysis of the figures, bearing in mind that it is offered as an estimate, since, singular to say, the Government have not hitherto thought it worth while to separate the two descriptions of vessels.

The total tonnage conveying goods to and fro between India and the West is supposed to have been 3,000,000 tons, of this we have good reason to suppose that 2,200,000 went through the canal. If this estimate be correct, and it is probably pretty nearly so—since the whole canal tonnage was steam, and the remainder viâ the Cape sailing—it follows that whereas previous to the opening of the canal steam tonnage was probably not more than one-fifth of the whole, in the year 1874 it was two-thirds of the whole, and this proportion has no doubt been very considerably increased since. The canal may therefore be said to have given a death blow to sailing vessels except for a few special purposes.

A selection of the aggregate figures as to imports and exports, and again among the leading countries of the West, which the canal has no doubt specially affected, will, I think, prove interesting, and although the absolute measurement in tons cannot be arrived at with perfect accuracy, there is sufficient upon which to form a reliable judgment.

Value of Imports (including Treasure) into British India, from Europe, in each of the undermentioned Years.

Countries whence Imported.	Years Ending 31st March.				
	1870.	1871.	1872.	1873.	1874.
United Kingdom	£30,357,055	£28,840,903	£32,730,458	£28,273,590	£29,665,763
France	930,766	423,448	555,201	378,300	362,388
Germany	43,197	36,296	33,501	47,404	23,423
Mediterranean Ports	12,292	148,227	285,378	298,926	462,716
Other countries in Europe	42,098	19,221	22,113	27,566	24,193
Total Foreign Europe	1,028,253	627,192	895,193	752,196	872,720
Total Europe, including United Kingdom	£31,385,408	£29,468,095	£33,626,651	£29,025,786	£30,538,483

The above Table fully bears out my statement that the great expectations entertained of a large increase of trade due to the canal have not been borne out. It will be seen that imports into India from the United Kingdom are but feebly stationary. The falling off from France is immense, but is greatly due to the effects of the war, from which at that time there had been no recovery. The figures under the heading of Germany and other countries are of little account, but the item which deserves your most particular attention is that of the Mediterranean ports. In the year 1869 that heading did not exist, because there was no trade. In the year ending 1874 they sent goods to India to the value of £462,000; and an analysis of the descriptions of these goods is more suggestive still. They consist of every description of manufacture, including cotton, which hitherto has been supplied from England; and the sooner our manufacturers study the subject, to discover where they are being competed with, the better.

Value of Exports of Indian Produce and Manufactures, of Foreign Merchandise, and of Treasure, from British India to Europe, in each of the undermentioned Years.

Countries whence Exported.	Years Ending 31st March.				
	1870.	1871.	1872.	1873.	1874.
United Kingdom	£27,798,698	£32,083,883	£33,020,522	£28,666,818	£28,885,756
France	4,227,279	2,012,818	4,175,223	2,673,000	3,134,078
Germany	77,101	255,011	355,588	196,453	60,145
Mediterranean Ports	626,719	1,429,818	2,230,125	2,158,122	2,232,291
Other countries in Europe	393,530	285,179	987,833	393,658	510,104
Total, Foreign Europe......	5,334,629	3,982,826	7,748,769	5,421,233	5,936,618
Total Europe, including United Kingdom	£33,133,327	£36,066,702	£40,769,291	£34,088,051	£34,822,374

This Table gives a similar view of the exports to Europe.

In regard to the United Kingdom, it tells the same story of stagnation. The French figures are rather more hopeful, but those relating to Germany are even more unsatisfactory than the known bad state of German trade would have led us to expect. Not so the Mediterranean ports, which alone of all places equal the buoyant figures of 1872. This large amount of over two millions is also made up of the principal staple articles of Indian produce—cotton, coffee, jute, hides, seeds, &c., which formerly used to be shipped to London for distribution upon the Continent. I have lately seen it asked, why should not Italians, Germans, Swiss, &c., import their Eastern produce direct from India, if they please? Why should we complain if they do? I am not here to complain, but to show how the canal has affected trade. In this particular matter it has affected trade most materially; it is likely to do so still more in the future, and more than that, this effect upon trade is most injurious to this country. It is very easy to talk with irresponsible generosity towards other nations, and give a fine impression at the time of large-hearted liberality, but the time may come when we may feel the want of what we are losing, and it will not conduce to regaining it in some other direction, if it is put aside as a matter of no consequence to the nation.

From the Table in p. 259 may be gathered the proof of what I have before stated, that of most of the main articles the cost has been greatly reduced. Although in 1875 we paid for cotton exactly one-half the cost of 1869, we received only one-fifth less quantity, and for the same money we received nearly three-fourths more jute. The producers must have suffered seriously by this great reduction in price, and yet it is well-known that the trade of consumers was not satisfactory. Coffee is an exception to the general rule. It would seem that, as was once before the case during the war times, about 1812, the consumption of the world appears to have overtaken the production. The enormous increase in the production of Indian tea is a very noticeable feature, and I have added the statistics of that article from China also. I do not think it is possible to deny that the facilities for rapid transport afforded by the canal have tended so powerfully to keep prices at a minimum, that consumption has been enormously stimulated, and one effect of the canal certainly has been that the importation is no longer confined to a special class of merchants. So generally has this branch of the trade been dispersed, that we may shortly see, if they do not do so already, the grocers drawing their supplies direct from the Chinese dealers.

At this point I may describe one of the causes for the great reduction in price, and yet unsatisfactory trade. Everyone knows how produce formerly was dealt in; merchants imported and sold two or three months after arrival in a leisurely manner, as suited their convenience.

Now, we will say, a Calcutta commission agent, through a clerk in London, contracts to sell jute or cotton by mark to a manufacturer, fixing the price by telegraph. An inevitable steamer is sure to be in port to leave in a couple of days, the jute is bought and hurried down to the ship, the agent draws through a bank with shipping documents. In five weeks the shipment arrives, the manufacturer pays the bill under discount, either with his own money or his banker's, and before the week is out the cotton or jute is probably going through the mill. At the outside such a transaction requires six weeks.

Imports into the United Kingdom of Goods from India, according to the Board of Trade Returns.

	1869.		1870.	1871.	1872.	1873.	1874.	1875.	
	Value.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Cwt.	Value.
*Cotton	£18,405,206	4,298,573	3,049,434	3,818,630	3,883,193	3,289,065	3,676,270	3,446,121	£9,255,392
*Jute	2,143,100	2,467,817	2,376,690	3,454,386	4,052,006	4,643,438	4,299,336	3,417,922	2,576,525
*Hides	1,090,562	367,256	383,687	404,153	482,233	362,787	354,035	334,828	1,316,112
*Saltpetre	307,764	278,820	295,538	341,618	335,672	331,517	294,419	282,705	287,475
*Ceylon Coffee	2,867,724	849,142	874,686	812,813	693,256	863,131	541,470	755,715	3,825,044

* Prices of these articles in London are much lower now than in 1869. In the Board of Trade returns the quantity of indigo and oil seeds imported from India are not kept separate.

Imports into United Kingdom of Tea and Silk from India and China, according to Board of Trade Returns.

	1869.		1870.		1875.	
	lbs.	Value.	lbs.	Value.	lbs.	Value.
Tea, from India	139,223,298	£10,311,466	13,046,235	£1,141,548	25,784,866	£2,295,668
" " China			125,593,898	8,787,894	170,966,836	11,754,511
Total	..	..	138,940,133	9,929,442	196,851,702	14,050,179

It is easy to calculate what it was formerly:—

Order by letter to buy	5 weeks.
Buying, packing, shipping, certainly	3 "
Sailing, via Cape	10 "
Discharging, and sale by auction	2 "
Gradual delivery rather over	4 "

That is to say, six months instead of six weeks.

Similar transactions take place in, indeed, all the principal articles. Is it, therefore, surprising that, with all the old six months machinery still in existence, trade, owing to the action of the canal, should be in a disjointed state, and competition should be so keen that prices have been driven down to a minimum.

I will now conclude with a very brief reference to three important articles.

SEEDS.

	Cwts.
1869, viâ Suez	1,400
1875 "	2,000,000

It is a significant fact, that in 1869 the quantities of seeds which were shipped overland viâ Suez were limited to 1,400 cwt., in 1874 reached the enormous amount of 2,000,000 through the canal.

WHEAT.

	Cwts.
1869	
1875	1,750,000

In the year 1869 the export of wheat from India was unknown, at least commercially so. The liability to heat during the long voyage round the Cape, and the length of time required to communicate with the places of production, far in the interior, rendered the venture too risky. The telegraph has remedied the latter defect, and now, by means of the canal, orders can be executed by delivery in London in little more than, or even within a month, so that in 1875 we received by that route the immense supply set down above.

COTTON.

1869	1,000,000, via Cape.
"	200,000 " Suez.
1875	400,000 " Cape.
"	900,000 " Canal.

Lastly, I will draw your attention to the shipments of the article cotton—which, of all others, perhaps interests this country the most. It will be seen by the table that the quantities viâ the Cape and viâ Suez have been practically reversed by the opening of the canal.

I do not propose to weary you with more figures. I think that those I have given support the proposition with which I started, that the canal has made very great changes; that these changes have not been hitherto beneficial to trade, in consequence of the suddenness with which they have occurred; and that their tendency in the future is likely to be increasingly adverse to this country, having regard to the old lines on which trade used to be conducted.

Whether the energy of our traders will devise some means of neutralising the loss of our geographical advantage remains to be seen. Of one thing, gentlemen, I have long been persuaded—that we shall not be able to compete with other nations unless our commercial classes study their business as scientifically as the soldier, the sailor, the lawyer, or the statesman. Chambers of Com-

merce, by their opportunities for discussion, have done much to popularise a study which few follow, but although on the surface it may appear hard and dry, it will be found to contain the solution of many problems interesting to the human race, and most interesting to us, because in them is involved the question of our continued existence as the leading commercial nation of the world.

I have endeavoured to put before you all these facts as briefly as possible. Whatever we may say or do, however much industries or individuals may suffer at first, one thing we do know, that India has been brought within three weeks journey of England. We gained our supremacy there when a letter and its reply were frequently twelve months on the road. The same thing can now be done in twelve minutes. Is it to be supposed that this energetic nation will not find its advantage in such facilities as these; I am sure it will, and that even many here will live to see it.

Canal Tariff.

I propose now, as briefly as possible, to call attention to one or two points connected with the canal, which affect our position as customers in respect of our trade; and since the purchase of shares our position as shareholders is so mixed up with it, that it is impossible I can avoid allusions which, however, I desire to say will not be made with a view to criticise the purchase, which is not our present purpose.

I stated just now the capital upon which interest and dividend have to be paid, and everyone knows that these are the minimum expectations of the French shareholders. Through the hardest of times they have never lost sight of the dividend question, either in money or paper. It was to be paid, and whenever any question has arisen an attitude has been assumed, which a perusal of the documents will show augurs ill for that perfect accord between the customers of the canal and its shareholders, which in some quarters appears to be so confidently expected. It is instructive to see that although the canal is only now, and that by favour, beginning to pay its way, it seems to be assumed by the shareholders that they are raised above the mere vulgar position of the ordinary investor, who is subject to the adverse as well as to the favourable influences which may affect his enterprise. Throughout the documents so ostentatiously put forward by the company, we continually see high sounding phrases dwelling upon the sacrifices made for the benefit of the world, but these, when tested by the touchstone of so much per cent. vanish into thin air, and leave behind querulous claims for remuneration out of the pockets of other people.

The payments in cash or paper by way of dividends on the shares have been made as follows:—

	Francs.
1859 to 1869, 11 years	66,846,868
1st coupon 1870 paid in 1873	5,000,000
2nd coupon 1870 paid in 1874	5,000,000
7 coupons 1871 to 1874 paid in bonds	35,000,000
2nd coupon 1874 paid in 1874	5,000,000
	116,846,868
Say	£4,673,000

So that the shareholders have nothing to complain of in this respect.

I have shown how the enterprise was saved from bankruptcy by the liberality of the Pasha. A similar crisis occurred in the year 1873, and on that occasion shipowners were made to come to the rescue, and as the point is a most important and indeed vital one for commerce, I propose as briefly as possible to state the facts.

In the early months of 1872, the gross tonnage passing through the canal was not averaging 2,000,000 tons per annum, and it was evident that unless means could be found for raising the traffic or the receipts, the company would be unable to pay its way.

Up to that time the tonnage rate of 10f. per ton had been charged upon the registered tonnage, which is the available space, after deduction of the space occupied by the engines and coals of a steamer. Of sailing vessels we need take no account.

This charge was made under the 17th article of the statutes, which provides that the rate shall not exceed "10frs. par tonneau de capacité des navires." It occurred to, I believe, the very clever gentleman who represents the company in this country, that these words were sufficiently elastic to admit of tonnage being charged upon a much smaller space than the legal registered ton.

Perhaps there are some here who do not know that the word ton as applied to shipments varies infinitely with the particular goods and the place of shipment, and that the only invariable ton is the registered ton, which, however, itself varies according to its nationality.

Since the year 1854 England has applied a scientific rule to the measurement of ships according to a system established by Captain Moorsom based upon Newton's laws for the measurement of curvilinear bodies.

The interior capacity of every British ship since 1854 is accurately measured in cubic feet by this rule. The total capacity thus obtained is called the gross tonnage, and from it is deducted the space, similarly measured, occupied by the engines and coals, and the remainder gives the space utilisable for carrying cargo, which is expressed in registered tons by division by 100. Hence a ship whose total cubic capacity is 120,000 cubic feet, has a gross tonnage of 1,200 tons. Supposing her engine and coal space measure 60,000 cubic feet her net registered tonnage will be 600 tons of 100 cubic feet. It is universally admitted that this is the only certain method of ascertaining correctly the cargo capacity of a ship. Here all accord ceases. Some nations had adopted this system, others adhered to their old plans, which were mostly empirical, having been converted from some certain basis by a rule of thumb upon no basis at all, to suit the exigencies of the moment, the general principle of all being to discover some system to save port dues by enlarging the registered ton upon which they are habitually charged. Of all these systems the French was probably the most empirical.

It affected aristocratic airs of antiquity, professing to date from the time of Colbert, and ostensibly was a ton having a cubic measurement of 1·44 metre, equal to 51 cubic feet English. Based upon this the French claim was a very plausible one.

They said that the concession was in French—that the French ton was therefore intended—that the French ton was a cube of 1·44 metre. That by

their act of concession they were entitled to charge 10 francs for each *tonneau de capacité*, which was a cube of 1·44 metre, or of 51 English cubic feet. That experience showed that as a rule the number of tons of this magnitude in English ships was equal to the whole contents or gross tonnage of the ship before deduction of engine and coal space as ascertained by the Moorsom rule. That, therefore, to save trouble they would charge 10 francs per ton on the gross tonnage. This little arrangement at once added 40 to 50 per cent. to the charge upon every steamer, and, consequently, to the company's receipts.

I think the case as thus shown was not a bad one, and nothing but the sifting it received at the hands of an International Commission could probably have exposed the weak point, for unless it could not be shown that a "tonneau de capacité des navires" meant something definite, the contention of the company for a small ton was as good as that of the shipowners for a large one.

The gentleman who drew up the concession was appealed to say what he meant. He replied that the expression meant "the real capacity of the ship." The Porte, appealed to, declared it to mean the utilisable capacity, and it was a plausible enough contention that if a French or English ship could carry 30 to 40 per cent. more cubic tons of 1·44 metre than her net register showed, it was right to charge accordingly.

The Commission met and the whole case crumbled away at the first touch. An ardent partisan of the Canal Company represented France. He stated his case, and it at once appeared that although the French legal maritime ton was ascertained by using 42 French feet, or 1·44 metre as a divisor of the supposed total capacity, the ingenious device had been adopted of reducing this total capacity so as to minimise the product. Instead of ascertaining the real contents of the ship by the Moorsom, or some equally correct mode, by the use of an arithmetical formula, constructed for the purpose, the bulk of every ship was systematically reduced. For instance, by the mode of gross measurement, a ship of 60,000 cubic feet was reduced to 44,000, and although the ton was apparently one of 1·44 cubic metres, the gross capacity was so reduced that the legal ton of capacity actually became one of 2·82 metres, or very nearly double the ostensible ton.

It was thus shown that the ton of 1·44 metre was an imaginary one.

Though put forward as the commercial ton, it was admitted that the ton varied in France even according to the ship and the article, the French messageries charging for the ton of one metre, which might with equal justice have been put forward.

The International Commission, composed of representatives of twelve countries, decided by a majority of 11 to 1 in their report to adopt the Moorsom ton of capacity.

Eventually, however, in consequence of the representations of the company, that their condition of impecuniosity necessitated a higher charge than 10 frs., the commission agreed, with the concurrence of their respective Governments, to recommend the concession of a surtax of 3 frs. per ton, to be reduced on a sliding scale by reductions of 50 cents. 13 francs to be charged upon 2,000,000, and half a franc to be deducted for every 100,000 tons annual increase.

I desire to bring this specially forward because the returns to the end of 1875 appear to show that as during that year the tonnage liable to dues has greatly increased, therefore this year the tariff rate should be reduced. Notwithstanding that the French Government authorised their representatives to agree to it, M. Lesseps has never ceased to vituperate the English Government for the course they have taken in the matter, although they adopted the same course as nine other countries who were practically unanimous throughout. It is of the greatest importance to British shipowners, for their share of the surtax amounts to from £210,000 to £250,000, and when the shareholders set up claims to a profit for their work, I think it should be borne in mind, if their claim is good, that of shipowners is no less so. Why should they work at a loss for the benefit of the Suez Canal? The concession is a large one, as I shall show you by the canal revenue returns for 1875, which have just been published:—

Canal Receipts and Tonnage.

	1874.		1875.
Gross tonnage....	2,436,629	......	2,950,026
Net tonnage	1,649,188	......	2,019,495
Receipts	24,976,500 frs.	....	29,026,000 frs.

A glance at the above Table will show that the Canal Company, by some means or other, still succeed in charging the rate of 13frs. per net ton, so as to yield within a fraction of the 10frs. per ton gross, which for more than a year was illegally levied. Fuller details are required to ascertain the precise facts, but it is clear that the surtax of 3frs. yields at least £270,000, the far larger proportion of which is paid by British shipowners, and which is considerably more than enough to enable a full dividend of five per cent. to be paid on the shares.

I regretted to see it stated in Parliament that one of the advantages of the purchase of shares would be, to get the "tonnage question" settled. If ever there was a settlement, and a liberal one, this was one, and I hope that Parliament will bear in mind that our own people are entitled to consideration as well as the Suez Canal shareholders, and will refuse to allow it to be re-opened.

There are many other points connected with the Suez Canal of the highest interest to us, particularly now that we are likely, in adddition to our preponderating position of customers, to occupy that of shareholders also. The jurisdiction to which the canal and its shareholders are subject, the voting powers conferred by the Khedive shares, the share of representation we shall have upon the direction, the rights appertaining to the founders' shares, and, above all, the question of an international purchase of the whole undertaking, all these and many more will require careful watching, and if I have contributed to draw attention to any portion of the subject I shall feel with satisfaction that the time spent upon it has not been uselessly employed.

DISCUSSION.

Dr. Burn said the Suez Canal had an interesting bearing on the connection of England and India. Many people felt very anxious about the approach of Russia

to the North-Western Provinces, but for his own part he thought the Russian conquest of Affghanistan would be the best thing which could happen.

The Chairman having reminded the speaker that the question for discussion was the commercial aspects of the Suez Canal, and that it was not usual to introduce political topics at these meetings,

Dr. Burn said he would only make one remark, viz., as to one of the articles of export from India mentioned in the paper. Wheat was stated to be now coming from India in large and increasing quantities, but more than twenty years ago he proposed the cultivation of wheat in India, and proved that it could be grown to a large extent. The merchants at Bombay met his proposals with laughter, saying there was an insect, the weevil, which would destroy the grain before it could reach England round the Cape. However, he sent a cargo round the Cape to Liverpool, where it sold for as high a price as any in the market, showing that with proper precautions even the weevil might be defied. He was glad to see that what he had said twenty years ago was now being verified, and that there was a prospect that the millions of money now spent in America, Russia, and other countries for corn might be spent in India.

Mr. Maitland moved the adjournment of the discussion. As an old Indian, he had been much interested in the paper, and had taken great pains to follow it, but it was very difficult to do so without a printed copy before one. In moving the adjournment of the discussion he also begged to propose a hearty vote of thanks to Mr. Magniac for the great labour he had taken to collect so much valuable information.

Mr. Hyde Clarke, in seconding the motion, named the Thursday following for the resumed discussion, and also expressed the thanks of the meeting to Mr. Grant-Duff for presiding.

The motion for adjournment was carried unanimously, and the proceedings terminated.

TWELFTH ORDINARY MEETING.

Wednesday, February 23rd; Clare Sewell Read, M.P., in the chair.

The following candidates were proposed for election as members of the Society:—

Backler, Henry McLauchlan, F.R.G.S., 11, Austin-friars, E.C.
Boese, Waldemar, Memel-villa, Dulwich-road, Herne-hill, and 22, Great St. Helen's, E.C.
Cadman, Major William Edwin, 28, Upper Park-road, Haverstock-hill, N.W.
Carter, R. Brudenell, 69, Wimpole-street, Cavendish-square, W.
Heath, Arthur Henry, C.E., Royal Engineering College, Cooper's-hill, near Staines, Middlesex.
Peebles, D. Bruce, The Fountain Bridge Works, Edinburgh.
Rosebery, The Earl of, 2, Berkeley-square, W.
Wilkinson, Thomas Read, Manchester.

The following candidates were balloted for and duly elected members of the Society:—

Austin, C. E., The Beeches, Barlow Moor-lane, Didsbury, near Manchester.
Dods, Lieut.-Colonel P., 3, West Cromwell-road, South Kensington, S.W.
Mitchell, Aurelius Bruce, 40, Calthorpe-road, Edgbaston.
Walker, Frederick, 47, Frederick-road, Edgbaston.

The paper read was—

THE CONTAGIOUS DISEASES OF ANIMALS: THEIR INFLUENCE ON THE WEALTH AND HEALTH OF THE NATION, AND HOW THEY ARE TO BE COMBATED.

By George Fleming, F.R.G.S.
Veterinary Surgeon, Royal Engineers.

Having had the pleasure of hearing Lord Alfred Churchill deliver a most instructive address, at the commencement of the present session of the Society of Arts, I was particularly struck with the reference made to the increasing demand for animal food, and the means which were being devised to import the flesh of animals from distant countries, where cattle and other food-producing creatures are abundant and cheap. But while much interested in the attempts that were made to accomplish this most important object, I could not help thinking, at the same time, that we were far too little concerned about home produce, and that we were not exerting ourselves as we ought to increase, and consequently to cheapen, our own food-productions. Neither do we appear to be at all alive to the terrible loss annually sustained in this country from the ravages of transmissible or "contagious," but preventible, diseases among animals which furnish us with food, or yield us essential services as beasts of burden. And neither do we seem anxious to consider, as we should, the heavy embarrassment to cattle traffic, nor the danger to health, which some of these "catching" maladies inflict upon us—losses, embarrassments, and dangers which are yearly on the increase, and to which we calmly submit as if we were fatalists, or lived in the dark ages when medical or sanitary science did not exist. And, again, when looking to other regions for increased supplies—regions which can now furnish them, because their human population is as yet too sparse to require them for their own sustenance—we are apt to overlook the fact that some day this source may fail us, either because the supplies may be required on the spot where they are created, or the very diseases which now diminish our own contribution may abolish this source when they are introduced into these, as yet, uncontaminated countries.

These reflections, which did not arise for the first time in November last, but have been impelling me for many years to an earnest study of this subject in all its bearings, made me resolve to request permission to introduce this paper before your excellent Society, with a view to draw public attention to the serious issues involved in its consideration, and, if possible, to assist in indicating the most appropriate and efficient measures to limit, or altogether suppress, the scourges of animals we designate "contagious diseases."

In this resolution I was confirmed by the remarks of Lord Alfred Churchill, and also by the knowledge that the subject was quite within the scope of your Society. For though, in some of its features, it may be deemed an essentially medical or sanitary question, yet, on the other hand, it is on the whole one of vast public interest and pressing urgency, and one with which the aims of your Society are closely allied. For the art of preserving human life from the operation of influences connected with the arts whose development you encourage, you have already praiseworthily recognised on many occasions, but on

none, perhaps, so strikingly as in that intensely engrossing series of lectures now being delivered by one of the greatest medical philosophers of our age, Dr. Benjamin Richardson. The preservation of human life from accidents of all kinds has also largely engaged your attention; and to prove that your good intentions are not limited to our own species, I may with gratitude refer to the honourable distinction you conferred upon me last year, for a paper which had for its object the preservation of the horse, in so far as the art of farriery is concerned.

Besides all this, medical or sanitary science has pointed out that, in order to combat diseases, and especially those of a spreading kind, a most complete and efficient organisation is absolutely necessary. For the invasion of contagious maladies is like that of a most wily and subtle human foe—powerful only in his subtlety, and capacity to elude observation until he makes his attack. Not only this, but every step gained by him forms a new basis, from which an advance may be made in all directions. Therefore, knowing this, we require a correspondingly perfect and skilled organisation to cope with him; and we may also have to control the districts he invades, even though they be our own. Here, then, the art of organisation comes into play, and this is an art in which, and particularly with regard to sanitary organisation, we as yet do not shine, because, I suppose, your Society has not included it among the arts it fosters and patronises. Let us hope that you may recognise it as one well worthy of your solicitude and advancement.

The daily increasing value of many of the domesticated animals, due to the greater demand for them as nations increase in numbers and civilisation, and the greater necessity for perfecting and preserving them, have been apparent for many years. Animal food has become more and more requisite for the busy physical or mental toiler, and animals have become more and more necessary as motor machines, notwithstanding the large number of non-vital machines invented by man to supplement or supplant them. Anything, therefore, which diminishes our flesh supply, or hampers it, or reduces the services we require from these animals, is a matter of great moment in the conditions under which we now live. And when, besides this, we are at the same time exposed to serious—it may be fatal—maladies, through consuming their flesh or products, or coming in contact with them, then is the question greatly increased in importance.

I need not dwell at any length on the medical aspect of the subject, though I hail with delight a growing desire on the part of the masses to learn more pertaining to vitality—to life, health, and disease. It may, therefore, be sufficient if, in relation to what I am about to say, it is stated that transmissible maladies may only be so in respect to the same species, that is, from horse to horse, cow to cow, &c., or to one or two allied species; or from one to every or nearly every species. We have well marked instances of these. Again, a "catching" disease may be so intensely virulent, that the slightest contact of a healthy with a sick animal, or even a few minutes' stay some distance from it, or near anything which has touched it or has been in its vicinity, will produce infection in almost every animal so exposed; or it may be so slightly transmissible that prolonged contact, or even inoculation with some of the fluids containing the virus, is necessary to produce the disease in only a certain number. In this respect every contagious disease has its special characters—its own individual potency and diffusibility. Some of these communicable disorders, again, are extremely fatal, and kill almost every creature they attack; while others only produce a slight and transient derangement of health. In this respect, however, they vary, malignant diseases being sometimes less deadly, and benignant ones occasionally very destructive.

The "catching" quality of a disease depends upon the presence of certain exceedingly minute living particles or germs—at least, for convenience sake, we will suppose it does. These are possessed of immense reproductive power, and more or less tenacity of life. Some of these specific germs possess the faculty of reproduction to such a degree, that a very few of them introduced into an animal body adapted for their reception, will, in a short time, have become so multiplied, that the whole of the tissues and fluids—it may be of an elephant—are impregnated with them. We have also diseases due to animals more or less minute, which take up their abode in different parts of the body, and give rise to particular disorders; and which again, if they obtain access to another animal, when this eats the flesh or any of the products of the one they infested, may give rise to great inconvenience, or a more serious form of disease. We have, likewise, transmissible diseases due to vegetable growths in the interior or on the surface of the body. Some of these contagious diseases may affect the entire mass of an animal, and the poison exist in the flesh, secretions, breath, &c., or only certain organs, tissues, or fluids may be involved.

The poison, germs, parasites, or whatever the agents may be upon which the disease depends for its maintenance or multiplication, may gain access to a healthy body through the breathing apparatus, stomach, skin, a wound, &c.; and before its effects are manifest, a certain period—in some diseases pretty well defined, in others not so—generally elapses. The disease may, or may not, be communicable during this latent period.

Some of these diseases are, in the present state of our knowledge, incurable; all are more or less prejudicial to the animals they affect, either by killing them outright, or when curable, depreciating them in value, permanently or temporarily: diminishing more or less their products or their services, or rendering their flesh or products of less value, or even dangerous, as food for man or other creatures.

Though certain diseases are transmissible from man to animals, yet a far greater number are communicable from these to man, and some of them are extremely fatal when so transmitted.

Some of these diseases of animals are indigenous to the country, and may be developed "spontaneously," through unsanitary or other influences; while other of these maladies are "exotic," or foreign to our soil, and are, or have been introduced from countries where they are more or less prevalent. These exotic diseases are by far the most serious, and have proved a most terrible scourge

to this country; they cannot be developed here by any combination of circumstances or conditions, but depend solely for their maintenance on their contagious properties.

A knowledge of this undeniable fact is of great moment, in connection with their suppression; for badly informed people, who fancy these can be "generated" in different ways in this country, would also have us believe that it is useless trying to suppress them like other contagious diseases. This was the painfully erroneous notion which also prevailed when the cattle-plague was introduced twelve years ago, and the injury the silly idea wrought we can all remember; we can also recollect how it was proved to be utterly destitute of a shadow of probability by the manner in which the plague was eventually stamped out. The same ignorance yet prevails with regard to the exotic diseases from which we now suffer, and the baseless notions are working as much harm every year as they then did. The people who entertain such fancies, when they are not moved by interested motives, cannot know anything of the history or the nature of such maladies.

It is only quite recently that these foreign contagions have been introduced among our more valuable animals. On the Continent of Europe, the events of war, but more especially the greatly extended intercourse brought about by railways and steamboats, have been carrying these diseases from their birth-place, and gradually diffusing them all over the world. For the most serious of them have a wonderful power of adaptation, and they can maintain themselves in a great range of climate, and under extremely variable and diverse circumstances.

The most formidable and harassing of the exotic contagions of animals of which we have as yet had any experience, are three in number—the rinderpest or "cattle-plague," and what are commonly known as the "lung-plague," and "foot-and-mouth" disease. The rinderpest has made only one great invasion of this country during the present century; and then, through the most unpardonable ignorance and supineness, it wrought an amount of destruction and ruin which is absolutely appalling, when we consider the short time it was allowed to revel unchecked among our herds and flocks. In the cattle-plague invasion of 1865 and 1866, we may set down the money loss from its ravages at something between ten and twelve millions of pounds. Indeed, it is scarcely possible to compute the total amount of damage it inflicted, as we had not very trustworthy means of arriving at the truth. Yet this is a purely contagious, and therefore a preventable malady.

But if the rinderpest caused such startling havoc in such a brief space, it must be confessed that the two other diseases—"lung-plague" and "foot-and-mouth" disease—have been no less serious scourges; inasmuch as, owing to their less fatality and their having been for so many years domiciled in these islands, they have not attracted so much attention, though they have become none the less universal, and their ravages have been yearly on the increase.

For reasons which will be presently alluded to, we are unable to arrive at anything like a correct estimate of the damage inflicted on the national wealth by the two scourges just named, since their introduction some thirty-six years ago. Until within the last eight or nine years, no effort was made to ascertain the exact loss they were causing; and though it is now attempted to give a statement of this loss, yet the returns cannot be accepted as affording us any more than a very faint idea of the money swallowed up by these two contagious but preventible scourges. In fact, we are almost in the dark as to the actual damage, in pounds, shillings, and pence—to say nothing of the embarrassment to trade—which these two diseases occasion.

The "lung-plague" is pretty well a concealed disease, and one with whose prevalence the small cattle dealer and petty butcher are better acquainted, perhaps, than the police or other kind of inspector. Yet it has been calculated that in Edinburgh alone, the annual loss from it is between £200,000 and £300,000. For the six years ending with 1860, it has been estimated that there perished considerably more than a million of cattle in the United Kingdom, the value of which must have amounted to at least twelve millions of pounds. The tables of an English Cattle Insurance Company prove that from 1863 to 1866, the death-rate from this scourge was from fifty to sixty-three per cent. annually. If we can form any judgment from these figures, it will not be too much to assert that the "lung-plague" costs us at the very least £2,000,000 a year.

The malady has been carried from Great Britain to her colonies; and in Australia it is estimated that the stock of cattle is reduced by a million of pounds annually.

But we have no time to notice this disease further than to observe, that what with its long duration in those attacked, the slow and protracted convalescence when they chance to recover, the consecutive disorders—perhaps permanent loss of condition—the non-productiveness of the animals for months, all this makes it one of the most disastrous plagues than can afflict a cattle-producing country.

The other exotic malady, "foot-and-mouth disease," though not nearly so fatal, is yet, perhaps, a greater destroyer of the national wealth than the "lung-plague." We cannot arrive at anything approaching exactitude with regard to the damage it inflicts, as a large number of the outbreaks are never reported. Little is known as to the loss incurred from it previous to 1869; but from the attempts that have been made to arrive at a proximate estimate of the destruction it and lung-plague occasioned for the thirty years preceding that date, we may infer that both maladies had cost the country at least £84,000,000. If we add to this the ravages of the cattle-plague in 1865-66, we shall not be far wrong if we put down the damage sustained, from 1839 up to 1870, as £100,000,000.

But the ravages of foot-and-mouth disease have been almost yearly on the increase since then. In 1871, according to the report of the Veterinary Department of the Privy Council (which, however, cannot be relied upon, as it is certain to be below the mark), no fewer than 519,523 cattle, or 10 per cent. of the entire stock of Great Britain, were attacked. Somersetshire, however, reported 12 per cent. attacked; and it is possible that some

other counties had more. In 1872 the malady was so prevalent among cattle, sheep, and pigs, that in England and Scotland the direct money loss from it was rated at the astounding sum of £13,000,000; and even this enormous figure is supposed to be under the actual amount. In Leicestershire, for example, where an attempt was made to obtain returns of the number and species of creatures affected, and where the loss on each bovine animal was put down at the low figure of £2, and sheep and pigs at 10s., it was computed that a sum total of upwards of £340,000 would not have covered the loss in that county alone. In Cheshire, in the same year, one-third of the total horned stock was attacked, the money loss being valued at 9 to 10 per cent. of the whole head of cattle in the county. In Herefordshire, in that year also, it was ascertained that more than 35,000 cattle, 108,000 sheep, and 9,000 pigs were affected with it, the loss being estimated at £156,000. In Ireland, for the same year, though the cattle reported as diseased must have been a mere tithe of the number actually infected, the loss is reckoned at about £442,000. What the loss was in 1874 it is impossible to say, the Veterinary Department of the Privy Council having given up recording the outbreaks of the malady since 1871. It must certainly have been very great, as, in thirteen parishes around Shaftesbury alone, 10,000 cattle, or nearly one-fourth of all the stock in them, were attacked, the loss being at least £15,000 in this small district. In 1875, owing to the disease having been more widely diffused than it ever was before, the damage inflicted by it must have been considerably over eight millions of pounds. From east to west, and north to south, it raged with a violence and virulence which showed that time does not modify its intensity like some other contagious diseases. The county of Somerset alone lost £150,000 through it; while so far north as Aberdeen, the very lowest estimate shows that in this county 7,731 cattle and 8,954 sheep were attacked, the damage probably not being less than £65,000. Other counties, doubtless, suffered to a similar if not to a greater extent.

These astounding losses from three imported foreign diseases, which owe their maintenance and diffusion solely to their contagious properties, will testify at once to the immense importance of the subject I have brought before you, from a money point of view alone. Two preventable contagions, which rob the country of four, six, eight, ten, or twelve millions of pounds annually, cannot be designated anything less than scourges of the greatest magnitude.

Some superficial people have tried to make light of "foot-and-mouth" disease, merely because it is not always very fatal. But they little know what it is among the cattle, sheep, and pigs of farmers who are not wealthy, or among the dairy stock of those whose living depends upon the produce of their cows. When it is considered how rapidly animals lose condition, especially fat stock, what losses occur when it appears among milch cows, cows in calf, and oxen, sheep, pigs, and even poultry, and the embarrassment it may, from its presence, occasion to agriculture and the cattle and milk trades, as well as the expense of curative measures, it cannot be denied for a moment that, even under the most favourable circumstances, this malady causes greater loss than the cattle-plague itself.

But we have other contagious maladies which, though they may be imported from abroad, like the three just alluded to, may yet be said to be "indigenous." One of these is the horrible disease "glanders" of the horse—which is transmissible to other species and also to mankind.

We are in the dark as to the extent to which this dangerous malady prevails, as here also the returns of the Veterinary Department of the Privy Council are not reliable. In London, where it exists to a far greater extent than is perhaps dreamed of, it is supposed to destroy horses to the value, annually, of £5,000; and in other parts of the country the loss may be set down at £20,000 more.

The ox suffers from scrofula, and some forms of blood disease which are contagious and destructive, but are not included in the Privy Council list.

The sheep is affected with some serious contagious maladies, but chiefly with a parasitic disease of the skin, that occasions much loss.

It may be said that thousands of pigs perish every year from contagious diseases which are not recognised by the authorities; and we do not know the extent of the loss they occasion, nor even the nature of the diseases.

Rabid dogs cause much destruction to property, and numbers of people die every year from hydrophobia; yet rabies is a terrible disease not mentioned in any of the official records of the Privy Council.

In fact, we are altogether uninformed as to the injury inflicted on the national wealth by many maladies which are very serious and alarming, and are yet preventible.

With regard to the influence of the contagious diseases of animals upon the health of the nation, I am sorry I can say but very little indeed. The sanitary science of man is only in its infancy, while the sanitary science of animals scarcely exists; and until these two most important branches of medicine have attained a greater development than they can at present boast of, we shall not be in a position to estimate the amount of injury to health we suffer from in our dealings or our contact (external or internal) with animals.

The money loss from the more prevalent and serious of the diseases which attack cattle, sheep, and pigs must, to a certain extent, affect the public health, and especially that of the poorer classes, as it has a tendency to heighten the price of food, and to place that of good quality beyond their reach. What is originally an individual loss—a loss to the breeder or feeder of animals—becomes in this way a public loss, which increases as it extends outwards: from the cow-shed or pasture, to the lowly dwelling in the close, foul alley, because it is made a pretext for higher prices than the occasion really requires.

But the poorer classes suffer still more, perhaps, from the low-priced flesh of unhealthy animals, which they are compelled to buy. There cannot be the least hesitation in asserting that a regular traffic in diseased animals is carried out on a large scale in town and country; and if the flesh from them is not absolutely hurtful, it is at the very least less nutritious than that of healthy, properly-conditioned animals.

But there is every reason to fear that much of this flesh must be credited with increasing the bills of mortality to an extent that we cannot at present imagine. It is only now and again, and by mere chance, as it were, that instances of the traffic we have mentioned are lighted upon; and that wo hear of the poisonous flesh of animals which have died or been killed in consequence of a fatal malady, being seized by an inspector. It is still more rare to hear of poor people actually suffering from consuming this kind of flesh. Yet, comparatively speaking, very few cattle, sheep, or pigs, which die from, or are slaughtered for disease, find their way to the knacker, or are buried. It is, we fear, not at all unusual to kill and dispose of the flesh of these creatures after they have been medically treated, and made to swallow drugs which will act as poisons on those persons who are so unfortunate as to consume this flesh; and when the animals are suddenly seized with a fatal malady, it is the custom to call in the butcher to kill them, and dress their carcases for the market.

The flesh of the ox, sheep, pig, and goat may be injurious, nay, absolutely poisonous, from disease; or it may be most pernicious from the presence of parasites, which will infest the bodies of the people who consume it.

Recent researches have shown, in the clearest manner, that scrofula or tuberculosis—a contagious disease—is very common in cattle, and especially in dairy cows—and that not only will the flesh of these produce consumption in other animals fed upon it—and particularly young animals—but that their milk also will infect. We dare not experiment upon human beings, to ascertain whether such a terrible result is possible with them, but judging from analogy, we cannot venture to doubt it. The flesh and the milk of scrofulous cattle enter regularly into the diet of probably thousands of people every year. That contamination may take place from the milk is, perhaps, the most serious reflection, as this is rarely boiled; for it has been proved that a high temperature will detroy the infective property, and hence the flesh, if thoroughly cooked, may be rendered inert.

When we remember that milk is the staple diet of young children, and that infantile diarrhœa and glandular affections of a scrofulous nature annually carry off large numbers, while phthisis in young people and adults is a wide-spread and fatal malady, we are brought face to face with the serious question as to the share the flesh and milk of diseased cattle may have in the production of this mortality.

Not only this, but some other diseases or local conditions infect the milk, so much used as an article of diet. Evidence in abundance goes to prove that in "foot-and-mouth" disease the milk is positively injurious; it will kill young animals, and it affects children, and even adults, who partake of it.

There cannot be a doubt that the manner in which cows are kept has a great influence, not only on their own health, but also on that of those who consume their produce. Unsanitary conditions may render such secretions as the milk very hurtful, and poisons may even be conveyed through the medium of that fluid, without the animals themselves exhibiting much, if any, disturbance. We are only on the threshold of our inquiries into these alarming but, nevertheless, necessary to be recognised facts in sanitary science.

We have now to consider what, under the circumstances, we require to protect the wealth and preserve the health of tho country, in so far as the contagious diseases of animals are concerned.

The prime essential of such a protection is a sanitary organisation that will meet both requirements. At present this does not exist, and has never existed in this country. And yet in no part of the world has the necessity for it been more evident or more urgent during very many years. Though two of the destructive diseases we have more particularly alluded to, and which are now always with us, invaded the country some thirty-five years ago, I cannot discover that any steps were taken, up to 1865, to check their ravages, limit their extension, or properly ascertain their nature and mode of diffusion.

Had the sanitary science or medicine of the lower animals been what it might and should have been, in 1839, the country would have been spared the invasion of these diseases; as they were well known on the Continent, and had been recognised as serious contagions years before they were introduced to us. Our insular position should have insured our exemption from them had veterinary science been on a proper footing, and competent to afford advice as to the measures necessary for their exclusion from our shores, or extinction when they did appear. As it was, they were not recognised, and were permitted to spread with all the rapidity and virulence that marks the course of newly introduced contagions of this description. Up to 1865, the two diseases were allowed to exist and to be carried about evidently without let or hindrance. In that year, however, the introduction of the cattle-plague caused a great panic, which, in 1866, led to suppressive measures being adopted for the extinction of that malady; and these measures also had the effect of pretty well extinguishing the "foot-and-mouth" disease and "lung-plague." The sharp lesson taught by the "cattle-plague," directed attention to the damage wrought by the other diseases, which began to prevail again as soon as the restrictions were removed, and fresh importations of contagion allowed. A Veterinary Department of the Privy Council was formed during the cattle-plague panic, and this undertook the control, more or less, of these maladies. For various reasons, which are not far to seek, however, neither the prevalence nor the virulence of contagious diseases appear to have been modified to any appreciable extent; indeed, since 1866, the country has been more severely scourged than before that year. The attempts made to limit the destruction of these diseases have failed, simply because it was impossible they could succeed; while the endeavour to carry them out has been attended with serious inconvenience to the country, and heavy expense.

Any one possessing the slightest acquaintance with these contagious diseases, of sanitary science, of the traffic in animals, and of the character of many of those who own or deal in these (for conscientious scruples appear to be abolished when such maladies prevail), could have foretold that the attempts would not only have been utterly

futile, but that they would also prove onerous and unsatisfactory in every way.

In the first place, those most concerned were not informed as to the nature and more important features of the diseases to be combated; in the next place, the carrying out of the measures was left to the local authorities, who, perhaps energetic in the extreme in one county, may have been as supine and negligent in another; and, thirdly, there were very few competent men employed to carry out the necessary sanitary operations.

The latter was, perhaps, the most serious omission; for instead of the authorities entrusting such important duties as the tracing and controlling outbreaks of disease, and guarding against its extension by every means which science and intelligence can alone suggest, this was left chiefly to policemen, who, when in doubt as to the nature of the malady an animal was suffering from, called in a veterinary surgeon or "cow-leech" (for qualifications are not essential) merely to settle that point. The members of the veterinary profession must, as a body, disclaim all responsibility for the enormous losses the country has sustained for so many years. Indeed, if they could lift up their voice, they would complain bitterly of the neglect with which their science and their services have been treated by the country during all this time of national loss and embarrassment.

Veterinary science has been allowed to struggle into existence, or perish in the attempt to maintain itself, in Britain, as if it was of no value or consideration. And in 1865 and 1866, during the reign of the cattle-plague, its graduates were exposed to the grossest abuse and indignity to which a profession has ever had to submit in any land, merely because they spoke truthfully, and, declining to pander to the mistaken notions of those who ought to have known better, they pointed out the real nature of the malady. And yet they had at last to be called in to extinguish that pestilence, when physicians, amateurs, empirics, policemen, and local authorities had failed to cure or check its spread. No sooner had they done so, than they were once more placed in the background, where they will remain, in all probability, until the same heterogeneous forces have broken down in their futile endeavours to rid the country of the scourges which now afflict it.

It only remains to say that the measures now in force, and the machinery at work in carrying them into operation, will never effect the object with which, we presume, they were devised—the suppression of contagious diseases, until an efficient sanitary organisation is established, in which well trained veterinarians, under Government direction, and independent of local influences, shall play the chief part, and be held responsible for the sanitary condition of their districts: advising the local authorities on important questions, watching the movements of cattle, keeping a careful eye on fairs and markets, superintending personally the more essential operations needed for the extinction of a contagion when it suddenly manifests itself, and directing the police while carrying out instructions in sanitary affairs, instead of being directed by these functionaries. Until this is done, which is not now done, we shall never rid ourselves of these scourges, nor save ourselves from loss and embarrassment. On the contrary, we may expect to see them yearly on the increase, and have perpetually exemplified the painful results of a "penny wise and pound foolish" policy.

It is a grave mistake to suppose that the exclusion of foreign animals alone would rid the country of its contagious maladies. Foreign countries suffer less from them than we do, as these diseases are not so prevalent in them, and are more energetically dealt with. If our importations from the Continent were stopped to-morrow, we should scarcely be better off; because, for want of proper measures and proper means, we cannot extinguish the disease germs, which are either active or latent in every county, every district, and nearly every cowshed and pasture throughout the land. If we had to export to the Continent, I fear our neighbours across the Channel would find us indeed dangerous importers in the matter of contagious diseases.

What we require is the sanitary service I have mentioned; and this, besides rendering other benefits of a most important character than those pertaining to contagious diseases, would scarcely cost us a fraction of the money loss we now suffer. In addition to this, we require a more energetic, responsible, enlightened, and efficient central administration. There should be no permissive legislation for the control of contagious diseases by local authorities, who often have no interest in their exclusion and suppression; but more frequently have every inducement to wink at their existence, in order that they may obtain credit for keeping down county rates. Whatever measures may be necessary should be universally applied throughout Great Britain and Ireland, and if possible with more rigour to those parts which export.

It is a grave mistake to omit any part of the country from the operation of laws which may be deemed necessary for the suppression of contagious diseases, and especially if that part is much infected. Such an omission must not only be fatal to success, but will prove a serious hardship to other parts where the measures are attempted to be rigidly carried out.

Information as to the prevalence of disease among animals is urgently required, and this could be obtained by the organisation I have described, and would be found much more exact, interesting, valuable, and reliable than that procured by uneducated policemen.

While extinguishing contagious diseases within our own shores, care must be exercised that they are not introduced from without. With this object in view, animals which are imported for fattening or other purposes that require their admission into the interior of the country alive, should be drawn, whenever possible, from uninfected regions; or if this cannot be done, then they should certainly undergo a period of quarantine. Animals fit for immediate slaughter should, if they must be carried alive to our shores, be killed at the port of debarkation. There need be little difficulty in this. No country in the world is better situated for the carrying out of such a proposal. With numerous excellent ports studded in most favourable situations all round our coasts, and railways traversing the country in every direction, there is no reason whatever why the present inconvenient, and only too often very cruel system, of conveying ship-exhausted, and perhaps diseased cattle long

distances in railway trucks all over the land, and at great risk to home stock, should be continued. To abolish it should tend to cheapen flesh from foreign sources, diminish the chances of introducing fresh supplies of contagion, and would certainly prove most humane and economical.

I have no faith in port inspection for the detection of contagious diseases, and am convinced that it is a fallacy. It is impossible for any inspector to detect disease in a latent form, or to discover if apparently healthy animals have herded with those which were sick; and unless he can do this, in very many instances his services must be worse than useless.

The details which are absolutely necessary to be observed in the suppression or prevention of contagious diseases, I cannot touch upon here. Suffice it to say that they are not observed in the country at present, and they can only be carried into effective operation by the sanitary organisation I have indicated.

With regard to the preservation of the public health, so far as its relation to animal diseases is concerned, this also must be left to the management of such an organisation. None but the best-trained veterinarians can protect the public in this direction; and until the inspection of meat and milk, dairy, stable, kennel, and pasture, slaughter-house and butcher's stall, are placed under their supervision, the public must incur risk and suffer loss. Here one of the first essentials is the establishing of public slaughter-houses in every town and city. The majority of private slaughter-houses are simply an abomination, and a disgrace to the age we live in. They are a fertile source of contagious diseases among animals; from their situation, and the way in which they are kept, they are nothing less than a public nuisance; and it is in them that animals diseased, or otherwise unfit for food, are prepared for the market.

In public slaughter-houses animals can be inspected before and after they are killed; and if found to be suffering from a contagious disease their origin can be traced, and perhaps foci of contagion be in this way discovered and extinguished. The abolition of private slaughter-houses would spare unfortunate animals an amount of torture of which the public has no idea.

Such are the remarks which I have ventured to bring before you on one of the most important subjects connected with sanitary science and the welfare of our country. I have endeavoured to do so without blaming unjustly either governments, professions, or individuals. Governments are swayed in such matters as this by their advisers, and these, doubtless, advise to the best of their knowledge. In direct proportion as their knowledge is exact, and as their advice is adopted by governments, so does the public benefit. But conflicting interests may often baffle statesmen, and render them hesitating, and inclined to adopt temporising or half-measures. In the presence of such contagious diseases as have scourged this country during this century, half measures are worse than useless, and incline the public to lose faith in sanitary science altogether. The stern fact must be looked in the face, that for ten years, imperfect attempts, whose only recommendation was that they were cheap, have not only failed to diminish the prevalence of these maladies, which have rather increased, but they have been a source of great embarrassment to trade, and have materially tended to increase the price of food. We appear to avoid looking at things as they really are, and to shut our ears to the truth. Political, class, or party considerations should have no place in such a question as this. The loss and embarrassment may first fall upon, and be most severely felt by, the breeders, feeders, and owners of animals, but these are quickly shared by the whole nation, and the result becomes a public calamity.

No country in Europe has, possibly, sustained greater loss during the last thirty-five years than our own; yet no country, perhaps, should have suffered less. With the finest breed of horses, and the most magnificent herds and flocks in the world, and a teeming population, whose health and wealth are largely centred in these, we have almost entirely neglected to protect them from the ravages of diseases of home and foreign origin, by forgetting to foster and encourage that science which alone can accomplish this. That neglect has cost Britain and her colonies untold millions. Until it is acknowledged, the omission repaired, and veterinary science placed in its proper position, so that it can yield its benefits to the full, we must be prepared to record annually the heavy damages to health and wealth inflicted upon us through the influence of the contagious diseases of animals.

At one time the British army suffered the greatest losses from disease among its horses. Through the enlightened influence of those who commanded it, veterinary science was allowed to come into play; and now disease is scarcely known, while the efficiency and durability of the animals are vastly increased. This is merely because there is an organisation of trained men, and a competent central authority to guide and direct them. What holds good in the one case must hold good in the other. Let us trust that, through your influence this evening, the public may be led to recognise this incontrovertible fact. If in the army we acted in regard to this matter as you do in civil life, our troop stables would soon be converted into hospitals, and the knackers would drive a flourishing trade. It only requires a patriotic resolution, enlightened views, and a well-organised service, to preserve the wealth and protect the health of the country, so far as the domesticated animals are concerned. Surely these can be forthcoming!

DISCUSSION.

Mr. Hunting said the remark that these diseases were not studied until 1865 required one exception to be made, that of Professor Gamgee, who had, in fact, stated twelve years ago nearly everything that Mr. Fleming had now brought forward. He thought no man living was a greater memorial of national ingratitude than Professor Gamgee. In some respects he thought the veterinary profession had been upheld rather too strongly, because not long ago they were informed by some of the leading men in it that these diseases arose spontaneously, and still more recently that they were indigenous, or had become acclimatised. Mr. Fleming now said they arose from contagion alone, and he knew of no reason why they should arise differently in other countries. The difference was that England being surrounded by water could more easily prevent traffic in diseased animals. If these diseases could not arise spontaneously, and he believed no leading man in the profession would say

they could arise in any other way, if they could stamp them out, their return could be prevented. The value of the imported cattle was only about five millions a-year, and as the country lost from five to ten millions through these diseases, it would be seen that it would be economical even to stop the whole traffic in live animals. If they had only lost one million a-year since 1830, they might easily draw the conclusion that if they had never imported a single head of live stock they would have had more meat in the country, and cheaper than at present. Only two things were requisite to keep out the disease, the slaughter of all fat stock, and the quarantine of lean. There was no reason why fat stock should not be killed at once, except that they could hold over live stock to the next market, but they could not do so with dead meat. But now-a-days the market was regulated by telegraph, so that the difficulty could easily be got over; and if the British public would support the agriculturist in this matter, they would reap the benefit of cheaper meat. The Government were not so much to blame as some people thought, and neither veterinary surgeons nor agriculturists were altogether blameless, for whilst the former had been mistaken, the latter objected to stringent regulations. During the cattle-plague very strict rules were enforced, and they had the effect of stamping out the foot-and-mouth disease, though not directed to it. This was a very important point, because it showed that the same regulations, or even milder ones, would, if applied directly to the foot-and-mouth disease, get rid of it. They need not insist on the killing of animals, as in the case of the cattle-plague; the stoppage of fairs, and of the movement of cattle for a given time would be sufficient. One important point had not yet been settled, viz., how long the poison remained active. If it were once established that it was limited to six or eight weeks, they could at once limit the time during which the regulations need be enforced. During the six or seven years the Veterinary Department of the Privy Council had been at work, it had not instituted one experiment to settle this point, though large sums were granted every year for the purpose of experiments. It seemed strange that a few pounds was not devoted to this purpose at the Brown Institution. With regard to the importation of cattle from Ireland, unfortunately it raised political animosities and national jealousies; but it was absurd to say that they wanted to treat Ireland as a foreign country. They only wanted to exercise the same precautions as would be taken by one country against the importation of disease from another. The period of incubation in foot-and-mouth disease was short, and it could generally be detected in a few days; but in lung disease, which perhaps caused more damage than any other, it was very long, and did not show itself sometimes for weeks. When it broke out, it was first seen in one or two animals in the herd, and then the interest of the owner was to get rid of them all as soon as possible. He killed those which were affected, and sold the rest to a cattle jobber, and thus they were rapidly spread over the whole country, or, if it were in Ireland, very likely sent across the Channel. An Irish inspector had been sent over to England to inquire into the existence of lung disease in cattle imported from Ireland, and he sent in a report showing that it was brought over by the cattle; but the chief veterinary inspector in Ireland made another report, in which he suggested that it was the dirty manure on the English farms which produced it. At the same time, every authority in the country, and a great many small farmers and jobbers, knew that it spread only from contagion. With regard to glanders, it was liable to be transmitted to any animal, and probably killed more in London than any other disease. It was increasing every year, and there was not a veterinary surgeon in London who could not put his hand on a dozen cases. All animals affected with it were ordered to be killed, but there was no one to enforce the regulations, and they were utterly neglected. If a cab proprietor found it in his stables, he first tried to cure it, and failing in that, killed those evidently suffering, and then had a sale of his whole stock, and perhaps changed his stables, and thus the disease spread. The Veterinary Department published tables showing that there were about 200 or 300 cases per annum, but probably some men had as many as that in their own practice. It was rather remarkable that the veterinary inspectors' list always tallied exactly with that of the horse slaughterers, showing apparently that both did their duty; but the explanation was that if the inspector sent a case to the slaughterer as glanders or farcey it was so entered, but cases sent by private individuals were not recognised. On the other hand, if a private veterinary sent a case to the yard condemned as glanders, the slaughterer sent to the inspector to inform him of it, and thus their figures always agreed. He feared that unless the department were reorganised, and public attention given to the matter, things would get worse and worse.

Mr. Webber thought those who put forward the views that these diseases were always imported ought to show that there was a time when this country knew nothing of cattle disease. His experience went to show that disease was as common thirty years ago as at present, but it was less noticed. When a young man he settled in Cheshire as a cheese factor, and was constantly in the habit of visiting farms where there were large herds of cattle, and he could distinctly recollect that about 1840 or 1842 pleuro-pneumonia prevailed on many of these farms to a very large extent. He believed the cause of it was that many of the farmers were overstocked, and their sheds and buildings wretchedly inadequate. Pleuro-pneumonia he apprehended was a disease analogous to consumption, and it was easily attributable to ill-drained farms and ill-housed cattle. Since then there had been very active competition, and there was a large importation of foreign manure, and this he thought was not a politic mode of checking the spread of contagion. Veterinary surgeons failed to discover the causes of these diseases, and could only recommend the slaughter of the animals, and difficulties being placed in the way of the importation of food; but he should like to know what would have been the price of meat in large cities, if it had not been for foreign importations. He thought men of science should turn their attention to finding a cure for these diseases, rather than advocate slaughtering and stamping out.

Captain Craigie remarked that the first speaker, in blaming the farmers, had omitted one fact, that they objected not so much to the restrictions in themselves, as to their being enforced in one part of the country, and not in another, and still more to importation being permitted from abroad. If the system advocated by Mr. Fleming had been in force, he very much doubted if they would have heard so much objection to it. The paper was a strong argument in favour of dead meat being imported wherever possible, and he looked forward to the time when it would become a universal system. It was stated, on good authority, that bullocks coming from foreign countries, and having to cross the line, lost 2 cwt. on the voyage, and, certainly, the mode in which the cattle traffic was conducted called for great reforms. It was much to be regretted that this question should be regarded in any sense as one of restricting the food supply of the people, it was precisely the opposite, and the clamour raised against it on that ground was wholly mistaken. They did not want to check free trade in cattle, but free trade in disease. He hoped it would soon be generally recognised that these diseases were imported into this country, and that they could be checked at the ports, and then, perhaps, something might be done. He did not quite understand what system was proposed, but, no doubt, a uniform and effective organisation was required, and it ought, in any case, to be

national. That being the case, it seemed to him that the administration should be central, and the expenses borne by the imperial exchequer.

Mr. McComber had been much interested in the paper, and thought the great question was, what remedy could he found for so great an evil. One of the ideas now being developed was the importation of dead meat instead of live cattle, and he knew that in his native country there were thousands of cattle roaming over the prairies for which there was no home market. The great question was, could they be slaughtered and brought here in the shape of fresh meat, and he believed recent experiments in that direction had been very successful; at any rate he was quite sure that there was none of this disease in the United States, and therefore, if they could be killed and brought here in good condition, the question would be solved. It seemed to him, therefore, that the Society could not do better than endeavour to encourage the development of such a system as would bring fresh meat to this country free from any disease, and which, therefore, could not communicate it.

Mr. W. Botly said he must take exception to one remark in the paper, because he had just received a paper from a gentleman in Australia on this very subject, showing that the cattle there were exceedingly healthy, and were increasing enormously. The increase in sheep was more than 20 millions over the number a few years ago. The statements of high authorities in the veterinary profession were entitled to great weight, but they could not always be literally accepted, for he remembered, some 12 years ago, hearing Professor Gamgee at Croydon utter certain lamentations over the then state of the cattlo in England, and make prophecies which certainly had not been fulfilled. For instance, he said that the youngest person in that assembly would never see anything like the number of sheep or cattle in England again that could be seen at that time; but the fact was, the increase had been enormous. Only last year, he read a paper at the British Association, showing that from 1872 to 1874 the increase both in cattle and sheep had been very great, in the latter more than two and a half millions. It was of the greatest importance to stamp out these diseases, if possible; but, at the same time, it was not desirable to alarm the country unnecessarily.

Mr. Hunting asked permission to say a word or two on the question of quarantine. Some sanitary authorities said it was out of the question, because the place would become simply a pest-house; but it had been shown at the Vienna Congress that this was not the case, that the disease was never communicated from Hungary to Austria through the quarantine, but always by means of smuggling. With proper arrangements and disinfectants there was no danger at all; the only objection was the expense, and it was a very simple rule of three sum whether it would not be more than saved by the prevention of disease.

Mr. Hill (Wolverhampton) endorsed the statements of Mr. Fleming. In his town they were carrying out very strict regulations with great advantage, heavy fines, and in some cases imprisonment, being inflicted for selling diseased cattle or meat. There was no doubt that tubercle in the lower animals was analogous to the same disease in human beings, and that milk from diseased cows should be strictly condemned. He could fully endorse Mr. Botly's statement as to the increase of cattle in Australia, having recently returned from that country. He was not quite sure who it was who had attributed pleuro-pneumonia to decomposed manure.

The Chairman—Professor Ferguson, of Dublin.

Mr. Hill said such a thing was simply impossible. The subject of diseased meat had not received the attention it ought, and he hoped that discussion, therefore, would be the means of doing good. Pleuro-pneumonia and foot-and-mouth disease prevailed to some extent in Australia, but he believed it was introduced from England by an animal which was not known to be affected for some time after it was landed, thus showing that tho period of incubation was considerable.

The Chairman, in proposing a vote of thanks to Mr. Fleming, said he had never listened to a paper with more satisfaction. He had frequently stated that this question was one of great national importance, and though people might say that the statements and estimates made were fabulous, in his opinion they were well founded, and the loss occasioned by these diseases was much greater than most people had any idea of. A great deal of nonsense was talked the other day at a meeting at Exeter-hall, and even in that Society he had not expected to find such an endorsement of views which practical farmers had advocated for the last 12 or 14 years. He could bear testimony to the truth of Professor Gamgee's prophecy, which was made at the time of the cattle-plague, and was to the effect that if that plague were not got rid of, they would never have so many cattle in the country again, nor would they. There were, however, two points in the paper as to which he must beg leave to reserve his opinion. First, with regard to diseased meat, he thought people might be unnecessarily frightened, because fire was a great destroyer of any infection, and when meat was thoroughly cooked, it was not quite so bad as people imagined. Capt. Craigie knew that the Highland shepherds were accustomed to eat braxy mutton from sheep which happened to die, and they were a very healthy race of men; and more than that, at the time of the cattle-plague, to his certain knowledge the men employed to bury the diseased animals, for months and months fed themselves and their families on beefsteaks cut from cattle which were killed, or had even died from the plague. He asked several gentlemen, of high standing in the medical profession, to watch the results, and to his great surprise they found that the men rather improved in condition than otherwise. The question of milk was more serious, because it was frequently taken without being cooked, hut when foot-and-mouth disease rccurred, almost all secretion of milk was stopped, and that which was produced was so offensive that people would not take it. It was very difficult to know what to drink; they were told not to take spirits because it was a poison, nor beer because it contained alcohol, while the Rivers' Pollution Commissioners said there was hardly a drop of pure water to be found anywhere, so that really they were in a great difficulty to know what to drink at all. The other point on which he reserved his opinion was as to the laudation of veterinary science. They had much to thank the profession for, no doubt, hut there was a good deal to be said against them. It was only within the last few years that the diseases of cattle, sheep, and pigs had been thought of in veterinary colleges; attention being directed solely to horses. Not many years ago, the gentleman who was supposed to be at the head of the profession in England, said the foot-and mouth disease came in the air, and the head of the Veterinary Department of the Privy Council in Dublin said that pleuro-pneumonia was caused by the way in which cattle were kept in Norfolk, in covered boxes, and well-littered yards. On the other hand, Mr. Fleming said that no combination of adverse circumstances would create it without contagion. Thirty years ago an Act was passed providing that in the present year all private slaughter-houses in London should be abolished, but the trade interests mastered science, and Dr. Brewer obtained a committee which made a report, from which one would imagine that a slaughter-house was the most healthy and delightful place on the face of the earth. The Act had consequently been repealed, and a long lease again given to private slaughter-houses. If Paris could be supplied with meat from an abattoir outside the walls, he thought half-a-dozen public slaughter-houses

would be quite enough for London; and when people talked of the impossibility of bringing dead meat from Deptford to Smithfield and other parts of London, it was quite sufficient answer to point to the wonderful importation of fresh meat from America, which had been referred to. Mr. Webber said he had seen pleuro-pneumonia in 1842 in Cheshire, and no doubt he had, but it was not known in this country before 1839, though it had existed on the Continent for more than a century. Virgil had described the cattle-plague, but it was not known here until 1845, and again in 1865. It had been kept out of England by the "silver streak of sea," and it might still be kept out with due precautions. In answer to Mr. McComber, he would say that the Food Committee of the Society had for a long time been investigating methods for importing fresh meat, but from what was now said it seemed as if the question had solved itself. In conclusion, he repudiated the idea that farmers desired protection, or to check the importation of food; they only wanted to keep out disease.

The vote of thanks having been passed unanimously,

Mr. Botly begged to say that he was present when Prof. Gamgee made the statement he had referred to, and it was not accompanied by the qualification stated by the Chairman.

Mr. Fleming, in reply, said this question was one of the greatest importance to the public, and until it got beyond the limits of farmers and veterinary surgeons it would never receive due attention. He was glad to find from the Chairman that he had been supporting the views of the farmers, for he had always maintained that veterinary science and agriculture were closely allied. The veterinary surgeon could assist the farmer not only in curing or preventing disease, but also in developing, improving, and multiplying his animals. Some of his remarks had, no doubt, been strong, but he had endeavoured to keep strictly to the truth, not desiring to exaggerate or cause needless alarm. Pleuro-pneumonia appeared very generally in 1841, and his old teacher, Prof. Barlow, who was then in Cheshire, said it was very virulent in that district. It first appeared in 1839, and there was no dispute as to its being exotic. No one who had written on the diseases of animals before that time mentioned it, and there were several very careful and able writers at the beginning of the century. When the foot-and-mouth disease appeared, it spread so rapidly that it was described as "the new disease;" and it was invariably found to arise from infection. It was all nonsense to suppose that these diseases sprang up spontaneously; and until it was recognised as nonsense they would not be got rid of. Looking at the subject from a wider point of view, he thought it their duty to point out to countries which were as yet exempt from these maladies, the necessity of taking precautions. In America, for instance, what would be the consequence if it were introduced? If veterinary science in 1839 had been what it should have been, they might have been free from disease all these years. The heads of the profession had been spoken of, and they might, in one sense, be so described; but old men sometimes had old ideas, and many of them had studied at a time when veterinary science was little more than farriery. If they put forward such strange views about diseases springing up spontaneously, he thought it the duty of younger members to protest against their being allowed to represent the profession. Veterinary surgeons had not been blameless, but if the advice of the leading men had been taken in 1865 they never would have had the cattle-plague. It was even now maintained by some that foot-and-mouth disease and lung disease could not be extinguished; but once prove that these diseases depended on contagion for their existence, and they could soon be suppressed.

During the evening a model of Murray's cattle truck was exhibited. The following description has been supplied by the inventor:—"Under the existing system of conveying cattle by rail, when on long journeys, they are subjected to great privations and suffering from exposure and the want of food and water, this injures their health and weakens their vital powers, rendering the animals more susceptible to the attack of contagious diseases in their various forms. The object of this invention is, as far as practicable, to mitigate those evils. The arrangements admit of their application to the existing rolling stock of the various lines of railway. When the train is run into a siding, or stopped to take in water for the engine, a flexible hose is attached, which forms a connection between the hydrant and the first truck of the train; the water flows through a pipe running along each side of the truck, and communicating by branch pipes with drinking troughs; an unbroken line of any length can easily be maintained by means of a flexible pipe, connecting each pair of trucks. This pipe can be detached and replaced at pleasure. A pipe with a stop-cock is inserted in the bottom of each trough; this admits of the troughs being emptied before the train proceeds on its journey. The water pipes are further utilised as a hinge for the hay-rack. A sloping lid outside is lifted, and the hay or other fodder put in. The hay-rack, when closed, completely covers the drinking troughs. It is secured in its position by a sliding-rod, having a loop at the end for inserting the hand. When the rod is pulled backward the rack is set at liberty, and swings outwards, leaving the water-trough fully exposed to the cattle; by again pushing the rod forward the rack is maintained in position. A cotter pipe attached to a chain passes into a slot in the rod, securely fastening the rack in whatever position may be desirable."

MISCELLANEOUS.

THE NATIONAL TRAINING SCHOOL FOR MUSIC.

On Wednesday, a public meeting was held at the Mansion-house in aid of this institution, the Right Hon. the Lord Mayor, Alderman Cotton, M.P., presiding, and His Royal Highness the Duke of Edinburgh being present. There were also present, supporting the Chief Magistrate of the City, Lord Newry, the Swedish Minister, Dr. Lyon Playfair, M.P., Sir Julius Benedict, Sir George Elvey, Sir William Anderson, Sir Henry Cole, K.C.B., Mr. Alan Cole, Profesor Ella, Mr. John Hullah, Mr. Brinley Richards, Mr. C. J. Freake, Alderman Sir Thomas Dakin, Alderman Sir Robert Carden, Alderman Sir William Rose, Mr. Alderman and Sheriff Knight, Mr. Deputy Lowman-Taylor, Mr. Deputy Fry, the Master of the Merchant Taylors' Company, the Master of the Skinners' Company, the Master of the Glaziers' Company; the Rev. G. C. Bell, Head Master of Christ's Hospital; Alderman Sir Francis Truscott, Sir John Bennett, Mr. J. W. Bosanquet, Mr. Bernard Bosanquet, Mr. William Cotton, Mr. John Holms, M.P., Mr. Arthur Kinnaird, M.P., Mr. Rawlinson, C.B., the Rev. H. P. Chase, the Rev. L. B. White; Mr. Edwin Caffin, Master of the Turners' Company; the Rev. William Rogers, Mr. Reuben Sassoon, Mr. Edward Masterman, Mr. Hamilton Hoare, Mr. Teede, the Master of the Musicians' Company (Mr. Chappell), the Rev. Dr. Irons, Capt. Douglas Galton, C.B., F.R.S., Mr. Henry Leslie, Mr. Manns, Mr. Blumenthal, Mr. Frederick Clay, and many more.

The Lord Mayor said his Royal Highness was there to support, by his august presence and by the very great interest he had taken in it, a National Training School for Music; and they hoped that the company assembled in his honour would feel equally interested in the object in view as his Royal Highness himself, and, by con-

tributing to found scholarships, would help to make it as great a success as his Royal Highness desired it to be. The days of probation, as far as the school was concerned, had passed, and it was at that moment a success, inasmuch as the number of scholarships given already, or to be given that day, would be quite sufficient to enable the school to be opened about Easter, and to provide ample funds for the education of the 100 or 120 scholars who would at once take their places therein. (Cheers.) Perhaps it would not be out of place to state at once, in order to remove doubts as to the feeling with which this National School had been founded, that it was not created in any spirit of rivalry to the Royal Academy of Music. (Hear, hear.) It was hoped, on the contrary, that the Royal Academy of Music would think as kindly towards the National Training School for Music, as all who were concerned in the latter were inclined to feel towards the Academy. (Hear, hear.) In these days it was thought that there was ample room for the two schools of music, and when it was remembered to what an extent musical cultivation had been carried, and how much more musical England had become than it used to be, the meeting would at once agree with his Royal Highness that there was ample scope for the new institution. (Cheers.) Having explained that the word "scholarship" perhaps conveyed a dubious idea, and that "donation" would be more accurate, inasmuch as all contributions would go into a consolidated and corporate fund, the Lord Mayor, after commenting on the effect that such an institution was likely to have in musical progress in this country, appealed to the audience to contribute towards the foundation of scholarships.

The Duke of Edinburgh said, I have had placed in my hand the first resolution to propose to the meeting—namely, the adoption of the report which is presented to you to-day by the City of London Committee. The report deals only with the acts of that single committee, and gives but little information about the history and working of the Managing Committee, of which I have the honour to be the President, or as to what has been done by them towards bringing the school into existence. You will, therefore, allow me to refer to some points which I think are the most important for you to know. 1. In moving the adoption of the report of the City and Metropolitan Committee it will, I think, be of interest to the meeting if I state the objects of the school and the steps which have been taken to attain those objects by the Committee of Management, of which I have the honour of being the President. 2. The fundamental principle and primary object of the National Training School for Music is the cultivation of the highest musical aptitude in the country, in whatever station of society it may be found. 3. To frame a scheme for the establishment and working of the school, a committee of management of eight members, with power to add to their number, was appointed in December, 1873. The constitution of the committee is as follows:—The Society of Arts appoints three members. Her Majesty's Commissioners, landlords of the ground on which the school stands, appoint two; the Council of the Royal Albert-hall, who have granted accommodation in the hall, appoint three. In addition to these, Mr. Freake, the munificent donor of the building (cheers), became a member in 1875; and in the same year the Right Hon. the Lord Mayor of London for the time being was added to the committee. It has been also resolved that founders of ten scholarships may elect a representative to serve on the committee, and various subscribers have been called upon within the last few months to perform this duty, as at Birmingham, where Mr. Richard Peyton had been chosen to represent the scholarships founded there. The same duty now devolves upon the founders of the City and metropolitan scholarships, and it is desirable, in the interests of the school, that the representatives of these scholarships should be chosen with as little delay as may be. 4. The work undertaken by the Committee of Management was of an unusually complex and difficult character, calling for serious consideration, patient inquiry, and prolonged deliberation, but it is gratifying to be able to announce to you the gradual removal of many obstacles which at first seriously threatened the success of the scheme. In the first instance, her Majesty's Commissioners for the Exhibition of 1851 came forward and granted a plot of ground as a site for the school. Shortly afterwards the Musical Committee of the Society of Arts, under my presidency, had to consider how a fund could be obtained for the erection of a suitable building, and Mr. Charles James Freake, a member of that committee, wrote to me on the 19th of July, 1873, expressing his willingness to erect such a building at his own cost, thus clearing away, by an act of patriotic munificence, another formidable difficulty. (Renewed cheers.) 5. During the time the building was being erected the Committee of Management devoted their attention to the organisation of the official staff, and devised the method now in full operation of competing for scholarships. 6. The Council of the Society of Arts undertook the supervision of the foundation of scholarships, and through the strenuous exertions of its officers a very considerable amount of interest has been created throughout the country. In all parts of the United Kingdom local committees have been or are being formed to promote the establishment of musical scholarships for five years, and the increasing number of such scholarships throughout the country testifies to the public appreciation of the scheme, and affords a guarantee of success. 7. It may be well to state here precisely what the scholarships are. Each scholarship is of the value of £40 per year for five years, and can be held only by persons who shall have been successful in a competitive examination. The general rules to be observed in the competitions for scholarships are laid down in the directory of the school, which is now published. The particular arrangements for local competitions will be regulated entirely by the founders of the scholarships, a founder being at liberty to make them free or open scholarships. 6. No person will be admitted as a student of the school without having competed for and obtained a scholarship. 9. In determining the organisation of the school, the Committee of Management have had the advantage of advice from eminent commercial men and from experienced administrators with respect to the lay administration of the school; while, with regard to the professional administration, the committee, acting on the advice of many of the leading musicians of the day, have appointed the professional staff, consisting of Mr. Arthur Sullivan, Principal of the School and Chairman of the Board of Principal Professors, and the following gentlemen, viz.:—Mr. Ernst Pauer, Dr. Stainer, Signor Visetti, and Mr. J. T. Carrodus. To test the work done in the school the following gentlemen have accepted the posts of professional examiners, viz.:—Sir Michael Costa, Sir Jules Benedict, Sir George Elvey, Professor Ella, Mr. Charles Hallé, and Mr. John Hullah. 10. Last year the school building was completed, and, as the time had arrived for ascertaining what number of scholarships were likely to be forthcoming for the opening of the school, his Royal Highness the Prince of Wales, President of the Society of Arts, convened a meeting at Marlborough-house, to which the Lord Mayor of the City of London, representatives of the Court of Common Council, of the City Companies, and other important bodies who had intimated their intention of establishing scholarships, were invited. At that meeting his Royal Highness the Prince of Wales read a letter from Mr. Freake, who was prevented by severe indisposition from being present, announcing his generous intention of presenting the building to the nation. The result of the meeting is embodied in the report of the City and Metropolitan Committee, the adoption of which I have the pleasure of moving. Since last Midsummer many meetings have been held in provincial towns and

districts, and the reports of general progress in the establishing of musical scholarships have been so satisfactory that the Committee of Management have felt themselves justified in announcing that the school will be opened for study immediately after the approaching Easter. I would here briefly refer to the impression which has arisen that the existence of the National Training School for Music is calculated to interfere with the operations of the Royal Academy of Music. An occasion like the present affords an opportunity of correcting this erroneous impression. The two institutions have one and the same object in view, which is the promotion of musical education, but their modes of proceeding in attaining their object are perfectly distinct. At the Royal Academy of Music instruction may be obtained by any individual of musical capacity who can afford to pay for it, while at the National Training School for Music the scholars will be educated without actual expense to themselves. In other words, it is a free school. The Principal of the Royal Academy of Music fully sympathises with the objects of the school; and I have learnt with satisfaction that, before accepting the position of Principal of the National Training School for Music, Mr. Arthur Sullivan consulted his friend Mr. Macfarren, who expressed his hearty goodwill towards the new school. In conclusion I may mention that 42 scholarships have been established in addition to those scholarships which are included in the list of the City and Metropolitan Committee. Competitions for the Northumberland Scholarships, for the Society of Arts', for Mrs. Freake's, and for Mr. Morrison's scholarships have been already held. Competitions for the scholarships founded at Birmingham and at Liverpool are announced for next month. Many other scholarships—at least 20—are in the course of foundation throughout the country, with regard to which negotiations are being carried on. The scholarships which I am very glad to hear announced as having been founded in the City of London should be competed for as soon as possible, and, as I have already said, the founders of them may frame the special regulations of the competitions according to their own views. The school will provide accommodation for 300 scholars, and it is very desirable that the full number of scholarships should be established as soon as possible. I now formally move the adoption of the report of the City and Metropolitan Committee.

Mr. Charles Morley, one of the honorary secretaries, then read the report of the City and Metropolitan Committee, which related the circumstances connected with the formation of the institution, adding, "And this committee has much pleasure in reporting that the Queen, the Prince of Wales, the Duke of Edinburgh, and the Duchess of Edinburgh have given scholarships—viz., Her Majesty the Queen, one scholarship; the Prince of Wales, two; the Duke of Edinburgh, one; the Duchess of Edinburgh, one; the Corporation of London, ten; the Merchant Taylors' Company, five; the Fishmongers' Company, two; the Skinners' Company, one; the Lord Mayor, one; Mrs. Freake, five; the Society of Arts, four; Mrs. Stone, one; Mr. F. Morrison, one; Messrs. Rothschild, two; Mr. S. Morley, M.P., two; Mr. Charles Morley, one; the late Mr. J. C. Sim (to be continued by his executors), one; donations and annual subscriptions, being equal in all to three; and through the provinces, 50; making a total of 93 scholarships." A list of annual subscriptions and donations was also read, amounting to £207 odd.

The adoption of the report, seconded by **Dr. Lyon Playfair, M.P.**, was put by the **Lord Mayor**, and unanimously confirmed.

On the motion of **Sir J. Harington**, seconded by **Alderman Sir Thomas Dakin**, it was resolved that, as this was the first national movement in favour of a free school for musical education, and as it was based upon a practical and comprehensive system of representative management, it was, in the opinion of the meeting, worthy the cordial support of all classes of the community.

At the instance of **Sir Julius Benedict**, seconded by **Mr. Alderman and Sheriff Knight**, it was resolved that the meeting having approved of a free National Training School for Music, earnestly recommended the same to the consideration of corporations, associated bodies, and individuals, by their taking one or more scholarships of £40 per annum, for at least five years.

At this point the **Lord Mayor** announced that since the arrival of his Royal Highness one scholarship had been contributed by the Sheriffs of London and Middlesex, two by the Mercers' Company, one jointly by Mr. Joseph Causton, the present, and Mr. Charles Barry, a past Master of the Skinners' Company, each for five years. Mr. Hammack also announced the gift of a similar scholarship by the Common Councilmen for the Ward of Bishopgate, of whom he is one. Mr. Chappell, of the musical firm of that name, announced a similar donation.

Alderman Sir Francis Truscott announced the donation of a scholarship by the Vintners' Company.

The Lord Mayor having announced that Mr. R. D. Sassoon had given a scholarship, proposed a vote of thanks to the Duke of Edinburgh for his presence.

The Master of the Merchant Taylors' Company seconded the motion, which was adopted.

The Duke of Edinburgh responded, and proposed a vote of thanks to the Lord Mayor for his kind and able conduct in the chair.

Sir H. Cole seconded the resolution, which was put to the meeting by the Duke of Edinburgh, and carried with acclamation.

The Lord Mayor having briefly acknowledged the compliment, the proceedings terminated.

GLASS REFINING.

The following is extracted from a paper submitted to the French Academy of Science by M. Frémy:—"The difficult portion of glass manufacture is the refining, which has the object of rendering the metal homogeneous, and of expelling, as far as possible, the air-bubbles which are produced in abundance at the moment of the formation of the glass; these bubbles remain in the vitreous mass, even when the chemical reactions seem to be accomplished. The nature of these gases, which cause a defect in the glass known by the name of 'point,' has not hitherto been exactly determined. It is not even known what are the reactions which, at the end of the operation, cause this disengagement of gas which lowers the quality of the product. In observations made during a long period, I conclude that the defect is due to the action of the reducing bodies on the sulphate of soda which is contained in excess in the glass. The action of the silica on a mixture of sulphate of soda and charcoal may be represented by the following formulæ:—

$$SiO^3 + SO^3, NaO + C = SiO^3, NaO + CO + SO^2.$$

$$SiO^3 + SO^3, NaO + C^3 = SiO^3, NaO + 3\,CO + S.$$

"But it is possible to explain the phenomenon of vitrification in another manner, and admit that one part of the soda of the glass is due to the reaction of the sulphate of soda on the sulphuret of sodium, in the presence of silica. I have also added, in my lectures at the Ecole Polytechnique, for several years past, the following formulæ to those which represent the formation of glass:—

$$SO^3, NaO + C^4 = 4\,CO + SNa.$$

$$SNa + SO^3, NaO + SiO^3 = SiO^3, 2\,NaO + SO^2 + S.$$

"I have assured myself of the reality of this last action by a method of synthesis, producing silicate of soda by the calcination of a mixture of sulphuret of sodium, sulphate of soda, and silica. I have even discovered, in collecting the volatile products, that, in this case, the sulphur and the sulphurous acid may be evolved in the proportions expressed by the formulæ. This action of a sulphuret on the sulphate of soda, in the presence of silica, is not peculiar to the alkaline sulphurets, it extends to other sulphurets, and especially to the alkalino-terreous sulphurets. I have, in fact, been able to make glass very easily by melting in a crucible a mixture of sulphate of soda, silica, and soda residuum, when the following reaction took place:—

$$Ca\,S + SO^3, Na\,O + Si\,O^3 = Si\,O^3, Na\,O, Ca\,O + SO^2 + S.$$

"It is to be remarked that the silicate of soda, $Si\,O^3\,2\,Na\,O$, and the sulphate of sodium, Na S, being powerful fluxes, must considerably favour the vitrification. In the manufacture of glass, if a solid or gaseous reducing agent causes to pass into the state of sulphuret the excess there is of sulphate in the glass, the vitreous mass again begins to 'work,' as the men call it; I explain this phenomenon, by saying that the sulphuret reacts on the sulphate and produces gas which remains in the glass if then poured, and thus causes the defect.

"To arrive at a satisfactory refining, it is necessary, when the vitrification takes place, to avoid as much as possible the action of the reducing agents on the sulphate of soda retained by the glass, or still better to destroy this excess of the sulphate of soda without generating fresh gases in the vitreous mass. The excess of sulphate of soda is, then, useful during the melting of glass; it is only white and fusible under this condition; traces of sulphuret of sodium colour it yellow, consequently the presence of the sulphate of soda is a guarantee of the absence of the sulphuret of sodium, since these two bodies destroy one another; but the sulphate of soda should disappear at the end of the operation. The skill of the glass worker consists, then, in turning to account the excess of sulphate of soda in effecting the vitrification of the silica, and in destroying it at the moment of refining by avoiding its transformation into a sulphate, since the gases are then generated afresh and the refining will remain incomplete. It is well known that in the manufacture of glass the excess of sulphate of soda is destroyed by various means, but especially by the use of billets of wood. At the moment the sulphate of soda is thus subjected to the action of an organic substance, the fermentation of the sulphuret is shown by the yellow colour assumed by the glass, but which afterwards disappears by the action of oxygen; the disengagement of the sulphur is rendered manifest by the colour of the gases."

ADULT EDUCATION THROUGH PUBLIC MUSEUMS.

The results, giving important information for public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. Number of visitors for the month of January, 1876. When they are counted by sight the letter "S" is used, when by turnstile the letter "M":—

Institutions.	Amounts voted in 1875.	Number of Visitors in January.	How counted.	Remarks.
1. British Museum	£ 107,471	28,176	S	Return refused. Number given for January of year last published in estimates. (1)
2. National Gallery, Charing-cross	6,346	46,130	S	18 days closed. Total for the year 1875, 806,250. (2)
3. Kew Gardens and Museum	4,273	6,391	S	Open on Sundays and week days. (3)
4. South Kensington Museum	39,019	65,842	M	Total for year, 839,212. Open daily except Sundays. (4)
5. Bethnal-green Museum	7,325	41,250	M	Total for year, 522,098. Open daily except Sundays. (5)
6. National Portrait Gallery, South Kensington	1,956	..	M	Return refused. Open daily except Sundays. (6)
7. Geological Museum, Jermyn-street	9,070	5,324	M	(7)
8. Patent Office Museum, South Kensington	..	34,604	M	Total for the year 1875, 265,233. (8)
9. Edinburgh National Gallery	2,100	20,486	M	Open on Sundays. (9)
10. Edinburgh Museum of Antiquities	..	19,640	M	Open on Sundays. (10)
11. Edinburgh Museum of Science and Art	10,509	52,024	M	Total for 1876, 455,784. (11)
12. Edinburgh Botanic Gardens	1,750	3,741	M	(12)
13. Dublin Museum of Natural History	1,717	6,181	M	Open daily, and in the evening. (13)
14. Glasnevin Botanical Gardens and Museum	2,224	5,580	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland	2,389	9,508	M	(15)
16. Museum of Royal Irish Academy, Dublin	200	..	M	(16)
17. Zoological Gardens, Dublin	500	4,733	M	Open daily, including Sundays. (17)
18. Tower of London	1,500	28,402	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall	..	17,782	S	Open daily, including Sundays. (19)
20. Royal Naval Museum, Greenwich	1,190	2,366	S	(20)
21. East Indian Museum, South Kensington	5,883	2,430	M	Paid for by Indian Government. (21)
22. Hampton Court Palace	3,465	..	M	Open on Sundays, and on week days except Fridays. (22)

(1) Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays.
(2) Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays.
(4) Open morning and evening till 10, on Mondays, Tuesdays, and Saturdays. Students' days—Wednesday, Thursday, and Friday, 6d. entrance.
(21) Admission daily by payment of 1d., except Thursday and Friday, 6d.

IMPORTATION OF FRESH MEAT FROM AMERICA IN REFRIGERATED CHAMBERS.

Attention having very recently been called in these columns to the various methods projected and experimented on for bringing meat to this country by the aid of refrigeration, it is not necessary to recapitulate them. Though some have been partially successful when tried on a small scale, it is unhappily a fact that, till within the last few months, or it might be said weeks, no method has been practically adopted in the way of a commercial enterprise likely to appreciably augment our meat supply and affect our home market. The cost of producing and maintaining by ice itself, or by some chemical process, a sufficiently low temperature for the transportation of fresh meat to this country, has been the main obstacle in the way of a realisation of the much desired end; and it will, therefore, be interesting to put on record some account of a recent attempt to supply our Metropolitan Meat-market with fresh meat from America, by aid of the means alluded to.

It was in October last that the experiment was first made, and this having proved successful, it has been followed up with a succession of importations since Christmas, the total weight imported having reached as much as 400 tons, and it is stated that the consignment which arrived last week exceeded all previous ones. The meat hitherto received, consisting chiefly of beef, has been shipped in steamers at New York, landed at Liverpool, and forwarded to the Metropolitan Meat-market by train, where it has been openly sold, and in as good condition as that in which it left New York. Of course there is nothing new in meat being kept in a temporary state of preservation by means of refrigeration. At the International Exhibition at South Kensington in 1873, when a variety of refrigerators or ice-safes were exhibited in the Food Section, Mr. Kent, of High Holborn, exhibited a ventilated ice-safe constructed on this principle. A large number of the leading butchers in London and the provinces have had chambers constructed on this principle in their establishments, and found them to answer admirably; at the Alexandra Palace, the refreshment contractors keep tons of miscellaneous provisions in such a chamber during the hottest weather; several first-class ocean steamers, the *Walmer Castle* and *Windsor Castle* for instance, have been furnished with them, so that passengers and crew can depend on a supply of fresh meat for more than two months; while the principle has been adopted at the House of Commons, and the draught of air over tons of ice keeps the house at a comfortably low temperature during the dog-days. But this "draught" principle of refrigeration has not been yet applied in reference to the transport of fresh meat from foreign countries, unless, indeed, the patented system by which the recent importations of meat have been effected is more or less an adaption of it, thereby affording another instance of an American borrowing English ideas and getting the credit of originality.

The result of the experimental importations has been reported as satisfactory as far as the condition of the meat is concerned. The quarters of beef, being tightly stitched up in canvas and suspended in a chamber on board ship, are constantly surrounded by a temperature of about 37 degrees, this atmosphere being kept in constant motion by the action of a fan worked over the ice tanks by steam. Hence the meat is kept not only cool but dry, in fact so much dryer than ordinary meat that it is not in the least affected by its transit from Liverpool to London. But, according to the old adage, the best proof of the pudding is in the eating. The imported American beef has been entrusted to several salesmen in the Metropolitan Market by Mr. J. D. Link, also of the Metropolitan Market, and sole agent of the American consignors, and the salesmen have made no secret of the matter at all, but sold it for what it was, and at a price but a few pence per stone below that realised by good Scotch and English meat. Those who have tasted it in a critical spirit, and among them may be mentioned the Lord Mayor and other civic authorities, have declared it to be in no way inferior to sound Norfolk beef or even "prime Scot."

What will be the future of this experiment, the extent of its development, and its effect on our markets, are interesting questions. It is said that it has already caused a fall in Scotch meat of 1d. per lb., though the foreign meat imported is, comparatively speaking, inappreciable in quantity. But the consignors, it is stated, are ready to send over 500 tons per week, "if the market will bear it." If this were carried out, prices "all round" must be affected, but with them the price of the imported meat itself. And then what will happen? The question is asked, because the price of meat in New York does not differ substantially from the price here. Perhaps the success of the experiment will lead to its being tried in reference to meat obtained in some cheap locality, and shipped at other ports than New York, and thus the cost of present carriage, or of driving the cattle from Western districts to New York, would be saved. But, then, arises the question of a longer voyage, increased consumption of ice, and so increased cost in these particulars. Again, the recent experiments have been made mainly in the winter months. How will the system work in the summer months? There will be a greater consumption of ice, of course, and not so much to sell of that unconsumed on the voyage as has been sold in Liverpool during the winter months And further, the transport of the meat from Liverpool to London by railway will be a hazardous thing in the summer, unless refrigerating and ventilated waggons are used—and this would, of course, add to the expenses.

It is probable that the Food Committee of the Society will shortly make a trial of some of the American meat, and report upon the result.

OBITUARY.

George Locke.—This gentleman was a member of a family which, for four generations, has been identified with the art of wood-carving. Mr. Matthew Locke, a contemporary of Chippendale, was the designer and publisher of a book of designs in the style of that period. Mr. George Locke was many years the designer to Messrs. Charles Hindley and Sons, Oxford-street, but had been for some time in business on his own account, and was devoted to the development of artistic furniture and decoration. At the time when the Society offered prizes for Art workmanship, Mr. Locke was very energetic in the aid he rendered, and his frequent presence at the Conferences held in connection with the subject will be remembered. His death, which was caused by an overdose of morphia, took place last week.

NOTICES.

SUBSCRIPTIONS.

The Christmas subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

March 1.—"Aquarium Construction and Management," by W. Saville-Kent, Esq., F.L.S., F.Z.S.
March 8.—"Hall Marking of Jewellery," by Alfred Lutschaunig, Esq.
March 15.—"A New Bridge for Providing for the Traffic across the Thames below London Bridge," by Frederic Barnett, Esq.
March 22.—"Railway Couplings," by F. A. Brocklebank, Esq.
March 29.—"Model Dwellings for the Rich," by T. Roger Smith, Esq., and W. H. White, Esq.
April 5.—"The Cultivation in India of Caoutchouc-yielding Trees," by Clements R. Markham, C.B.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

March 14.—"The Diamond Fields of Griqualand, and their probable Influence on the Native Races of South Africa." By John B. Currey, Esq., late Secretary to the Government, at Griqualand West.
March 28.—"The Industries of South Africa." By T. B. Granville, Esq.
April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.
May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following papers will be read:—

March 3.—The Fall in the Price of Silver; its causes, its consequences, and their possible avoidance; with special reference to India," by Ernest Seyd, Esq. Lord Borthwick will preside.
March 24.—"The Land Revenues of India," by Major-General Marriott, C.S.I.
April 21.—"The Sanitary Progress of India," by Captain Douglas Galton, C.B,
May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

Chemical Section.

Friday evenings at 8 o'clock. The following papers will be read:—

February 25.—"Some Recent Metallurgical Processes." By J. Arthur Phillips, Esq. C. W. Siemens, Esq., D.C.L., F.R.S., will preside.
March 10.—"The Manufacture of Citric and Tartaric Acids." By Robert Warington, Esq., F.C.S.
March 17.—"The Preparation of Dextrine-Maltose (malt-sugar), and its Use for Brewing and other Purposes." By W. Valentin, Esq., F.C.S.
March 31.—"The Methods of Estimating the Illuminating Power and Purity of Coal Gas." By A. Vernon Harcourt, Esq., M.A., F.R.S.
April 28.—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.
May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne.

Cantor Lectures.

Monday evenings at 8 o'clock. Third Course, "On Wool Dyeing," by George Jarmain, Esq.

Lecture I.—March 6th.

Introductory remarks.—Waters most suitable for the treatment of wool.—Scouring and bleaching operations.

Lecture II.—March 20th.

Indigo and its modes of application to the dyeing of wool and woollen fabrics.

Lecture III.—March 27th.

General principles of the fixation of colour upon wool, —Wool mordants.

Lecture IV.—April 3rd.

Logwood and other woods, and their application to the dyeing of wool and woollen fabrics.

Lecture V.—April 24th.

Ditto (*continued*).

Lecture VI.—May 1st.

Aniline and other allied colours, and their application to the dyeing of wool and woollen and mixed fabrics.—Concluding remarks.

Tickets for the course are sent out with this *Journal*.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Mr. Ney Elias, "The Shueli Valley of Burma." 2. Mr. C. R. Markham, "Afghan Geography."
British Architects, 9, Conduit-street, W., 8 p.m. Mr. R. F. Chisholm, "The Palace of Tiroomal Naik, Madras."
Institute of Actuaries, Quadrangle, King's College, W.C., 7 p.m.
Medical, 11, Chandos-street, W., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m.

Tues. ...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "Classification of Vertebrated Animals." (Lecture VII.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. G. J. Symons, "The Floods in England and Wales during 1875, and Water Economy." 2. Mr. C. Greaves, "Evaporation and Percolation."

Wed. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Saville-Kent, "Aquarium Construction and Management."
Medical and Chirurgical, 53, Berners-street, W., 8 p.m. Annual Meeting.
Microscopical, King's College, W.C., 8 p.m.
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m.
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.
Entomological, 11, Chandos-street, W., 7 p.m.

Thurs ..Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. I. B. Balfour, "A New Genus of Tumeraceæ from Rodriquez." 2. Mr. M. P. Edgeworth, "Pollen." 3. Dr. John Anderson, "Note on the Development of the Plastron of *Emyda dura*." 4. Professor Dickie, "Notes on Algæ found at Kerguelen Land."
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. C. R. Markham, "Recent Geographical Explorations."
Chemical, Burlington House, W., 8 p.m. Discussion on Dr. Frankland's Paper on "Water Analysis."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Daniel Grant, "Characteristics in Art."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gladstone, "Chemistry of the Non-metallic Elements." (Lecture VII.)
Institute of Marine Engineers (at the House of the Society of Arts), 8 p.m.
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri.......SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section). Mr. Seyd, "The Fall in the Price of Silver; its Causes, its Consequences, and their possible Avoidance; with Special Reference to India."
Royal United Service Insitution, Whitehall-yard, 3 p.m., Major Frank S. Russell, "Cavalry Tactics."
Royal Institution, Albemarle-street, W. 8 p.m., Weekly Meeting. 9 p.m., Professor Odling, "The Paraffins and their Alcohols,"
Geologists' Association, University College, W C., 8 p.m.
Philological, University College, W.C., 8 p.m.
Archæological Institution, 16, New Burlington-street, W., 4 p.m.

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Thistleton Dyer, "The Vegetable Kingdom." (Lecture IV.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,215. Vol. XXIV.

FRIDAY, MARCH 3, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

SUBSCRIPTION FOR THE FAMILY OF THE LATE S. T. DAVENPORT.

The following subscriptions have been promised, making, with sums previously acknowledged, a total of £1,628 19s. 6d.

It is requested that members will accept this notice as an acknowledgment of their subscriptions:—

	£	s.	d.
C. R. Ford	1	1	0
J. Horton	3	3	0
J. F. Iselin	1	1	0
J. S. Lapraik	2	2	0
Capt. Bedford Pim, R.N., M.P.	2	2	0

NATIONAL TRAINING SCHOOL FOR MUSIC.

The following is the list of scholars and candidates recommended as qualified for scholarships at the recent examinations for the Society of Arts scholarships, and those founded by Mrs. Freake and Mr. Morrison:—

Alphabetical List of Candidates selected for Scholarships:—

Eugenie Bénard.
Gertrude Bradwen.
Charlotte Rose Davis.
Hélène Heale.
Norah Hughes.
Robert Jefford.
Lucy Riley.
Eugenie Sturmfels.
Elizabeth Turner.
Marion L. Wardroper.

List, in order of merit, of Candidates reported by the Examiners as qualified for Scholarships had they had more to award:—

1. Walter G. Alcock.
2. Monimia Twist.
3. Helen Akroyd.
4. Percy H. Mull.
5. Marion Westmacott.
6. Frederick S. Dove.
7. Florence M. Warman.
8. Emilie P. Brickwell.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1876, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (now Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., in "recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, Foreign Member of the Royal Society, Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food-economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to M. Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. Henry Bessemer, "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to M. Michel Eugène Chevreul, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Mons. Michel Chevalier, the distinguished French statesman, "who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

The Council invite members of the Society to forward to the Secretary, on or before the 16th of April, the names of such men of high distinction as they may think worthy of this honour.

INDIAN SECTION.

The adjourned discussion on Mr. Magniac's paper on the "Commercial Aspects of the Suez Canal, with especial reference to the trade with India,"* was resumed on Thursday evening, 24th

* Mr. Magniac wishes it to be understood that his paper is only to be considered as dealing with the Suez Canal in its effect on Indian trade, and not with the general effects of the Canal on the commerce of the world.

February, ANDREW CASSELS, Member of the Council of India, in the chair.

The Chairman, after expressing his regret that Mr. Grant-Duff was not able to be present, called upon Mr. Maitland to open the discussion.

Mr. Maitland, after speaking in highly appreciative terms of the paper read by Mr. Magniac, said there were still some parts of it in which he could not concur. It appeared to him that the argument was defective in this respect, that it hardly viewed this great subject from a sufficiently wide standpoint. The subject was, the Suez Canal in its commercial aspects, but it had been treated simply with regard to its influence on the commerce of Great Britain, and on the interests of English merchants and shipowners. Again, in the early part of his paper, he had stated that up to the present time the Suez Canal had been a disappointment, and on one of the audience intimating dissent from that statement, he mentioned three classes of persons whom alone, he thought, had reason to be satisfied with it. The response to that was, that the dissentient did not belong to either of those classes, but to the world, and that this was a question which concerned the world. In his (Mr. Maitland's) opinion that was the foundation of the whole question. Mr. Magniac had said most truly that history repeated itself, and if we could transport ourselves back to Venice or Genoa about the time that the commerce of the East, which passed through the Mediterranean and the Italian seaports, was being diverted round the Cape of Good Hope by the discovery of Vasco de Gama, we should have heard the merchants of those cities, the Antonios and Bassanios, urging much the same arguments as Mr. Magniac had brought forward. And if we could go still further back, and picture ourselves citizens of Palmyra, we should have regarded in the same view the changes which were then taking place. The commerce of the whole world ought to be considered, and especially that with which we were so intimately connected, that of our Indian fellow subjects. If there were any change of trade caused by the opening of the canal, we should consider not only how it affected British merchants and shipowners, but also how it affected the people of India and the growers of produce which came here. Mr. Magniac seemed to consider that the growth of commerce in some of the Italian cities, owing to the opening of the canal, was a thing to be regretted, and no doubt to an Englishman the beau ideal of commerce would be for the people in India to take from England all we could give them, and for us to take in return all they could give us; but when we saw so great a change in trade as was now taking place, one should consider also how that affected the people in India, and if they were benefited by the extension of trade with Italian ports, and could get from those places some things which we could not send them at all, and others more beneficially to themselves, that should be taken into account. Mr. Magniac's paper appeared to be divisible into three parts. First, he spoke of the ancient communication between the East and Europe through Africa, the second part had reference particularly to the state of commerce as it was affected by the opening of the canal, and the third and most practical dealt with the position of commerce since the opening of the canal with reference more particularly to the shipowners of Great Britain, and in connection with that he mentioned the change which had lately taken place in English trade. On the first point he referred to the ancient communication with the East by way of Africa, and said no one could look at the small tongue of land uniting Africa and Asia without being struck by the idea that a communication might be made between the Mediterranean and the Red Sea, and referred to the supposed communication in the time of Abraham, and of Alexander the Great. It was known that one of the earliest kings of Egypt, and one of the Ptolemies, contemplated something of the kind, and had surveys made, and Plutarch, in his life of Marcus Antonius, where he referred to Queen Cleopatra, had this passage, "Between the Red Sea and Egypt there is an isthmus which divides Asia from Africa, which in the narrowest part is about 300 furlongs in breadth. Cleopatra had formed a design of drawing her galleys over this part into the Red Sea, and purposed, with all her wealth and forces, to seek a remote country where she might never be reduced to slavery or involved in war. However, the first galleys being burnt by the Arabians, and Antonius not knowing then that his land forces were dispersed, she gave up this enterprise, and began to fortify the avenues to her kingdom." Mr. Magniac next came to the formation of the canal by M. de Lesseps, and to the opinion expressed by Mr. Stephenson, and Lord Palmerston, saying it was not to be wondered at that the English people did not cooperate in the construction of the canal. He (Mr. Maitland) thought it much to be regretted that England did not then join in the work; and the admiration which had been bestowed already on the energetic man to whose indomitable energy and forethought the world was indebted for this great work could not be too often repeated. There was no doubt that a great deal of political feeling was connected with it, the French supporting it under the anticipation that a great part of the commerce with the East would be transferred to Marseilles, that the Mediterranean would become a French lake, and that they would benefit accordingly. Nor was this to be much wondered at. Referring to the anecdote related by Lord Granville in the House of Lords, about the Frenchman who was willing to subscribe to the company under the idea that it was for a railroad in the island of Sweden, he hoped that worthy gentleman did take shares, and still held them, and would reap the benefit of them. Mr. Magniac said, again, that the shareholders' satisfaction with their prospects dated from the time of the English Government buying the shares; but he very much deprecated such a statement going forth without some examination. He thought it could scarcely be true, because it was well known that the value of the shares and the commerce passing through the canal had largely increased, so that in all probability had the purchase never taken place they would have proved a good investment. According to the figures given by the Chancellor of the Exchequer, the revenue in 1870 showed a deficit, but in 1874 that deficit had been turned into a surplus of £322,000, and it was known that in 1875 the amount of tonnage passing through had largely increased, although the precise figures were not known. That the shares should advance in value in consequence of the purchase was matter of course, but he thought in any case they would have proved a good investment. Mr. Magniac said most truly that the original estimate of eight millions had been enormously exceeded, and referred also, in a tone of great good feeling, to the fact that in the construction of the canal there had been considerable sacrifice of human life and a great deal of misery in consequence of the forced labour. Unhappily that was not confined to the Suez Canal, the same thing having occurred with the Mahmoudi Canal, and other large public works. Many people in England thought that when the canal was formed it was a serious blow to British shipping; but the result, so far, showed that 73 per cent. of the whole tonnage passing through the canal belonged to Great Britain. The second part of Mr. Magniac's statement contained a great array of figures, which must have occupied a great deal of time in preparation, and which he could not analyse without having them before him; but the general tone expressed was that the influence of the canal on commerce had been so far unsatisfactory, though he accompanied that statement with an expression of opinion that the loss would not be permanent. In that he agreed. But it must be remembered that between India, China, and this country trade had for some time past been in an

unsatisfactory condition, and there were other circumstances which, even before the formation of the canal, had conspired to this effect. The opening of the canal was not the commencement of the traffic viâ Suez, for even before that a large amount of traffic went by the way of the Red Sea, being transported from Suez to Alexandria. Mr. Magniac also referred to the fact that a large number of steamers were now unemployed, whilst new ones were being built. But the same thing occurred in other quarters; for instance, in the Royal Navy, where wooden vessels were being superseded by iron ones; and it was always the case that improved methods of construction had, to some extent, the effect of displacing capital. The question of insurance had already been mentioned, and of this he knew something, being a shareholder and director of a marine insurance company. It was quite true that the opening of the canal had not caused so great a reduction in premiums as was expected, but still it had some effect, and so far was an advantage. The tea trade was also referred to, and Mr. Magniac spoke of the enormous quantity which was sometimes thrown on the market too early, thus occasioning a loss, but the same sort of thing occurred before, though not to the same extent. Then he made a remark, as if it was to be regretted that cotton could be worked up in six weeks instead of six months, but though this might cause a loss to those concerned, it appeared to him that the object should be to work up the produce of the soil as early as possible, and if it could be brought to market and put to a serviceable use in six weeks instead of six months it must prove beneficial in the long run. He also knew something of the wheat trade which had been mentioned, and he believed England would enormously benefit by the wheat trade now springing up with India in consequence of the opening of the canal. Dr. Burn said he had grown wheat in India himself of good quality on the Bombay side, and he could say, as an old Calcutta merchant, that the wheat on that side also was of very good quality, and he had shipped it to London and elsewhere, but unfortunately the weevil intervened, and instead of making a profit, he believed not only he but all parties concerned made a loss. Only lately the Indian Government had taken off the small export duty on wheat, and a largely increasing quantity was coming over, especially from the ports to the north of Bombay. An almost indefinite quantity could be produced in Seinde, and if it could be got to England in good condition, which it never could by sending it round the Cape of Good Hope, it must be of immense advantage both to England and India. We might do without shellac, safflower, and some other substances, but we could not do without wheat, and with the development of railways and roads in India, which was now being carried on not only by the Government, but by some of the native princes, there would be hardly any bounds to the quantity of wheat which could be sent over from India. The production of seeds and other matters was also largely increasing, but wheat was the most important, and it alone was sufficient to justify the canal. The third part of the paper referred to the question of shipping, and it appeared that 73 per cent. was British. Mr. Magniac asked whether the tonnage dues were to be indefinitely extended so as to benefit the shareholders, and then came in the question which had lately so much occupied men's minds, namely, the position in which we stood, in consequence of having bought the Khedive's shares. He felt with Mr. Magniac, that if the shareholders were allowed indefinitely to extend their tariff, it would be a great hardship on shipowners generally, but he could not help thinking that we now occupied a much stronger position with reference to this question than we held before. In a recent newspaper there was an unofficial telegram stating that a convention respecting the Suez Canal had been signed by Colonel Stokes and M. de Lesseps, stipulating that the surtax should be abolished in 1882, being gradually reduced by half a franc every year; that the Council of Administration was to be increased to 24; that England was to nominate three; and that the company would expend an additional million francs in improving the canal. If this proved to be a correct statement, it would show that what had taken place had already begun to bear fruit. Mr. Magniac paid a just tribute to Col. Stokes when he said we were safe in his hands, and the telegram he had just referred to seemed thoroughly to bear out that statement. In common with the Chairman, he regretted the absence of Mr. Grant-Duff, especially as he would have been able to enforce some remarks in the latter part of the paper, on the advisability of young men intended for a commercial life bearing in mind the rivalry to which they were exposed, and the importance of preparing themselves accordingly. Mr. Grant-Duff had recently, at the City of London College, taken up the question, and urged on young men the importance of attending to their general mercantile education if they did not wish to be distanced in the race, especially by Germans. In conclusion, he desired to express his opinion that the opening of the canal would prove beneficial to the commerce and shipping, not only of England, but India, the Colonies, and the world at large.

Sir George Campbell, M.P., regretted he was not able to be present on the previous evening, but he was quite sure, from the abstract he had seen, that Mr. Magniac's paper was a most interesting one. He entirely agreed with Mr. Maitland that the canal was undoubtedly a great benefit to England. From the other side of India he had seen and appreciated that benefit, and he could appreciate it also from this side, but was not quite clear that we had yet been able to arrive at the measure of benefit we had received from the canal as compared with the Cape route. He believed the great difficulty in doing so had arisen from this fact, that the advantage was due not to one source but to two; the opening of the canal, and the improvement in marine engines, and in the class of steamers which used the canal. He had been informed that without that improvement in marine steamers the canal would not have been of so much advantage, whilst, without the canal, the steamers would not have been so useful. It might be said that having this double advantage, it was immaterial to consider exactly what was due to each item, but he had been impressed by the recent discussions with the view that it was very important to rightly estimate the advantage derived from the canal, so that we might know how far the route would bear a heavy tariff imposed upon it, and what would be our situation if, under any circumstances, the canal came to be closed, for in such a discussion that could not be put quite out of view. It might be closed either by physical causes, by pecuniary causes, or by political and military causes, and, therefore, it was important to know how much more in time and money it would cost to go round the Cape, not in sailing vessels, but in the improved full-power steamers, which now used coal. This question was suggested by an important statement made in the House of Commons by a gentleman well qualified to speak on the matter, Mr. Norwood, one of the most eminent representatives of the shipping interest. He stated that, comparing the canal route with that by the Cape, the difference in distance between London and Calcutta was about 3,200 miles, and the difference in time for a full-power steamer about twelve or thirteen days. That statement took him somewhat by surprise, for he had no idea that the difference was so small; but Mr. Norwood was very precise, and he did not think he was likely to be mistaken. Of course the difference would be greater in the case of Bombay, and gentlemen connected with that port did not much like to hear that Calcutta was superior to it, but still there was no dispute that with regard to the bulk of the traffic, the difference was enormous, and that Calcutta was far superior. Besides

which there was the whole of the trade with China, and the further east, as to which the difference of distance would be slightly less than it was even in the case of Calcutta. It could, therefore, be pretty accurately calculated what was the additional expense caused by that additional difference of distance, and length of voyage, and he should very much like that question to be worked out in the discussion, so that they might appreciate what would be the exact difference in cost of sending a full-power steamer by way of the Cape of Good Hope or by the canal to Calcutta, and that would be a test by which one might learn the exact advantage derived from the canal. That calculation being made, they would be in a better position to judge what was the gain to England from the use of the canal, and what would be the loss if under any circumstances it were unfortunately closed—whether the loss would be one of enormous magnitude, or whether it would be only a percentage, which it would be possible to bear without a total destruction of trade. Another point had been suggested to him, and it was a matter of considerable importance, namely, that at Calcutta there was a great advantage in respect of coal, that port being very near to deposits of native coal, whilst at Bombay there was no such advantage.

Mr. Fleming thought the figures given by Mr. Magniac, and the statement made by Mr. Norwood in the House of Commons, would enable one to answer the question put by Sir George Campbell. Mr. Magniac said that with a large steamer of 2,400 tons the expenses were about £82 per day, and Mr. Norwood said that a large steamer would take 12 or 13 days longer going to Calcutta by way of the Cape than through the canal. There would, therefore, be an expense of about £1,000 more, or £2,000 on the double voyage; on the other hand the canal dues would amount to £1,800, so that the extra expense of going by the Cape would be about £200. He could not, however, accept unhesitatingly the figures given by Mr. Norwood. He thought some misapprehension existed in some people's minds as to the canal dues being a tax on British shipowners, and he was sure Mr. Magniac was too sound an economist to suppose such a thing. The fact was the canal dues, in common with all other charges in the working of the ship, must ultimately fall on the consumer of the goods carried. No doubt in the present depressed condition of the carrying trade, due to competition, the shipowners were unabled to recoup themselves for all their outlay, but it was not right to single out the canal dues and say they were a special tax, any more than it would be to say that the charges for coal, wages, and other things were a tax on the merchant. The fact was that too large an expectation was formed of what would take place when the canal was opened, too many steamers were provided, and at the present moment they were suffering from an excessive number of vessels. He thought the canal authorities had been rather unduly blamed for their agitation respecting some modification of the canal dues. He did not approve of advancing the rates, but there was sufficient to cause dissatisfaction, and create in the minds of the shareholders a reasonable desire to have the matter re-adjusted. He had taken out the figures concerning certain ships of which his firm had had the management in 1875, namely, thirty-five steam vessels from Bombay, and twelve from Kurrachee. With regard to the steamers from Bombay, the net tonnage upon which dues were paid was 39,998 tons, the gross tonnage was 56,555, but the actual cargo carried, for which freight was received, was 77,436 tons. It was not so much the disparity between the net tonnage and cargo carried which caused dissatisfaction, as the great disparity between different vessels, for whilst one carried 14·9 per cent. more cargo than the net tonnage upon which she paid dues, another carried as much as 51½ per cent. extra. At Kurrachee there was a different description of cargo, principally seeds and wheat, and whilst one vessel carried 40 per cent. more than her gross tonnage, another carried only 29½ per cent. Such facts presenting themselves to the canal authorities must lead them to suppose there was something wrong in the system of measuring English vessels. It was quite right to restrain them from excessive charges or arbitrary changes, not only in the interests of the canal, but of honest shipowners, it was desirable that something should be done to have ships measured more equally. He understood that since the opening of the canal, the disparity between the net and gross tonnage had very much increased. He entirely agreed with Mr. Maitland in the view he took as to the changes which had taken place of late years, and although they might be detrimental to the interests of this country, on the whole they would be a gain to the world. The formation of trade began to take place before the opening of the canal. The trade in cotton from America, cotton from Rio, and rice from Burmah, direct to the Continent, had commenced some years ago, and it all went towards cheapening the cost of articles carried to the consumer. Dr. Burn had rather challenged the statement as to the trade in wheat having sprung up from the opening of the canal, but he must fully endorse that statement; having had experience in the Bombay trade for the last 27 years, he had known many attempts to send wheat in a good condition from Bombay to this country by way of the Cape, but they had always proved unsuccessful, owing to the ravages of the little insect which Dr. Burn seemed rather to despise. Since the opening of the canal, however, wheat had been sent here to a good paying market. One of the demerits of Indian wheat was, that it was generally of a mixed quality, and he thought the attention of the agricultural department of the Government might very usefully be directed to the selection of good seed, and the encouragement of such seed being cultivated, as this would lead to a great development of the trade in grain with this country.

Mr. Hyde Clarke had listened with great interest to the admirable observations of Mr. Maitland, in which he had subjected Mr. Magniac's statement to a rather severe scrutiny, but on the whole he thought no part of that statement had been shaken. It had also been somewhat criticised by Mr. Fleming, but as he (Mr. Clarke) had no title to speak on the commercial part of the subject, he would leave that, especially as Mr. Magniac would have an opportunity to reply. He considered that gentleman was fully justified in limiting the subject, as far as possible, to the direct relations between India and England, and not giving it a wider scope. Nor was Mr. Maitland more fortunate in dealing with Mr. Magniac's statement with regard to the part taken by Lord Palmerston in this matter. We must not only judge by the present state of affairs, but must also refer to the circumstances which influenced the judgment of Lord Palmerston. He (Mr. Clarke) was at that time a strong supporter of the canal, but he was bound to say with his knowledge at that time, and with his knowledge afterwards acquired on the spot, that the design of M. de Lesseps was distinctly of a political character, and it was Lord Palmerston's duty to oppose it in the manner he did. If, at the present time, that opposition might appear to have less grounds, it should be remembered that they were to a great degree indebted to Lord Palmerston himself, for the fact that the evils which would have attended the designs of M. de Lesseps had been to a great extent counteracted. One of the circumstances which greatly weighed with Lord Palmerston was the fact that M. de Lesseps would have had a prerogative, and would have undoubtedly exercised it under the anomalous state of what were called capitulations in the East, by raising the French flag on the Suez Canal, and have created competition as to jurisdiction, which would have exercised a very prejudical influence on English interests, and upon those of most other countries. The measures taken by Lord Palmerston in dealing with this anomalous jurisdiction had

rendered the Suez Canal less prejudical in its political circumstances. He had also maintained the integrity of the Ottoman Empire as a security with regard to Egypt. He could not, however, concur with Mr. Magniac in his remarks with regard to Robert Stephenson, because, high as his character was, he was certainly not justified in taking the position he did in opposition to those who were justly held to be great authorities on the subject. Robert Stephenson was distinctly a railway engineer, who had shown no success in hydraulic engineering, while the plans of M. de Lesseps had received the sanction of men of the highest standing as hydraulic engineers of the Water Staat in Holland and in Lombardy. In opposition to them, Mr. Robert Stephenson, in a spirit of partisanship, took a course which certainly had not been justified; and he perhaps misled Lord Palmerston to a certain extent, and certainly misled the public with regard to the practicability of the canal. It was in reality the relations between India and England as affected by the canal to which Mr. Magniac had so pointedly called attention, and that was in truth the subject of the discussion. In reference to the mission of Mr. Cave, which was connected with the Suez Canal, it was to be hoped that that mission would be carried out in a spirit which would have regard to Indian interests. If Sir George Campbell had been still present, he should have said in his presence, as he would now in his absence, that it was much to be wished that that mission had been carried out by a man competent to deal with it in reference to the Indian point of view. The whole matter was eminently an Indian question, and those who had read the paper contributed by Sir George Campbell to the last number of the *Fortnightly Review* would see how he dealt with it, and appreciate the advantage it would have been if some member of the Civil Service of India, acquainted with the financial system in operation in the East, had been sent to Egypt, instead of a gentleman only conversant with the mode in which business was conducted here. Those who knew the great difference between the treatment of Oriental subjects practically and the treatment of Western subjects, would know how desirable it was that this whole question of the Suez Canal and our relations in Egypt in connection with it should be dealt with in direct reference to our Indian interests. He had been much impressed with the way Mr. Magniac treated this subject, because there were points of connection between India and Europe, which were much affected by the construction of the canal. One was the question of the Soudan railway. It was of the greatest interest to India that that railway should be carried out, because the effect would be a saving of two days in our intercourse with India, and an important saving in the conveyance of troops. Another communication with India injuriously affected by any complication of ours with the Suez Canal was that by the Euphrates Valley, which would always be a matter of very great importance with regard to our intercourse with the East. As to what Mr. Maitland had said about the Mahmoudi Canal and the loss of life connected with its formation, that was no doubt the case, but it was so with regard to every great public work carried on in Egypt, in consequence of the ruthless way in which forced labour was employed; but it could scarcely be an exculpation for the employment of forced labour in the Suez Canal, that it had previously been employed on other works. One point on which he should like to have an explanation from anyone practically acquainted with it was this, and it might tend to explain one of Mr. Magniac's statements. He said that there were three miles of steamships unemployed, and that at the same time a great number of new ones were being constructed. If he had been rightly informed, the vessels constructed for the Suez Canal were built in a particular way, for the purpose of passing through the canal, and were exceedingly unpleasant for passengers. If that were the case, it must have brought about the condition of affairs which had been referred to, and the displacement of steam vessels which would otherwise have been employed. Therefore, while concurring generally in the views of Mr. Fleming, it certainly was deserving of consideration that although ultimately there might be a great benefit from the disturbance caused by the Suez Canal that would not prevent a very great present loss to the shipowner, because it was on the shipowner in the first instance that the political economist must place the burden, though the loss might fall on the merchant too, and there was every reason to believe that the prodncer in India was suffering also.

Mr. Baruchson said Mr. Magniac had endeavoured to prove that at least five great English interests were unfavourably influenced by the canal; these were the merchants, shipowners, capitalists, warehouse owners, and insurance companies; but he should endeavour to show that this was not the case. First, he said, the merchants' business was entirely altered, and the producer and the consumer came together so that the merchant was displaced. This had been going on for many years past. There was no Suez Canal on the American coast, and yet the merchants of Liverpool had found that their trade was entirely slipping away from them. The fact was that since the extension of manufacturing industry on the Continent and the increase of wealth, particularly since the exhibition of 1851, and the discovery of gold in California and Australia, manufacturers on the Continent were not willing to buy any longer second-hand, but obtained their raw material direct. Forty or fifty years ago Egyptian cotton all came from Leghorn, but now there was a direct trade between Alexandria and Liverpool, to an extent never dreamt of, and the trade of Leghorn was now confined to a few minor products. Next with regard to the shipowners. They had heard that there were miles of steamers lying idle whilst new ones were being built, but the cause was simply that the profits on steam vessels had been so large for several years that an immense abundance of capital had flown into that branch of industry, and that reaction had now come as it would do in any other case. When people saw the immense fortunes made by steam companies, and also by private individuals, it was no wonder that superabundance of capital was attracted to such enterprises, and the result was that for a time steam was at a discount, but this would by-and-bye right itself; it was not attributable, in his opinion, to the Suez Canal. Mr. Magniac said that the expenses of a steamer were £82 per day, and she was obliged to be filled up, no matter at what freight, while sailing vessels could lie for three months loading. But he had forgotten to calculate that a steamer made the voyage in 75 days, whilst the sailing vessel took ten months, so that in reality the latter would be much more expensive to the shipowner than a steamer. It would not do in 1876 to advocate a ship lying six months loading. Look at the loss of interest and the extra insurance occasioned thereby. And after all it was not a fact that ships had suffered, because at the end of the paper it was stated that in 1869 only one million bales of cotton were shipped by sailing vessels, whilst in 1874 two million bales came in that way, and he knew as a fact that at the present moment sailing vessels were more valuable than they were before 1870. The fact was that everybody believed that sailing vessels were going to be superseded, but since then it was found that some cargoes were carried much better in sailing ships, for which purposes they would always be in demand. They could also go to small ports where large steamers could not. Sir George Campbell had said that Calcutta was a port of more importance than Bombay, and se it might be to London; but in Liverpool, with which he was better acquainted, the tonnage from Bombay was considerably larger than that from Calcutta, the imports being principally of cotton. The next point was the injury to the warehouses, because the cotton went direct to the consumer, but this

was not so, because if the sailing-ship arrived in port with a cargo of cotton, very often the broker or merchant would wait three weeks or a month, until he had sold the cargo, before unloading it. Whereas a steamer must be unloaded immediately, and hence the goods were warehoused; and the fact was that, for the last two years, warehouse rates in Liverpool had been much higher than before. Then something was said about capital and six months' bills. He believed the six months' bills had brought many speculators with very little means into the market, and a great many disasters had been the consequence. When palm oil was sold in Liverpool at six months' credit, and re-sold before the ship arrived, he had known a parcel of palm oil, the value of which was £7,000, being sold and re-sold each time with a six months' bill, until its value was unworthily represented by £42,000 worth of bills. He believed that short credit and quick disposal of merchandise was a great advantage, and it was always better for a merchant to advance money on goods in a warehouse than on a bill of lading. With regard to insurance, whilst some companies were paying from 10 to 25 per cent. dividends on their shares, and the shares were at 200 to 300 per cent. premium, it was evident that they could not be in a very bad state; and quite recently he knew of a company being started in Liverpool asking for £500,000 capital, and having two millions offered to them. He thought it was a great privilege to England to possess a share in the great highway of nations as it now did. When the Suez Canal was first projected, Lord Palmerston and Mr. Robert Stephenson did not see what would be its ultimate results, but he believed it would prove not only a benefit to England but to all nations.

Mr. Vesey Fitzgerald said—I was the first Englishman who published his expectation that the Suez Canal would be a success. I desire now to make an observation which I deem important, as affecting the sentiments entertained by many, especially in France. I think it desirable it should be generally considered that shareholders must be benefited by the British purchase. I understand that to be the opinion of M. de Lesseps, with whom I am on terms of intimate friendship. The prosperity shareholders may now look for will arise from the development of commerce, the advance of civilisation, and the maintenance of peace. These objects are all, as I believe, likely to be attained by the policy now adopted by our Government, and I therefore feel every confidence that the interests of the shareholders rest on a sure and satisfactory basis, and I congratulate them on the present aspect of affairs.

Mr. Ward was very glad to see the practical tone which Sir George Campbell's question gave to the discussion, because it was most important to get to practical points as much as possible. The question was, "What was the measure of advantage to England from the canal." But he should be inclined to ask, "What was the measure of disadvantage." A previous speaker had alluded to the advantage of the quick arrival of produce; but there was also a disadvantage sometimes, because you flooded the market, and, as Mr. Hyde Clarke justly remarked, the producers in India were now suffering. That was the case with the interest he represented, being connected with Indian tea. As a matter of fact, Indian tea growers had suffered rather than gained by the opening of the Suez Canal, because the tea had been sent to England before it was wanted, and it had deteriorated in value.

Dr. Burn explained, as to a statement he had made at the previous meeting, that by means of the canal shortening the route, wheat of superior quality could now be supplied from India. The long voyage round the Cape hitherto had rendered such a supply impossible, as the weevil ate up half the cargo on the voyage. The quantity now to be supplied through the canal would depend on the management of India. But he saw no reason why the whole foreign annual supply required by Great Britain, amounting to about fourteen millions sterling, should not be forthcoming in the course of a very few years from India.

Mr. Hale said the Suez Canal was the wonder of the age, and there could be no doubt as to its beneficial influence on the commerce of the world.

Captain Townshend, R.N., had listened with great interest to the paper of Mr. Magniac, particularly the part referring to Lord Palmerston and the circumstances attending the excavation of the canal. There was no doubt truth in what he said with regard to the hostile feelings entertained by the French, and the way in which they took shares to spite England was most absurd. It only reminded him of the story of the Irishmen, in the time of the rebellion, who formed a company to get hold of English bank-notes, and destroy them for the purpose of spiteing the Government of the day. A great deal of the opposition to the canal arose from the present trade being to a certain extent interfered with. But, on the other hand, there were those who considered that though that trade might suffer, there would be another to take its place, and that the nation at large would benefit. He recollected, when cabs first came into use in London and superseded hackney coaches, a gentleman relating that he overheard one hackney coachman say to another "Them cabs beats we!" That was rather ungrammatical, but it was very forcible, and only represented what took place in many other matters. When stage coaches were superseded by railways, it was feared that the breed of horses would be destroyed, but this had not proved to be the case; and the same with the Suez Canal, although there might be a little temporary loss, he was quite satisfied that the nation at large would benefit by the change in the long run. With regard to the comparative benefit derived from going through the canal instead of going round the Cape, the difference had been put forward as a matter of so many days and so many miles, but although it might not appear very considerable in one voyage, that should be multiplied by the number of voyages made during the year in order to arrive at a correct estimate. Beside that, there was the wear and tear of the vessel, which was a very serious matter in going round the Cape of Good Hope, one of the most stormy places in the world, whilst going to India by the Mediterranean and Red Sea was a fair-weather yachting voyage all the way. Then another matter which occurred to him was this, it surely was of considerable importance to feel that at any moment, if anything went wrong on the east side of Africa or the Indian seas, a vessel could be sent at once from the Mediterranean, if wanted. The Indian squadron might be in China or somewhere else, and it would be a great advantage if, on an emergency, a ship of war could be sent through the Suez Canal, instead of having to be detached from the China squadron, or sent round the Cape. Again, if in case of an outbreak in China, or in Burmah or India, it was necessary to send out a force of troops, it would be a great saving in every way, that whatever was done should be done rapidly. Even in a commercial point of view this was of great importance, as most ships of war in the East were principally occupied in the protection of commerce.

Mr. Magniac said he had no reason to be other than satisfied with the tone of the remarks which had been so kindly made with regard to his paper. He had been rather taken to task for a variety of things which he did not say, and which some people thought he ought to have said, particularly with regard to the benefits which would in general arise from the Suez Canal. But he had omitted them simply because the brief he received from the Society was to address them on the commercial effect of the Suez Canal in regard to the trade of India, and,

therefore, he had carefully excluded any reference to trade in general, or to the effects of the recent purchase. If he had gone into the effect on the world in general, he feared that instead of occupying them an hour and a half, he would not have finished yet, and therefore, in omitting those subjects, he had done so purposely and for a very good reason. Mr. Maitland said he ought not to have made any reference to the dissatisfaction of the shareholders previous to the purchase of shares by the Government, but his authority for that statement was the shareholders themselves, and no one who had had an opportunity of seeing the literature which they caused to be published could doubt that they had been crying out for the last eighteen months that they were ruined and their property spoiled, and even the words "international spoliation" and "robbery" were pretty freely indulged in. The same gentleman also said that the property was not depreciated, and referred to the surplus of 1874. But no reference had been made to the source whence it came, namely, the illegal charge levied on shipping. The Canal Company was authorised to charge ten francs per registered ton, but they levied it on the gross tonnage, by doing which they raised the receipts between 30 and 40 per cent. He had in his hand the approximate figures showing the position of the company in 1875, which it might be interesting to state, as they had not been published. The receipts of 1875 had increased over those of 1874 owing to the surtax of three francs per ton, which was allowed to be made, or, rather, recommended to be made, by the International Commission, and was not due to the charge authorised by the actual concession of the company. This increase was £174,000, and the result was the gross receipts, including the balance carried over from the previous year, were £1,330,000, and the expenses being £740,000, it left an available balance for distribution of £590,000. That balance would be probably applied in the following way:—£400,000 to the dividend of five per cent. on the shares; £67,000 interest on the obligations which were issued in satisfaction of the back interest which was not paid; and the balance of £123,000 carried forward to the next year, or applied in repairs and improvements of the canal, as the shareholders thought fit. Of that £590,000, £268,000 was derived from the increased charge of three francs per ton, which the Governments of the different nations allowed the company to charge in consideration of the circumstances which they laid before them—that the authorised charge would not be sufficient to defray expenses and pay a dividend. Mr. Maitland had read from a Cairo paper a statement showing an agreement come to by which this surtax was allowed to be continued until 1882. Until they saw the reasons why Colonel Stokes agreed to that it was difficult, and probably not right, to express any judgment upon it; but he could not but think there must be some mistake in the matter. It could not be a settled question, because when the twelve nations met in commission at Constantinople, there was a distinct agreement between them all and the Ottoman Porte that no change should be made in the dues to be levied without the consent of all, and there could not possibly have been time to communicate with all the nations of Europe. He apprehended, therefore, that this must be an informal arrangement between M. de Lesseps and Colonel Stokes, and a thing which perhaps other nations would be disposed to agree to. It should not be said that these things were settled by those two gentlemen, or it would at once arouse those jealousies in other nations which it was said would not be aroused by our purchasing the shares. With regard to the question put by Sir George Campbell, the real reason why steamers cannot in practice reach India *viâ* the Cape and can by the canal, is this—When you send a steamer to India by the canal there were half a dozen coaling places where she could coal at a small expense and with the greatest ease; but if she were sent round the Cape the coaling places were very inconsiderable in number, and the expense was enormous. Therefore, she had either to coal at an enormous expense or inconvenience, or carry her own coal; and every ton of coal carried meant one ton of freight left behind. The object, therefore, was to reduce the carrying of coal to a minimum, and if a steamer could coal at Gibraltar, Malta, Port Saïd, Aden, and Ceylon, it was evident that she could fill herself up much closer with cargo than if she had to go to the Cape of Good Hope; and that was the true reason why the Suez Canal did give such an impetus to the use of steamers in the Indian trade. His statements about the steamers being laid up had been referred to, and some gentlemen seemed not to understand it, but the explanation was very easy, those steamers which were laid up had such voracious appetites that it was utterly impossible to satisfy them commercially. They consumed coal to such an extent that the freights now obtained were insufficient to pay expenses. A saving of a few cwt. of coal a-day was quite sufficient to induce the building of a new steamer. He did not say that the canal injured various interests, but that various interests were suffering because the canal had altered the trade of the world, and that an old system and a new were being conducted side-by-side. It would be as true to say that Tenterden steeple was the cause of Goodwin Sands as that the Suez Canal had injured the trade of the world. The effects they had been considering were caused by a variety of circumstances, which arose out of the canal. One gentleman, from the mode in which he spoke of the trade at Leghorn, seemed to doubt the extent of the commerce between Italian ports and India, but the fact was indisputable that the trade was increasing, and he hoped as many English merchants would engage in it as there was room for. He had not said that insurance companies were not doing well, but that premiums had not fallen. As to the policy of the purchase, he expressed no opinion upon it as not coming within the scope of his duty. The measurement of ships was one of the most intricate and ill-understood subjects to be found in commerce, and he did not think Mr. Fleming understood him, from the remarks he made. The discrepancy between gross tonnage, net tonnage, and the carrying tonnage of a ship was much too long a subject to enter upon; but, as a matter of fact, Mr. Fleming must have misunderstood it when he said that the present system did not actually measure the tonnage of a ship. It was an absolute impossibility that the present system, recommended by the Constantinople Commission, could do otherwise than measure it accurately, it being based on a scientific rule of mathematics, worked out by Newton, by which the entire capacity of a ship was measured to a nicety, and upon that basis the whole of the measurements of tonnage was calculated. That there were differences between tons of weight and tons of capacity in every part of the world was well known, and these differences so confused the subject that few people understood it. Still, it was a fact that the representatives of all nations at Constantinople passed a unanimous resolution that the only system which accurately represented the contents of a ship was the Moorsom system, established by the British Government in 1854, and they recommended it to be adopted by the commerce of the world, as the unit of measurement of international purposes. That fact might be looked upon with some satisfaction, as showing that our calculation of tonnage stood on an equitable and scientific basis. In conclusion, he begged to thank the audience for the kind manner in which they had received his remarks.

The Chairman said he had heard it said that "If you left a letter long enough unanswered it answered itself," and he had that evening experienced the truth of this statement, for during the early part of the discussion many things were stated which he hoped to have had an opportunity of answering; but later speakers

had saved him the trouble. He remembered, when in Egypt many years ago, being told there was a tradition that in a certain part of the desert on a still night you could hear the lapping of both the Mediterranean and the Red Seas. Those waters had now met, and the result had been a complete revolution in the ways of the world. No doubt the first effect had been to throw the machinery of trade completely out of gear, coupled as it was with telegraphic wires, so that they were absolutely in a state of transition. He thought that trade would now lose much of its speculative character, that it would become more of a retail nature; and although it was dangerous to prophesy, he was inclined to think the race of merchant princes was likely to die out. It was thought in England that when the canal was constructed it would be detrimental to the interests of England, though an advantage to the Mediterranean ports; but the energy and enterprise of England had shown that that was not the case, since three-fourths of the traffic passing through the canal was English. Marseilles was thought likely to be benefited in a special degree, but Genoa, a port in its neighbourhood, appeared to be receiving even a still greater advantage; and from what he heard from there he was inclined to think her ancient commercial glories were likely to revive. A very wealthy and patriotic citizen had just given twenty million francs for the improvement of that port, and her trade, principally with India, was increasing very rapidly. But whatever the effect might be upon Europe, there was no doubt India must profit very largely by this new route. Her markets were now brought close to Europe, so that the produce could be brought fresh in a way which never could be done before. This was bound to lead to increased intercourse, and he had no doubt that our trade with that country would very greatly increase. He could not refrain from expressing satisfaction at the purchase of the Khedive's shares. He knew Egypt as well as most men, having been for many years partner in a house in Alexandria, and he thought a wiser thing had never been done by any Ministry. Virtually it was giving notice to the world that Egypt was not to be allowed to become the furtive colony of another nation, and that England intended to keep open the highway to India. Egypt herself would also profit largely by this canal; her trade was increasing rapidly, and curiously enough, it was said that the canal had produced a great influence upon the climate, which was now said to be much cooler, thanks to the canal, and the lakes fed by it. But the fertility of Egypt was wonderful. Her soil, as Douglas Jerrold said of another place, was such, that "if you tickled it with a hoe, it laughed with a harvest." It was opening out in a most wonderful way, and the canal was playing a great part there also. In his opinion, the effect of this canal on the commerce, civilisation, and politics of the world, had not yet been realised, and he would almost venture to say, had not yet been well considered.

CHEMICAL SECTION.

A meeting of this Section was held on Friday, February 25th, C. W. Siemens, F.R.S., D.C.L., Member of Council, in the chair.

The paper read was—

SOME RECENT METALLURGICAL PROCESSES.

By J. A. Phillips.

Among the most important of the recently introduced metallurgical processes, may be classed those having for their object the extraction of copper and silver from pyrites containing small quantities of those metals, and as a considerable portion of my time has for some years been occupied in carrying out operations of this nature, it affords me much pleasure to accede to a request that I should read, before the Chemical Section of the Society of Arts, a short paper on hydro-metallurgy.

It was remarked by Liebig, more than a quarter of a century since, that the commercial prosperity of a country may be judged of with a great degree of accuracy from its annual consumption of sulphuric acid.

Up to the year 1838, nearly the whole of this article was produced from Sicilian sulphur, but in that year the King of Naples granted a monopoly of it to a mercantile house at Marseilles. The immediate consequences of this arrangement was a rise in the price of sulphur from £5 to £14 per ton, and manufacturers at once looked around them for some material from which sulphuric acid might be produced at a cheaper rate.

This material was found in iron pyrites, which, when pure, contains above 50 per cent. of sulphur, and exists in almost inexhaustible quantities in various parts of Europe.

At first the supply of this commodity was drawn from the mines of Cornwall, and from those of Wicklow in Ireland, more particularly from the latter; the pyrites being burnt in suitable kilns, and the sulphurous anhydride conducted into the usual leaden chambers. The residual cinder or burnt ore resulting from this operation contained on an average rather more than 1 per cent. of copper, together with a little silver, and was subjected to a process of smelting by which these metals were separated from silica and oxide of iron in the form of a matt or regulus. This was subsequently sold to the copper-smelters, who employed it as one of the components of their furnace mixtures.

In 1842, a patent was granted to Mr. William Longmaid, for "Improvements in Treating Ores and Minerals, and in obtaining various Products therefrom, certain parts of which Improvements are applicable to the Manufacture of Alkali."

This invention consisted in roasting ground iron pyrites with common salt in a reverberatory furnace, by which sulphate of sodium was produced, while any copper which might be present was transformed into soluble cupric chloride. The soluble salts were separated from the insoluble residue by lixiviation, the copper precipitated either by lime or iron, and sulphate of sodium crystallised out.

In the specification of a second patent granted in 1844, Mr. Longmaid observes, "I have discovered that there are circumstances under which, and situations where, ores containing copper, tin, and zinc with sulphur, may with advantage be treated with common salt for obtaining the metallic parts, without depending mainly on the profits derivable from the sulphate of soda."

A modification of this process was worked for several years at St. Helens, where the copper was first precipitated by iron, and the liquors subsequently evaporated for sulphate of sodium, but was finally abandoned about the year 1863.

In 1860, a specification was filed by Mr. William Henderson for "Improvements in Treating Certain Ores and Alloys, and obtaining Products therefrom." This process does not materially differ from

that of Mr. Longmaid, as far as the treatment of ores are concerned, excepting that, under certain circumstances, they were to be subjected to a preliminary roasting for sulphur, and Mr. Henderson further proposed to obtain a large proportion of his copper by first volatilising, and subsequently condensing the cupric chloride produced. The amount of copper thus driven off is of comparatively little importance, but the employment of a condenser results in the collection of a considerable quantity of weak hydrochloric acid, which is advantageously employed for the subsequent lixiviation of the roasted ores.

At the time Mr. Longmaid was carrying out his inventions at St. Helens, the supply of ores suitable for this method of treatment was almost entirely derived from the mines of Ireland and Cornwall; but about the year 1859, Spanish and Portuguese pyrites had begun to find their way into the English market.

The annual consumption of these ores in the United Kingdom now amounts, in round numbers, to 500,000 tons, which after being employed as a source of sulphur in the manufacture of sulphuric acid, leaves a residue, or "cinder," known as "burnt ore," which is treated for copper by the "wet process." The pyrites imported into this country from Spain and Portugal is remarkably uniform in composition, and seldom varies more than one per cent. in the amount of copper it contains. A specimen of cupreous pyrites from the mines of San Domingos, Portugal, was found by my friend, Mr. F. Claudet, to have the following composition:—

Water	·70
Sulphur	49·00
Arsenic	·47
Iron	43·55
Copper	3·20
Zinc	·35
Lead	·93
Lime	·10
Siliceous residue	·63
Oxygen, and traces of various metals	1·07
	100·00

This pyrites, after having been burnt, leaves a residue representing about 70 per cent. in weight of the raw ore, and from this the copper and silver are extracted by various hydro-metallurgical processes. The cinder or residue remaining after the burning of San Domingos pyrites in the manufacture of sulphuric acid, has, after exposure for some time to the atmosphere, the following average composition:—

Water	3·85	
Sulphur	3·76	
Arsenic	·25	
Iron	58·25	—83 per cent. F_2O_3
Copper	4·14	
Zinc	·37	
Cobalt	traces	
Silver	traces	
Lead	1·14	
Lime	·25	
Oxygen and loss	26·93	
Insoluble residue	1·06	
	100·00	

The metallurgical treatment of these residues for copper comprehends the four following operations:—Firstly, Grinding and sifting. Secondly, Calcination with common salt. Thirdly, Lixiviation. Fourthly, Precipitation of the copper by means of iron.

Grinding.—For this purpose the ordinary Cornish crusher is employed, and in order to insure uniformity in the mixture, rock salt is added to the cinder previously to its being taken to the mill. The amount of salt thus added varies between twelve and fifteen per cent. according to the richness of the burnt ore in copper. Before grinding it is necessary to exactly determine the respective amounts of copper and sulphur present, since on the relations existing between these substances the success of the operation to a great extent depends. Generally speaking, the proportion of sulphur should exceed that of copper by about half a per cent.; the estimation of the former is effected by barium chloride, while the amount of the latter is determined by a titrated solution of cyanide of potassium.

When the proportion of sulphur is less than above indicated, an addition of unburnt pyrites must be made; when, on the contrary, it is greater, the ore must be mixed with other burnt pyrites, from which sulphur has been more completely expelled. The mixture, after passing between the rolls of the crushing-mill, falls into a circular revolving sieve having five meshes to the linear inch, through the apertures in which what has been sufficiently reduced in size escapes, while the larger fragments fall from the lower end into an elevator, by which they are again carried to the crushing-rolls.

Calcination.—The furnaces in which the mixture of ore and salt is calcined vary considerably in their construction. At the works belonging to the Tharsis Sulphur and Copper Company muffle furnaces are exclusively employed; at the Bede Metal Works, at Jarrow-on-Tyne, revolving automatic furnaces are, to some extent, used; in the majority of cases, however, long open furnaces fired by gas, are preferred.

The ordinary open gas-furnace in use in a great number of the Lancashire extraction works is 30 ft. in length and 11 ft. in width, outside measure, and gas from producers of the usual construction is conveyed to it by a suitable flue below the level of the floor. This is admitted into five parallel longitudinal flues beneath the hearth, and separated from one another by walls of brickwork; the supply in each being carefully regulated by means of dampers. A sufficient amount of air to consume about one-half of this gas is admitted into each flue through apertures provided with dampers, while the unconsumed portion passes over into the cavity of the furnace, where it is consumed by the aid of a further supply of air, admitted through openings situated at the opposite extremity of each of the five flues. By these means a long flame is caused to travel for about one-half the length of the furnace in such a way that the bottom, which is constructed of 5-inch fire-tiles, is at one end most strongly heated from beneath, whilst at the other the greater portion of the heat is communicated from above. In this way a tolerably equable temperature is maintained throughout the whole length of the apparatus, and the products of combustion, together with the gases and vapours evolved from the charge, are conveyed to the main flue, and thence pass through a series of condensing towers to the chimney.

The mixture of ground ore and salt is conveyed to the several furnaces by means of a high-level railway, and is charged through wrought-iron hoppers of the usual form; as soon as it is introduced, the charge is evenly spread over the surface of the tile bottom, where it is kept at a dull red-heat, and is frequently stirred by paddles or rakes introduced through the working doors. At the expiration of five and a-half hours after charging, a sample is taken in order to determine whether or not the whole of the copper in the ore is in a soluble state. In order to ascertain this, a fair sample of the charge is obtained by removing a small portion, with a paddle, from every part of the bottom; this is well mixed, and about an ounce of it afterwards ground in an iron mortar, and then boiled with water, which is subsequently poured off. This operation is repeated three times successively, and the residue afterwards boiled with dilute hydrochloric acid, which, in its turn, is poured off, and excess of ammonia added to it; finally, the residue from hydrochloric acid is washed with hot water, boiled with nitric acid, and ammonia added in excess. If by these trials it is found that the attack by hydrochloric acid only acquires a slightly blue tint, and that the nitric acid solution remains almost or nearly colourless after the addition of excess of ammonia, the charge is ready to be drawn, since it indicates that, practically, the whole of the copper has been rendered soluble in hot water. When, on the contrary, the nitric acid solution contains copper, it indicates that calcination has not been continued for a sufficient length of time, and should the hydrochloric acid solution become blue on the addition of excess of ammonia, it is probable that the amount of sulphur in the charge has not been sufficient to effect the chemical transformations required. The fire-bridge, at the far end of the furnace, has pillars extending from it to the roof, which thus gives it stability, and prevents its being readily injured by blows from the tools of the workmen; the flame thus enters the body of the furnace through a series of five rectangular openings.

During the operation of calcination, sulphur is oxidised, and sodium sulphate and cupric chloride are formed. Unless, however, the charges are both properly compounded and carefully worked at a suitable temperature, a considerable amount of comparatively insoluble cupreous chloride is produced; this is attended with a serious loss of copper in the residue or "purple ore." The charge of each furnace varies from 3 tons to 3 tons 5 cwt., in accordance with the furnace employed and the nature of the ores treated; the time required for furnacing is six hours, including charging and drawing.

The hydrochloric acid evolved during the operation, together with a little chlorine and some ferric and cupric chlorides, pass into a large arched flue and thence to a series of condensers, packed with open brickwork, through which a constant shower of water is caused to descend; these waters, which are slightly acid, are collected and employed for the lixiviation of roasted ores.

Lixiviation.—The ground ore, after calcination, is raked from the furnace through doors in one of its sides, and while still hot, is charged into washing tanks from ten to twelve feet square and about four feet in depth. These are made of pitch-pine, bolted together, and tightly caulked, and are provided with false bottoms, composed of fire-bricks resting on others set on edge on the floor of the tank. On this is spread a layer of small cinders, 3 inches in thickness, forming a kind of coarse filter, on which about 14 tons of calcined ore are charged. A plug-hole, which is between the bottom of the tank and the false bottom, is now closed, and either hot water, weak liquor, or tower liquor, is run in until the surface of the ore has been covered to a depth of several inches. This is allowed to remain for about two hours, when the plug is removed, the liquor runs off into proper receivers, and the tank is again filled with hot water, or with a mixture of hot water and weak or tower liquor.

In this way every tank receives from nine to ten washings, and at the seventh washing a little hydrochloric acid is sometimes introduced; all the liquids which drain from the different tanks, after the addition of hydrochloric acid, are collected in separate receivers, and instead of being treated by scrap iron for the precipitation of their copper, are employed, under the name of "weak liquors," for washing other tanks in a less advanced stage of lixiviation.

The filling, washing, and emptying of a tank occupies about 48 hours, and the residual purple ore, which is extensively used for "fettling" puddling furnaces, and for smelting in the blast-furnace, has, when dry, the following composition:—

Ferric oxide	96·20	= iron 67·35 per cent.
Lead	·86	
Copper	·18	
Cobalt	trace	
Alumina	·45	
Lime	·46	
Soda	·10	
Phosphoric anhydride	none	
Arsenic	trace	
Sulphuric anhydride	·49	
Sulphur	·16	
Chlorine	·03	
Silica	1·22	
	100·15	

This purple ore, if intended for use in the blast furnace, is sometimes formed into bricks, which are baked in the usual way, and thus become as hard as the most compact fire-brick. Well-washed purple ore should never contain above ·20 per cent. of copper.

Precipitation.—In those establishments in which the silver is extracted by Claudet's process, the liquors from the three first washings, containing practically the whole of that metal which has entered into solution, are treated with a soluble iodide, and the resulting insoluble iodide of silver is allowed to settle. The copper liquors, drawn off from the silver iodide, are added to weaker solutions from subsequent washings, or, when the silver is not recovered, the whole of the copper solutions, with the exception of the very weak ones, are run directly into the precipitating tanks. These, which are generally 12 feet square, are partially filled with clean scrap-iron, and the precipitation of copper is accelerated by boiling the liquors by the aid of steam. In the course of from eight to twelve hours complete precipitation of the copper will have been effected,

and when stains of that metal are no longer deposited on a brightly polished knife, if dipped into the liquors, they are first allowed to settle, and subsequently drawn off.

In order to separate the precipitated copper from the undissolved iron, the mass is turned over with an iron fork, and the larger pieces of the latter metal picked out. The precipitated copper thus roughly separated is subsequently washed on perforated cast-iron plates, through holes in which the granular particles of copper pass into a tank beneath, while the larger fragments of unattacked iron are raked off and returned to the precipitating tanks.

The "precipitate" thus prepared contains from 70 to 80 per cent. of metallic copper, and is either smelted and refined at the establishment in which it is produced, or is sold to the copper-smelters, who fuse it with "fine-metal" and afterwards subject it to processes of roasting and refining.

The following are the respective amounts of burnt ore which have been treated in the United Kingdom during the last six years; it must, however, be borne in mind that these figures represent only 70 per cent. of the weight of raw ore consumed each year:—

1869	192,000 tons
1870	200,000 "
1871	225,750 "
1872	253,529 "
1873	323,910 "
1874	329,004 "
1875	365,368 "

The quantity of copper extracted in this country in 1875 by the wet process from cupreous pyrites was probably not less than 14,000 tons, or rather more than three times the aggregate amount produced by the mines of the United Kingdom.

Separation of Silver.—It has long been known to those engaged in the extraction of copper by the wet process, that the precipitate from Spanish and Portuguese pyrites not only contains a notable quantity of silver, but also a little gold. No successful attempt to separate these metals, and to turn them to profitable account had, however, been made previously to 1870, but in that year, Mr. F. Claudet discovered the process which is now generally adopted in establishments in which the recovery of the precious metals is effected.

The silver contained in the burnt pyrites, spoken of in the analyses (pp. 285, 286) as "traces," usually exists in such minute quantities that its exact estimation is exceedingly difficult, but the results of a very large number of assays would go to show that the amount of silver present in a ton of ordinary burnt ore varies from 15 to 18 dwts.; at the present time, however, there are ores in the market which contain a larger proportion of the precious metals than that above indicated; these have, as yet, not been worked to any considerable extent.

During the process of roasting the ground burnt ores with salt, a large proportion of the silver which they contain is converted into chloride, and this in the subsequent operation of washing, is dissolved in the brine resulting from solution of undecomposed chloride of sodium.

The vats or tanks in which the burnt ore is lixiviated receive some nine or ten successive washings, and of these the first three contain nearly ninety-five per cent of the dissolved silver. An analysis of a first washing from a copper vat, afforded the following results (specific gravity, 1·24):—

	Contents per gallon. Grains.
Sodium sulphate	10,092
Sodium chloride	4,474
Chlorine (combined with metals)	4,630
Copper	3,700
Zinc	480
Lead	40
Iron	32
Lime	52
Silver	3·06

Arsenic, antimony, bismuth, &c., not estimated.

Total chlorine, 7,347 grs. = 12,106 grs. sodium chloride.

Total sulphuric anhydride, 5,686 grs. = 2,274 grs. sulphur.

Proportion of silver to copper, 10,000: 8·2.

Washings 1 and 2 contain 82·50 per cent. of total silver.

Washings 1, 2, and 3, contain 94·30 per cent. of total silver.

The several operations employed for the recovery of silver are conducted as follows:—

The liquors from the first three washings are run into suitable wooden cisterns, each having a capacity of 2,700 gallons, where they are allowed to settle. The yield of silver per gallon of these liquors is now ascertained by taking a measured quantity, to which are added hydrochloric acid, for the purpose of keeping the copper in solution, potassium iodide, which converts the silver into an insoluble iodide, and lead acetate; thus determining a plentiful precipitation of lead salts, which take down with them almost the whole of the silver present. The precipitate obtained by these means is thrown upon a coarse ribbed filter, and, after being roughly dried, is fused with a mixture of sodium carbonate, borax, and lamp-black. The resulting argentiferous lead is subsequently passed to the cupel, and from the weight of silver obtained, the amount of that metal in a gallon of liquor is calculated.

After the liquors in the settling vats have been assayed, they are drawn off into others of slightly larger capacity, while, at the same time, the exact amount of potassium iodide, or of some other soluble iodide, necessary to precipitate the silver present, is run in from carefully graduated tanks, together with a quantity of water equivalent to about one-tenth the volume of the copper solution. During the filling of these tanks, their contents are kept constantly stirred, and when full they are allowed to settle during 48 hours.

At the expiration of this period the whole of the iodide of silver will have fallen to the bottom, and the supernatant liquors, after being assayed for silver, are run off to the copper-precipitating vessels. The precipitate which collects at the bottom of the vats, into which the standardised iodide has been introduced, is once a fortnight washed into a storage tank, prepared for its reception.

This precipitate chiefly consists of a mixture of plumbic sulphate, plumbic chloride, argentic iodide, and subsalts of copper, from which the latter are removed by hot water acidulated with hydrochloric acid. After being thus freed from

copper salts, the "silver precipitate" is decomposed by boiling with metallic zinc, which reduces the argentic iodide and plumbic chloride, &c.

The results of these operations are:—

Firstly, a precipitate rich in silver, containing a small proportion of gold.

Secondly, a solution of zinc iodide, which, after being titrated, is employed in subsequent operations for the precipitation of further quantities of silver.

An analysis of a fair sample of the dried argentiferous precipitate afforded the following percentage results:—

Silver	5·95
Gold	·06
Lead	62·28
Copper	·60
Zinc oxide	15·46
Ferric „	1·50
Lime	1·10
Sulphuric anhydride	7·68
Insoluble residue	1·75
Oxygen and loss	3·62
	100,000

This analysis shows that the whole of the iodide of silver had been completely decomposed with formation of zinc iodide, since not even a trace of iodine could be detected in the residue.

The presence of gold in the precipitate, produced by the addition of a soluble iodide to the copper liquors, may be explained by supposing that a portion of this metal, which is known to exist in small quantities in the pyrites, is by calcination with salt converted into chloride of gold; this in the presence of large quantities of sodium chloride is not reduced by the temperature at which the charges are worked, and, entering into solution at the same time as the silver, is precipitated with it by the iodine.

At the Widnes Metal Works, where the liquors resulting from the treatment of about 22,500 tons of burnt ore were worked by this process during the year 1875, the resulting auriferous silver was sold for £2,600, which is equal to 2s. 3¾d. per ton on the burnt ore treated. The expense of treatment, including loss of iodine, labour, coals, wear and tear of apparatus, &c., amounted to £500, thus leaving a profit of £2,100, or 1s. 10¼d. on each ton of cinder operated on.

A process, invented by Mr. T. Gibb, adopted by the Bede Metal Company, and continuously worked for a considerable time, consists in the precipitation of the greater part of the silver, simultaneously with a comparatively small proportion of the copper, from the copper liquors by sulphuretted hydrogen. On passing this precipitant into copper liquors containing silver, almost the whole of the latter may be thrown down without precipitating more than a small proportion of the copper present. In practice, sulphuretted hydrogen is produced by the action of dilute hydrochloric acid on "tank waste." This waste is placed in covered tanks 6 ft. square and 6 ft. deep, inside measure, on a bed of ashes, and on a false bottom of boards. The acid is conducted under this false bottom, and rises through the waste to an overflow pipe 2 ft. 6 ins. from the top, thus allowing a large space for frothing.

The sulphuretted hydrogen evolved, in mixture with carbonic anhydride, is drawn off by a blowing engine, and is blown with a large quantity of air, purposely drawn in for dilution, through the liquors. Before blowing a sample is taken from each tank, and tested for copper by cyanide of potassium. The blowing is allowed to go on for about twenty minutes, until a sample of the liquor gives 6 per cent. less copper than the first sample. All the liquor produced in lixiviating the ores is treated by this method, and boys testing without any analytical training are able, by the aid of a table, to estimate very nearly the precipitation of any given per-centage of copper. The precipitate is allowed to settle, and the liquors are drawn off to the copper-precipitating tanks. The argentiferous precipitate is drawn off into washing tanks, where as much of the copper solution is removed as is practicable, and the precipitate is finally collected in a filter of the Needham and Kite form, but with chambers of at least twenty times the usual capacity.

The washed argentiferous sulphide is not quite free from chlorides, and in the next operation, viz., calcination at a low temperature, chlorides of silver and copper are produced, together with oxide and sulphate of the same metal. This calcined precipitate is ground to a rough powder and lixiviated, first with water, which dissolves the sulphate of copper with only a trace of silver, and subsequently with a hot solution of common salt, which dissolves out chloride of silver. The latter solution always contains copper and some sulphate of lead. This solution is mixed with milk of lime, and the precipitate well washed to free it from chloride of calcium; after which it is digested in dilute sulphuric acid, to separate oxide of copper, and again washed. After drying, this residue has the following composition:—

Silver	8·77
Oxide of lead	28·66
„ copper	3·75
Peroxide of iron	2·61
Lime	13·67
Sulphuric acid	31·72
Chlorine	4·70
Water	4·20
Insoluble residue	1·40
	99·48

This method of separating silver from the precipitated sulphides is certainly complicated, but was adopted at the Bede Metal Works, after sundry modifications, as being considered the most economical. Whether or not this process is still in operation I am not aware, as inquiries addressed to Mr. Gibb on the subject have elicited no reply.

The proportion of silver recoverable from each ton of burnt ore, about one in sixty thousand, appears at first sight very small, but when we consider that no less than 365,000 tons of these residues are annually treated in the United Kingdom, its importance becomes apparent. If the whole of the silver and gold which could be extracted from the ore by Claudet's process were annually recovered, they would represent a money value of at least £42,000, or a net profit of say £33,500.

Hunt and Douglas Process.—For the extraction of copper from its ores by this process, the metal should be in the state of an oxide oxy-

chloride, or carbonate. These oxidised compounds of copper are, under favourable conditions, decomposed by ferrous chloride, with the production of chlorides of copper, soluble in certain saline solutions, and of insoluble ferric oxide mixed with a certain amount of the basic persalts of iron.

To this end the pulverised and naturally or artificially oxidised ores are digested with an aqueous solution of a neutral protosalt of iron, with or without the addition of an earthy or alkaline medium, such as common salt. Neutral ferrous chloride may be obtained by the action of hydrochloric acid on metallic iron, or by the double decomposition of ferrous sulphate with chloride of sodium or chloride of calcium. The solution, or bath, employed for dissolving out the oxidised copper may be prepared as follows:—1,200 lbs. of common salt, or 1,120 lbs. of dry calcium chloride, or its equivalent of the hydrated chloride, are dissolved together with 2,500 lbs. of ferrous sulphate in 1,000 gallons of water. In place of the above an amount of ferrous chloride containing 560 lbs. of metallic iron may be substituted.

To this bath of 1,000 gallons, prepared in either way, are added 2,000 lbs. of common salt, and the solution, which is now ready for use, is capable of chlorinating about 900 lbs. of copper. The power of brine to dissolve the copper chloride formed increases greatly with its strength, and with the temperature at which it is employed. In the treatment of ores by this process, they may be divided into two classes, non-sulphuretted and sulphuretted ores. The first class, or non-sulphuretted varieties, includes black oxide of copper, the carbonates, the oxychloride, and the red oxide. To prepare these for treatment they must be finely pulverised, and the carbonates may with advantage be gently calcined before or after grinding, in order to expel carbonic anhydride. The red oxide, if alone, should be gently calcined to convert it into cupric oxide. The pulverised ores thus prepared are to be digested in the above bath with frequent agitation. Heat is not necessary, but greatly accelerates the solution of the copper. When solution is complete, and the liquid drawn off, the insoluble residue is lixiviated with a small quantity of strong, hot brine. The liquid is then digested with metallic iron, by which copper is thrown down as cement copper, two parts by weight of iron yielding about three parts of metallic copper. The bath thus freed from copper, contains a large amount of regenerated ferrous chloride, and can be used at once to treat a fresh portion of oxidised ore. A small loss of chlorine, which separates in the form of oxichlorides, has, however, to be supplied, by adding to the bath, from time to time, a little ferrous chloride; this addition, however, need not exceed for each repetition one-eighth the original quantity of iron salt present.

In the case of sulphuretted ores, the first step has for its object the conversion of copper into an oxide soluble in the bath already described. This conversion is effected by a thorough calcination, with free access of air, by the aid of which the whole of the sulphur iron and copper become oxidised. For this purpose a muffle-furnace, heated to low redness, is usually employed, and the conversion is effected by thorough calcination in the air, by which means all the copper, iron, and sulphur are oxidised. To this end it is preferred to pulverise the sulphuretted ores, and to roast them in a muffle-furnace, with frequent stirring. A low red heat suffices, and what is called a "dead roast" is to be avoided, not only because it involves a waste of time and fuel, but because the high temperature required causes the oxide of copper to be difficultly soluble in the bath. The roasting need only be continued until the sulphide of copper has become converted into a mixture of oxide of copper with a variable proportion of sulphate of copper.

This process has not been employed in the United Kingdom, and, as far as I am aware, it is in operation in but one locality in America, namely, at Ore Knob, where it is stated to afford satisfactory results. Its greatest drawback appears to be the very fine state of division to which the ores require to be reduced; but, in countries where scrap-iron and salt are unusually expensive, it may perhaps be sometimes more advantageously employed than methods requiring the expenditure of larger quantities of those reagents.

The following table, prepared by Messrs. T. V. Bird and Co., of Liverpool, gives the different firms in the United Kingdom treating burnt cupreous pyrites by wet extraction, together with the quantities worked respectively by each during the years 1873, 1874, and 1875:—

Locality.	Name of Firms.	Consumption of Burnt Ore per Annum.		
		1873.	1874.	1875.
		Tons.	Tons.	Tons.
Widnes	N. Mathieson and Co.	6,700	11,421	11,613
Ditto	Widnes Metal Company, Limited	20,200	21,282	22,369
Ditto Newcastle Birmingham Glasgow	Tharsis Sulphur and Copper Company, Limited	126,000	145,517	169,098
St. Helen's	Duncan McKechnie	11,240	13,500	13,125
Runcorn	Wigg Bros. and Steele	15,500	15,386	17,236
Ditto	Runcorn Soap and Alkali Company, Limited	25,000	25,474	25,289
Manchester	Newton Heath Reduction Company	5,700	4,890	4,850
Bolton	Harrison, Blair, & Co., Kearsleay	1,200	1,100	1,155
Ditto	William Haslam	1,500	1,400	1,000
Mostyn	Mostyn Copper Comp., Limited	5,200	...	...
Flint	Muspratt Bros. and Huntley	10,500	9,800	10,628
South Shields	Solomon Mease and Co.	9,000	5,500	4,285
Newcastle	Wm. Russell and Sons	5,000	5,000	8,000
Ditto	Bede Metal and Chemical Company, Limited	52,670	49,000	46,000
Ditto	I. and W. Allen	5,000	2,400	2,000
Ditto	Jarrow Chemical Co.	4,000	...	...
Wednesbury	William Hunt and Sons, Lea Brook	3,000	2,000	1,500
Near Normanton	Wm. Hunt, Castleford	2,000	2,706	2,352
Doncaster	Morris and Co.	7,000	7,292	8,047
Devonport	Southdown Metal and Chemical Comp., Limited	7,500	4,836	4,092
Irvine	Wm. Henderson and Co.	...	...	9,735
Newcastle	H. D. Pochin and Co.	...	500	3,000
		323,910	329,004	365,368

DISCUSSION.

Mr. Riley said the process described was so neat, and seemed to be worked out so elaborately, that there

was very little room left for discussion. He perfectly agreed with what Mr. Phillips had stated with regard to the various processes as showing the application of exact science to ordinary commercial purposes, and being a great triumph of chemical knowledge. The only disadvantage, perhaps, was the expense of the iodide of potassium, iodine being a very expensive material, though much cheaper now than it was a short time ago. The price at the present time, he believed, was about 6d. per ounce, whereas a few years ago it was 3s. or 4s.

Mr. Phillips said they bought it by the cwt. At one time it was 30s. per lb., but it was now 8s. He then showed how the iodide of silver was decomposed by means of zinc, leaving iodide of zinc and reduced silver. The iodide of zinc in solution was still capable of precipitating a fresh quantity of silver, so that it might thus be used over and over again.

Mr. Riley said he had no doubt Mr. Claudet had tried bromine, but it was rather unfortunate that it would not answer the same purpose, because it was exceedingly cheap, and almost a drug in the market. The compression of exhausted pyrites in the simple way described, into bricks, was very interesting. He thought a great deal of the iron ore from Spain contained an appreciable quantity of gold and silver, but it was somewhat difficult to perceive how such small quantities could be separated.

Dr. C. Le Neve Foster asked whether Mr. Phillips hoped eventually to be able to apply the same process to the Cornish ores, which contained more silver than those spoken of, but were nothing like so uniform in composition, and contained other constituents, including arsenic and zinc. He had also heard of a process whereby the silver and copper were both precipitated at once by the aid of metallic iron, and he should like to hear Mr. Phillips' opinion upon it. It seemed a pity to throw down those two metals together when they might be separated in solution; but the process was in use, and certain advantages were claimed for it, though he was not aware what they were.

Mr. Bischoff asked if Mr. Phillips had made any estimate of the influence on the quality of the copper caused by the abstraction of the silver. They knew that very minute quantities of foreign matters—and silver certainly must be called an impurity in copper—had a very injurious influence on the quality of metals.

Mr. Kenelly asked what was the quantity of iodine practically lost in Mr. Claudet's process. He was also interested in the question with regard to the Cornish ores.

Mr. Phillips said the loss of iodine was about ten per cent.

Mr. Scott said Mr. Phillips had raised a very important question with regard to the formation of bricks made from the ore, and he should like some further information as to the cost of preparing them. He had made some attempts in that direction, but was not very successful. He knew they used the ore in a rotatory furnace, and produced very good iron; but it would be very important if it could be used in a blast furnace, as he had heard it had been in Lancashire. As the system did not appear to be extending, he much feared the manufacture of the bricks must be a rather expensive process.

Mr. Mattieu Williams said similar difficulties had been met with in the attempts to solidify other materials. Many years ago a multitude of experiments were made at Messrs. Mordan's, in the City-road, to solidify the waste Cumberland graphite which arose in the manufacture of lead pencils. Faraday made a number of attempts by chemical means, using clays, silicates, and other things; but at last Mr. Brockdon, an artist, effected the desired object by simply compressing it, aiding the pressure by heat, so as to expel as much of the air as possible. By this means he produced small blocks, as hard and as solid as the original plumbago, with the additional advantage that the hardness could be modified for HH, H, and HB pencils as required. Similar experiments had been made with coal dust, and it would be generally found that simple pressure, if sufficiently powerful, would effect the purpose.

Mr. Phillips said although iodine was expensive the process was a cheap one, because the loss was so small. The whole expense was about 5½d. per ton of ore treated, including labour, and he did not think they could hope for anything much cheaper. It had been asked why they did not precipitate with copper, but he thought that the questioner must have been dealing with sulphates if he had succeeded by that method. All he could say was that when you treated liquor containing cupric chlorides with metallic copper, the result was a dirty paste of cuprous chloride, which looked more like brick clay than anything else. It did reduce the silver, but the chlorine was divided between the copper, and you got a wretched mass which was utterly untreatable. He recollected that at first some tried to use copper pipes for blowing steam into the precipitators, but the result was they dissolved almost immediately, and seemed as if made of unbaked clay. It was possible perhaps under some circumstances to get cement copper to precipitate silver from chloride, but he had never been able to do so. You got it precipitated, no doubt, but there was so much chloride of copper with it that the silver was almost useless. With regard to Cornish ores, they contained about six to eight ounces of silver generally, and a large proportion of it could be got out, but the difficulty was, in the first place, there was so much arsenic in them and the gangue was siliceous, so that you lost all the value as iron ore, and consequently the only element of success was taken away, viz., the sale of the material for making iron. Lead was frequently present, and all these things made the treatment so complicated that he was afraid they had yet something to learn before treating Cornish ores successfully. With regard to precipitating silver and copper together, by iron, and running it out through shoots, the value of the silver was very much reduced in the presence of copper, so that only two-thirds of its price could be obtained. If you got a copper precipitate containing silver it was bought up by the sulphate of copper makers, who oxidised it in a furnace, attacked it with sulphuric acid, and there was always chlorine enough to leave the silver behind. But you were very much in their hands as to what price they would give for it. The advantage of Claudet's process was that you got the full price for the silver, the full price for the gold, and 3s. per unit for all the lead. About £12 per ton was charged for smelting, and they took off 3s. for every unit of zinc. The result was that you got paid for all the silver and all the gold, and the lead more than paid the fine upon zinc. In the other case you got nothing for the gold, and only two-thirds of the value of the silver. With regard to the quality of the copper, they got no more for the copper than they did before taking the silver out, and those who bought copper and refined it did not tell him it was at all better; still he found they could sell the precipitate at rather a better price, and if there were two lots in the market that freed from silver was generally preferred; besides which, they learned that the copper was improved, and that more than eight ounces of silver to a ton of copper very materially deteriorated its quality. In the other case there were 18 ounces, which would make a considerable difference. With regard to the cost of

making bricks, it was about 6s. 6d. a ton, including burning. It was not quite correct to say that the process was analogous to that of compressing black lead, because these bricks, when they come out of the press, were quite soft, and only became hard by baking at the same temperature as ordinary bricks. There was a great deal more magnetic oxide in the bricks than in the original ore. They had tried mixing lime with it, but the bricks did not stand. There was probably a litttle fusion in baking the bricks, but there was no protoxide of iron at any rate in the free state.

Mr. Hughes said no doubt Mr. Phillips had had great experience in the examination of sulphur ores, and and he should like to know whether as a rule he found that the samples fairly represented the bulk, because he believed that samples were sometimes sent for report to eminent chemists which were much better than the bulk. He understood that in point of silver the Spanish ores were superior, but was it the same with regard to copper.

Mr. Phillips said some ores were richer than others. As to the samples he never saw any from a respectable house which did not agree almost identically with the bulk. The produce from some of the smaller mines was not so regular, but those from the large mines, such as Mason's, or the Tharsis, were exceedingly regular, so that for the whole year they seemed exactly the same. Some of the smaller mines sent one cargo rich, and another poor, but with the large companies there was no difficulty at all. Even the common method of estimating copper by means of bleaching with cyanide of potassium must be very accurate when people were accustomed to it, as was shown by the following facts. They were in the habit in the course of the year of putting together the samples, taking the amount of copper worked out from the sample of each parcel, and calculating how much copper had come into the works. Then at the end of the year they saw how much precipitate had been sold, what they had left, and estimated what remained. The result was that they balanced as closely as possible.

Mr. Kock asked if there was any copper left in the bricks?

Mr. Phillips said yes, probably about ·20 per cent. of that metal still remained.

Mr. Kock said if that were charged in a blast furnace, the metal coming from the charge would get the whole of the copper concentrated in it, and when that was worked in the puddling furnace there would be a further concentration, and it would be found when it came to be worked, that though some of it might be worked beautifully, all of a sudden the bar would break in half.

Mr. Riley asked how the last speaker could account for crude steel containing ·6 per cent. of copper if it had so decidedly a deleterious effect. All iron contained some copper. Of course, no furnace would work with these bricks alone.

Mr. Phillips said, as far as his experience went, the bricks were liked very well.

Mr. Kenelly said the answer given to the question with regard to the precipitation of copper and silver together by means of scrap-iron was not such as to afford much hope to those who were using that process. He wished to ask Mr. Phillips, as he did not think Claudet's system was applicable to Cornish ores, if there was any other method of dealing with them.

Mr. Phillips said he would not say that Claudet's process was not applicable, but hitherto they had not succeeded so well with it as they had hoped. The great reason why the process for precipitating the two metals together was not so successful was this, that they expected to get the aggregate value of the two metals; but this was not so, because they could not obtain so much for the silver mixed with copper, as if it were pure or mixed with lead. The great difficulty in treating Cornish ores was to get a regular supply. You never got two parcels alike, and so you had to be constantly changing the process in order to treat them successfully. If you could get a large supply of something like a constant composition you might work it, but with small quantities of ever varying ores you had to be inventing a process for every fresh charge you put in.

Mr. Kenelly said in the case the ore which came from a large lode was pretty equable, he presumed there would be a hope that Mr. Claudet's process might be worked successfully.

Mr. Phillips said certainly, or even if you had a constant mixture of ores from different mines, but when you bought a small parcel here, and a small parcel there, by the time you had got anything like perfection in the process, the parcel was exhausted.

The Chairman said the process which Mr. Phillips had brought before them was one of many which distinguished the metallurgy of the present day. Ancient methods were always found to be very wasteful, both in fuel and materials, because it never occurred to the ancient metallurgist to separate the silver or gold from the copper, or to make use of the iron as a secondary process. He selected his ore for the one purpose he had in view, whether it was copper, silver, or iron, and used his fuel very wastefully in extracting it. This process was conducted at the expense of the iodide, which had only lately come into use mostly through photography, and at first sight he had been struck by the apparently great expense attaching to it. The discussion, however, had shown that this was really of very little importance, because although iodine was relatively expensive, the process was so perfect that it was used over and over again. This reminded him of another process lately come into use for the production of soda, where another expensive material, ammonia, was used over and over again to produce carbonate of soda directly from common salt, without the intermediate stages of soda ash, soda coke, and so forth. The question had been asked whether the extraction of silver deteriorated the value of the copper, and the answer was that it did not, but rather enhanced its value, and he could fully believe that. Lord Palmerston once defined dirt as "matter in the wrong place," and certainly silver in the copper must be reckoned as dirt, and those who dealt with copper as a metallic conductor of electricity regarded it as a dirt of a very objectionable character, for a very slight admixture of silver or any other foreign matter in the copper would reduce its conductivity to perhaps one-fourth of the proper amount. There could be no question, therefore, that it was advantageous to produce the metals separately and in their utmost purity. With regard to the use of the residue in the blast furnace, with all respect to Mr. Riley's opinion, he still thought copper was an objectionable element in wrought iron; for if any considerable amount of copper, say $\frac{1}{2}$ per cent., got into a puddled bar, it did not behave well under the hammer, and therefore the copper in that case must be classed with Lord Palmerston's dirt. He had had these residues examined repeatedly for sulphur and for copper, and found they yielded on an average 3 per cent., which was equal to 1 per cent. of the metallic iron contained in the ore. Therefore, although this material might be extremely useful in the blast furnace to assist in producing quantity, it ought to be used with great caution, in order not to increase unduly the proportion of copper or sulphur. With regard to the extraction of silver, he only hoped, for the benefit of this process, that the late discoveries in California, which it

was said would reduce the price of silver to an almost nominal amount, would not interfere with its financial development. He concluded by proposing a vote of thanks to Mr. Phillips, which was carried unanimously, and the proceedings terminated.

THIRTEENTH ORDINARY MEETING.

Wednesday, March 1st; Major-General Fred. C. Cotton, R.E., C.S.I., Member of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Carter, Theodore, 10, Hanover-street, Rye-lane, Peckham, S.E.
Harkervitz, Herman, Lorne-terrace, South Bank, Yorkshire.
Huxham, Hortensius, 3, Rutland-street, Swansea.
Holman, Stephen, 10, Laurence Pountney-lane, E.C.
Record, John, 8, Moorgate-street, E.C.
Robertson, David Trail, The Oaks, Cambridge-park, Twickenham.
Seath, Thomas Bollen, Sunny Oaks, Langbank, and Glasgow.

The following candidates were balloted for and duly elected members of the Society:—

Anderson, George, 25a, Great George-street, S.W.
Campion, Frank, The Mount, Duffield-road, Derby.
Clark, John, Imperial Gas Works, King's-cross, N.
Green, Thomas Bowden, M.A., F.R.S.L., F.R.Hist. Soc., 14, Argyll-street, Regent-street, W.
Syson, Edmund John, Hartford, near Huntingdon.

The paper read was—

AQUARIA, THEIR CONSTRUCTION, MANAGEMENT, AND UTILITY.

By W. Saville Kent, F.L.S., F.Z.S.,

Naturalist to the Yarmouth Aquarium; late of the British Museum, and of the Brighton and Manchester Aquaria.

The art of aquarium construction and management embraces as its subject all matters pertaining to the artificial cultivation and exhibition of aquatic forms of life, that is, such as inhabit the watery element, be it salt or fresh, which covers nearly three-fourths of the entire surface of the globe. The term aquarium itself is rightly used to express the mechanical means or apparatus, simple or complex, employed for the cultivation and exhibition of these aquatic forms; or, in its more recent and popular acceptation, it signifies a collection or exhibition of aquatic animals and plants in a state of artificial culture.

The earliest mention made of this word aquarium would appear to be in the year 1853, when it was introduced by Mr. P. H. Gosse, the author of some of the most eloquently-written works on animals suited for exhibition in aquaria that have yet appeared. It was also in the year 1853 that the first public aquarium was established in this country, or indeed anywhere; that first one being the "fish house" in the London Zoological Gardens, which still exists in almost precisely its original condition. Prior to this date many experiments, attended by greater or less success, were made in keeping aquatic animals and plants alive in small vessels, to which the term of water vivaria was then more generally applied; and with these experiments, which must be regarded as the origin of aquaria in their present advanced state of magnitude and perfection, the names of Dr. J. S. Bowerbank, Dr. Lankester, Mr. Robert Warrington, as also Mr. Gosse, are most intimately associated. With even such modest appliances as those first in use, very gratifying and valuable results have been and may be still obtained, though the space in these is necessarily so confined as only to permit of the introduction of living forms, exceedingly restricted both as to size and number.

At this date, when aquaria have assumed such comparatively gigantic proportions, and occupy so important a position from a commercial as well as scientific point of view, they have to be regarded as aquatic menageries, or aquatic zoological and botanic gardens; that aquarium, indeed, being the most perfect and efficient in which the greatest number and variety of life forms are successfully preserved, though with more especial reference to such species as are most impatient of artificial restraint and culture.

Among the multitude of animal forms essentially suited for exhibition in aquaria, the large and important class of fishes, numbering some 260 British, and upwards of thirteen thousand known species, occupies the most prominent position, but of this class less than one hundred varieties have as yet been exhibited in our public aquaria. To these we add the class of crustacea embracing crabs, lobsters, shrimps, and barnacles; aquatic mollusca, including whelks, oysters, mussels, with the cuttle fishes, squids, and well-known octopus at their head; the molluscoida, including lamp-shells, sea-mats, and the ascidians, or sea-squirts; the sea-worms, or annelids; the entire class of the echinodermata, or star-fishes, sea-urchins, and sea-cucumbers; the cœlenterata, including all sea anemones, corals, zoophytes, and jelly-fish; and, last and lowest of all, the sponges. To the foregoing list a few exceptional types may be added, including, where there is room for them, the smaller cetacea, such as dolphins and porpoises; turtles, water newts, and, indeed, all other forms whose existence is essentially associated with constant immersion in water. Seals and alligators, while legitimate and interesting accessories to an aquarium, do not, on account of their purely amphibious habits, require the special conditions provided in the tanks, and indeed could not permanently exist under them. This difference, expressed by the conditions of existence, marks the boundary line between what is and what is not fitted for exhibition in the tanks of an aquarium far more naturally, and consequently far more effectually, than the arbitrary one of the lung or gill-breathing properties of the animals occasionally advocated.

It is evident here, that those aquaria in which the animals are submitted to conditions corresponding most closely with those surrounding them in their natural state are in every respect the most perfect, and at this stage we may suitably inquire—What form of aquarium, so far devised, may be regarded as most nearly fulfilling these desirable conditions? In reply to this, it may be stated that, at the present day, the art of aquarium construction has

finally resolved itself into two systems, widely separate from each other at first sight, but actually supported on and springing from one common basis, as will appear further on.

Aquatic animals, like ourselves and all terrestrial forms, are dependent for life upon the supply of oxygen they assimilate from the surrounding fluid, be it water, as in the case of fishes, or atmospheric air, as in our own; lungs in terrestrial animals and gills in aquatic species being, with a few exceptions, the organs specially adapted for this assimilation. Thus, a number of people confined in a small room, and shut off from the access of fresh air, as illustrated by the notorious "black hole" of Calcutta, become speedily suffocated; so fish, if placed in large numbers in a single tank or vessel, soon exhaust the oxygen the water previously contained, and come panting to the surface, eventually dying also of suffocation if the life-giving oxygen is not in some way renewed. This latter fact has, doubtless, been observed by everyone who has kept gold-fish or other species in a glass globe, and this same principle is involved equally in aquaria of the largest type. In either case the object to be attained is the maintenance, by artificial means, of a supply of oxygen sufficient to compensate for that continually abstracted from the water by the animals, as also, by its cleansing influence, to get rid of all impurities that emanate from these animals, or are engendered by decay. With an aquarium as represented by an ordinary fish-globe, in which the number of animals and quantity of water are necessarily very limited, it is a common practice to throw away the old, exhausted water at more or less frequent intervals, replacing it by fresh, in which the oxygen is abundant. This method of proceeding, while not to be commended even on the small scale of a fish-globe, would involve a most serious expenditure, or rather waste of capital, to the extent of many thousand pounds sterling per annum, if applied to aquaria of the magnitude of those of the present day. If, in fact, no other means of replenishing the lost oxygen had been devised, such aquaria, as public exhibitions, would have been far too costly to maintain. Fortunately, however, this difficulty of replenishing the oxygen consumed, without discarding as waste material the water first in use, has at length been so successfully encountered that aquaria, as a means of popular recreation and instruction, are never likely to suffer from that reaction or decadence in public favour inseparable from the many difficulties and cost of maintenance associated with those of bygone days.

The two separate ways already briefly alluded to, by which their successful maintenance has been arrived at, may now be examined more fully. From the date when aquaria first began to attract notice, now about a quarter of a century ago, it was recognised by those who gave the subject intelligent attention, that it was only by maintaining a sufficient supply of oxygen in the water that aquatic animals could be kept in health, or any satisfactory results obtained. To some it occurred, and notably in the first instance to Dr. Ball, of Dublin, in the year 1853, that this oxygen might be supplied in its most direct and simple form, by passing through the tanks of an aquarium a stream of atmospheric air, which air being discharged through pipes into the bottom of the tanks, would ascend in bubbles to the surface, giving off to the surrounding water in their course a considerable portion of the oxygen it contained. An aquarium embodying this idea was successfully established in the Dublin Zoological Gardens, by Dr. Ball, who further displayed his ingenuity by devising bellows for blowing air into the tanks, which was worked by the feet of the visitors passing to and fro in the aquarium. As a first experiment the results of this arrangement were very gratifying, and though it has been emphatically stated by a writer on these matters* that "this system is of very trifling worth in a series of great tanks," it has been developed and applied with great success to the Berlin and other large Continental aquaria, further representing the system adopted and successfully maintained at the Brighton Aquarium since its opening in the year 1872, and where the tanks are of larger size than any previously or since constructed. This system of aquarium maintenance is most extensively known as the "aërating" one, this term being the most expressive of a system by which air, with the oxygen contained in it, is passed into the water in its concrete form, instead of the water being mechanically brought into contact with the air, as will be found to obtain in the one that remains to be described.

This second system took its origin at about the same date as that last mentioned, but differed from it so far that the reoxygenisation or freshening of the water in this instance was secured by the actual moving or circulation from place to place of the water itself, which was thus made to continually present fresh oxygen-absorbing surfaces to the atmosphere. This system, from the motion given to the water, is now best known as the "circulating" one. Like the "aërating" system first described, it was only by slow and tedious steps that the present point of progress was reached, and steam power employed, it being in the one case used to compress the air and force it into the bottom of the tanks, and in the other to pump and circulate the water. The first indication of a circulating system is associated with Mr. Gosse, who pointed out the advantage of suspending a reversed and perforated bell-glass over an ordinary window aquarium, this bell-glass being filled with water from the tank every morning, which was allowed to drip, or descend in slender streams, to the tank again, thus making a complete circuit.

The next practical application of the circulating principle assumed much larger and more important proportions, being embodied in the establishment of the "fish-house" in the London Zoological Gardens, already mentioned as the first public aquarium anywhere erected, which, indeed, must be accepted as the original type of the magnificent aquatic exhibitions which are now regarded as the *sine qua non* of every considerable town throughout the kingdom. This aquarium, opened to the public in the year 1853, was devised by the then secretary of the gardens, Mr. D. W. Mitchell, and the circulation of the water was effected by him with the aid of two supplementary cisterns and a hand-pump, the water being pumped at intervals

* "Crystal Palace Aquarium Hand-book," by W. A. Lloyd, sixth edition, p. 15.

from the lower cistern into the higher one, whence it flowed through the tanks, and returned to repeat the course. Although not attempting comparison with the colossal structures which represent its type at the present day, the Regent's-park aquarium is still maintained by the same mechanical means adopted at its opening, twenty-three years since, and though likely to be replaced before long by a series of tanks more in harmony with the high status of accommodation provided for the exhibition of terrestrial animals in the same gardens, it is still replete with much that will interest and instruct. When this new building is inaugurated at the Regent's-park, no doubt as great an advance upon aquaria in their existing stage will be accomplished as now subsists between those most recently erected and the one established in the year 1853. This advance should manifest itself more especially in reference to the appliances and provision adopted for the importation and preservation of aquatic forms from tropical and all exotic climes, in place of the limitation to species only inhabitating our native seas and rivers which, with a few exceptions, obtains in the aquaria of the present day.

The gratifying results of the Regent's-park aquarium led, in the year 1859, to the establishment of one on the same principles, but on a considerably larger scale, in the Paris Jardin d'Acclimatation, Mr. Mitchell's experience and personal supervision being employed upon its construction. Machinery was here first used to maintain a constant instead of intermittent circulation of the water, and the success of this undertaking was so great, from a financial as well as technical point of view, that other aquaria were immediately projected throughout France, Belgium, and Germany; it is a remarkable fact, however, that no further advance in the aquarium movement was made in England until the opening of the Crystal Palace one in the year 1871. In addition to being the then largest undertaking of its kind in this country, though since greatly eclipsed in size, the Crystal Palace Aquarium was prominent for the large space devoted to the stowage of reserve water, kept apart in the dark and uninhabited by the animals, and so corresponding with the spare cisterns, already mentioned in association with the aquarium at the Regent's-park. These spare cisterns, or reservoirs as they are now more generally termed, were constructed to contain no less than five times more water than did the show-tanks inhabited by the fish, the whole mass being circulated over and over again by powerful steam pumps. The entire series of tanks, both for exhibition purposes and for the storage of duplicate specimens in reserve, at the Crystal Palace Aquarium, contains 20,000 gallons of sea water; the longest single tank of these, about 18 feet in length, holding 6,000. Compared with these the reservoirs are constructed to contain no less than 100,000 gallons, making a total, with the tanks, of 120,000. Large as these proportions seemed in comparison with its predecessors in this country, they were and are of a very puny size contrasted with the magnificent aquarium at Brighton, completed in the succeeding year, that of 1872. In this fine building the tanks alone were constructed to hold over 300,000 gallons of water, while the largest single one, more than 100 feet in length, could accommodate the whole contents of both tanks and reservoirs at Sydenham, allowing space, indeed, for the evolutions of porpoises, full-grown sturgeons, and other monsters of the deep never previously displayed to the public under similar advantages. The Manchester and Southport aquaria, with tank accommodation little inferior to that of Brighton, were completed and opened in the year 1874, while others already in course of construction or contemplated at Yarmouth, Scarborough, Rothesay, Plymouth, Weymouth, Torquay, Southsea, Tynemouth, Margate, Rhyl, Westminster, and many other places, bring us abreast with the present position of the great movement still progressing in this country in favour of public aquaria.

As already remarked, the Brighton Aquarium is conspicuous as representing that system of maintenance characterised by the injection into the tanks of air in its simple form, and which system was distinguished as the aërating one. With the exception of the fine aquarium now building at Scarborough, which will be associated with the same system, being indeed planned by the same architect, all the other aquaria here enumerated are already, or will be, maintained on the circulating system first typified at the Regent's-park, and recently in its more perfected stage at the Crystal Palace. In certain important details, however, several of these aquaria depart widely from the Crystal Palace type. Foremost in this respect must be mentioned the vast bulk of water stored in reservoirs in comparison with that held by the tanks containing animals which obtains at that institution, and which is asserted by the superintendent, Mr. Lloyd, to be absolutely essential to maintain the fish in health and the water clear. Until experiments were instituted and contrary results arrived at, this dictum was implicitly accepted by the recent advocates of the circulating system, and in all aquaria undertaken with the assistance of Mr. Lloyd, reservoirs of these greatly preponderating proportions were insisted on as the *sine qua non* of success. The greatest length to which this fancy for reservoirs of such excessive size has been, and probably is likely to be, carried, is exemplified at Westminster—where, with water in the show tanks to the amount of under 150,000 gallons, or less than the contents of the two largest tanks in the Brighton Aquarium, accommodation has been made for storing no less than 600,000 in enormous reservoirs, which, to use the designer's own words, resemble "three railway tunnels placed side by side" occupying the whole space underneath the grand promenade. How many thousands of pounds have been spent, and must yet be spent, upon these reservoirs before they fulfil the purpose for which they were devised—that of holding water—it is impossible at present to estimate, though the filling of them with sea-water alone, at the same rate paid at Sydenham, *i.e.*, one penny per gallon, would amount to no less than £2,500.

To illustrate that this provision for reserve water, at both the Westminster and Crystal Palace aquaria, is altogether excessive and unreasonable, it may be stated that the Manchester Aquarium, adjacent to a densely-populated manufacturing centre, and with tank accommodation closely approximating that provided for at Westminster, has been, and is still, most successfully maintained

with reservoirs constructed to hold a supply of water only equal to that contained in the show-tanks. Practically, however, it has been kept in the highest state of efficiency, that is, with the water clear, and an abundant supply of fish of the largest size, with less than one-half of this full complement in the reservoirs. The superintendent of the Crystal Palace Aquarium has thought fit to question the truth of this assertion in print, but if more substantial proof is needed, it may be remarked that the promoters of both the Yarmouth and Westminster Aquaria, who visited the Manchester undertaking while under my charge, were so satisfied with the results there obtained, that in the latter case it was recognised that a most needless expenditure upon the reservoirs had been made; while in the case of Yarmouth, then uncommenced, and with the construction of which I am now associated, it was at once decided to alter the previous plans, embodying huge reservoirs of enormous cost, and to substitute in their place others corresponding only in capacity with the tanks above, as at Manchester. In fact, the show-tanks of the Yarmouth Aquarium being designed to hold an aggregate of 200,000 gallons of water, it would be necessary, in order to maintain the same ratio in the reservoirs as obtains at Westminster and the Crystal Palace, to construct reservoirs large enough to hold no less a quantity than 1,000,000 gallons. It is, in fact, this great primary expense of reservoir construction, usually insisted on as an altogether indispensable necessity, that has in many instances proved an insuperable bar to the carrying out of large public aquaria that have been proposed, and has certainly seriously hindered the more general establishment of these institutions throughout the country. As an argument in defence of reservoirs corresponding in proportional size with those of Sydenham and Westminster, it has been urged that the greater proportional amount of water in the reservoirs must necessarily carry with it greater clearness of water in the show-tanks. Surely, however, there is a limit to even the transparency of water, and when that is gained, such an argument becomes merely a *reductio ad absurdum*, involving a lamentable waste of time and money, when reservoirs and bulk of water in reserve are insisted on over and above what is proved to be all-sufficient for the purposes they are required to fulfil.

It has been already intimated that at Manchester the reservoirs correspond with the tanks in their cubical contents, and that the same proportions will be maintained at Yarmouth. It is not inferred by this, however, that the limit in the reduction of their size has been marked by the equalising of their respective bulks. Experience at Manchester has, on the contrary, illustrated that successful results may be obtained with a considerably less amount of water in the reservoirs; and, though it might be a bold experiment to attempt for the first time in some new aquarium, it is an open question whether, by a trifling increase of the pumping power, and acceleration of the circulating stream, reservoirs might not be done away with altogether, substituting in their place a mere well or cistern, for the reception of the water flowing over from the tanks and feeding of the pumps. This suggestion has been already made by me to the authorities at Westminster, as a temporary arrangement for the working of their aquarium, pending the removal of the chief obstacle which has delayed the stocking of the various tanks with fish—that obstacle being the unmanageable size of the reservoirs, involving a "three miles" circuit before the water returns to its starting point, and the difficulties associated with rendering such enormous reservoirs watertight. If here or anywhere else it could be shown that large aquaria can be efficiently maintained without the aid of reservoirs, the saving of one-half of their present cost as aquaria *per se*, will be accomplished.

It has been further represented by Mr. Lloyd that large dark reservoirs are indispensable to prevent the appearance of the multitude of vegetable spores, which occasionally multiply in aquaria to such an extent as to render the water turbid. This, however, may always be prevented by judiciously screening the tanks from undue access of the sun, and the Brighton Aquarium affords a practical illustration of water constantly exposed to the light, but where, through such judicious screening, these spores are not harmfully developed. It has also been asserted by the same writer that reservoirs of preponderating size are necessary to equalise the temperature of the water, which, he argues, would otherwise become too hot in summer and too cold in winter for the well-being of the animals; but the Brighton and Manchester Aquaria are again cases in point, to prove the fallacy of this argument, which, however, might be of some value if associated with an aquarium at Calcutta, or other tropical station. Under any other circumstances, the construction of these comparatively enormous reservoirs is an undoubted misapplication of capital.

The suggestion here made, in reference to the augmenting of the circulating current that would be found necessary, if reservoirs were dispensed with altogether, is also deserving of attention, upon entirely independent considerations; for, notwithstanding the very considerable advance that has been made during the last few years in the art of aquarium construction and management, there is much yet to be achieved before our aquaria can be looked upon as perfect. Thus, many species of fish have so far completely baffled all attempts at artificial preservation for any considerable length of time. The quaint lump-fish (*Cyclopterus lumpus*) may be mentioned as a familiar one among these. This species is tolerably plentiful on our shores during the spring months of the year, and when it arrives to spawn, but is especially abundant among the rocky fiords of the Norway coast. From that locality, in company with the magnificent red and blue wrasses (*Labrus mixtus*) it has been recently imported in considerable quantities to the Manchester Aquarium. On inquiring under what conditions these lump-fish were usually captured, the fishermen informed me that they invariably took them in the tideways amongst the rocks—adhering by their remarkable sucking-disc just where the current was most rapid. It is evident from this that a swiftly running stream offers those conditions which the lump-fish most delights in, if indeed such is not essential to its existence, and the one thing wanted to reconcile it to confinement in the tanks of our aquaria. If failure has thus been associated with the attempted culture of certain fish, this unpropitious word

applies still more extensively to our experiences with the vegetation of the sea. So far, no success worth naming has been achieved in the preservation in health of the marine plants or sea-weeds that so luxuriantly clothe our rockbound coasts; when introduced into an aquarium, these beautiful sea-weeds invariably, with a few exceptions, display a tendency to die and decay away. This they would scarcely do if there was not some very important link wanting in the conditions to which they have been hitherto submitted, and which must be intelligently recognised before greater success in the cultivation of these plants can be anticipated. To effect this we must, as in the last instance, go back to the fountain-head and see what nature herself has to teach us. Here we find that many species, including the coarser *Fuci*, absolutely require periodical exposure to the atmospheric air; while certain of the brilliant red varieties, or *Rhodosperms*, flourish best where the light is almost entirely excluded. Independent of these, however, there is a vast multitude to select from, abounding in the rock pools all along our coasts, and which, growing under the least complex conditions, especially recommend themselves to our attention. Nevertheless, with these last, as with all other seaweeds, one condition is everywhere invariably associated, and that one condition being their intermittent or constant exposure to the action of the waves, or the strongest currents of the ocean. Compared with these natural currents of the ocean, the most rapid circulation that has yet been introduced into an aquarium is altogether insignificant, and until the speed and volume of such circulation has been considerably increased, no material advance in the art of seaweed culture can be reasonably expected. To illustrate, indeed, that the treatment here indicated is likely to produce gratifying results, it may be recorded that, at the Manchester Aquarium, when experimenting on the growth of seaweeds, it was invariably found that those plants survived longest which were placed in a tank through which the most considerable and swiftest stream of water flowed, while of one familiar species, the Irish carageen (*Chondrus crispus*), which seems to exhibit an especial inclination to become domesticated, many specimens, although they have not increased materially in size, are as healthy now as when first introduced into the tank more than a year ago.

A circumstance frequently drawn attention to in relation to the growth of seaweeds in aquaria is the tendency of the finer silkweeds, or confervoid *algæ*, to spread themselves over the larger kinds, until, like the insidious *mycelium* of some parasitic fungus, they completely choke off and destroy the higher form. Such mishaps do not occur under the ordinary conditions of their growth, and, on inquiry into the matter, an explanation is readily afforded. These low *confervæ*, in fact, do not naturally grow in association with the more highly organised varieties we want to cultivate, but rather in those localities where the tide is sluggish, and more especially in pools, where they are undisturbed by the waves, except at only the highest tides. It would seem, indeed, that where a strong current prevails, such as the higher seaweeds luxuriate in, the *confervæ* are unable to obtain a foothold. This explanation still further recommends the adoption of a more rapid rate of circulation in our tanks. At the Yarmouth aquarium, as soon as it is opened this coming summer, this question of seaweed culture will be especially attended to.

The probable line of advance in the future improvement of aquarium construction and maintenance being indicated, a retrospect may now be taken of that which has been already accomplished; or, in other words, we may inquire what useful practical or scientific results have so far been achieved at the several public aquaria now established in this country? "In the Hand-book to the Crystal Palace Aquarium," (6th ed. p. 76) written by the superintendent, Mr. Lloyd, we read:—"It is very unlikely such direct benefit will ever result from any such aquaria yet made or projected."

If this applies to those undertakings with which Mr. Lloyd has been associated, it surely does not represent the position of those aquaria that lie without the pale of Mr. Lloyd's experience. Commencing with the Brighton institution, many observations of great value, from both a scientific and economic point of view, have been placed on record by its consulting naturalist, Mr. Henry Lee, F.L.S., since its establishment some four years back. It was at this aquarium that the floating properties of the ova of the *Gadidæ*, or cod and whiting tribe, first indicated by Professor Sars, were fully substantiated in this country, and this circumstance prevented the framing of laws to restrain trawling operations over the cod grounds during the spawning season, which were previously contemplated under the idea that these fish deposited their eggs at the bottom of the sea. It was through observations made at this aquarium that the singular crustacean form, *Phyllosoma*, was proved in this country to be the young of the sea cray-fish (*Palinurus quadricornis*). Still later, we are indebted to Mr. Henry Lee for the most valuable contribution to the life history of the octopus that has yet appeared, and in which, strange to say, many observations relative to the spawning of this animal, made by him, establish the correctness of the statements made by Aristotle in reference to the same creature, more than 2,000 years ago. From an economical point of view, however, Mr. Henry Lee's late communication to the Usk Fishery Board, concerning the rapidity of growth and general natural history of the salmon, founded upon experiments conducted in the Brighton tanks is perhaps of the highest importance, and sufficient of itself to rebut the charge of unprofitableness which has been brought against the Brighton institution, by one whose experiences would appear to have been confined to a less productive field of action. At the Southport Aquarium, experiments similar to those last described are now being made in reference to the life histories of the salmon trout and the bull trout, under the direction of Mr. C. L. Jackson, and these experiments are calculated to lead to results of considerable importance.

Referring to Mr. Lee's report upon the salmon, the *Field* newspaper has indicated the desirability of gaining a similar intimate knowledge of the life history of the "whitebait." The furthest step, I believe, in this direction, but towards which there are yet some few links wanting, have

been achieved by myself at the Manchester Aquarium, the only institution of the kind where this fish, as whitebait, has up to the present time been permanently established. As is already generally recognised, this whitebait is not, *sui generis*, a distinct species of fish, as formerly described, but, as proved by Dr. Albert Günther, of the British Museum, the young or fry of the herring (*Clupea harengus*), which, in this young or "whitebait" stage, visits the estuaries and shallow waters generally around our coasts. During the summer and autumn of the year 1874, several hundreds of these little fish were imported to Manchester by me from Mr. J. S. Parry Evans's salmon weirs at Colwyn Bay, North Wales, a distance of some seventy miles. A number of these are still in a flourishing condition, and have, during the eighteen mouths or more of their captivity, grown, in the most favourable instances, to fully half the size of a full-grown herring, with which species there is now no gainsaying their identity. In the open sea, where the supply of food is much more varied and abundant, and the fish is not submitted to the artificial conditions inseparable from an aquarium, it may be predicated that the growth is even more rapid, and that from two to three years is at the outside the total length of time required for the development of a newly-hatched whitebait into an adult herring. In the "Hand-book to the Crystal Palace Aquarium" it is stated that these fish (herrings) have not been kept at all at that institution, and that the failure cannot be accounted for by reference to any known cause, as also that it has not been shown yet that the species can be maintained for any but comparatively short periods in any aquarium yet devised. This last statement should certainly have been altered or excised in the present edition, herrings having been among the most interesting fish permanently on exhibition at the Brighton Aquarium for many years past, while at Manchester they have, in their younger stage, thriven equally. The causes operating against the maintenance of these fish at the Crystal Palace, again, are surely not so occult as to justify Mr. Lloyd in altogether despairing of adding them to his *menage*. Loudon is not situated so far from a prolific whitebait ground as is Manchester, and it would appear that Mr. Frank Buckland has already succeeded in bringing specimens up the Thames to the metropolis alive, although these died soon after, for the want of a tank suitable for their reception. The precautions requisite for preserving whitebait in health, certainly exceed those that need be taken in association with many of the more ordinary varieties, the food question at Manchester proving in the first instance especially vexatious. Herrings, whether old or young, are partial to living food, feeding chiefly, in the latter instance, on entromostraca and the larval conditions of the higher crustacea. Such pabulum being difficult to obtain so far inland, a variety of substitutes were offered by way of experiment, but for a long time none successfully. Ultimately an irresistible *bonne-bouche* suggested itself, in the form of the hard part or adductor muscle of the common mussel. This substance minced fine, being clean, hard, and white, with probably a somewhat crustacean flavour, was devoured with avidity by the little fish, and has constituted the chief staple of their existence ever since. In the course of a few weeks these whitebait became so accustomed to confinement as to readily take their prepared food from the keeper's hand—a circumstance which would seem to indicate that young fish, like the young of other animals, are more readily susceptible of domestication, adult herrings not being known to display an equal amount of confidence towards those who tend them. The food question being settled, another difficulty presented itself, and this time one that threatened, sooner or later, to accomplish the extermination of the whole shoal. Immediately succeeding their advent, a large number of these little fish were found dead each morning at the bottom of their tank, a circumstance which at first seemed inexplicable in association with their quiet behaviour throughout the day. A night inspection, however, happily revealed the cause of their rapid destruction. It was then seen that the nocturnal movements of the herring, at least in confinement, are altogether distinct from what obtain in daylight. In the latter instance these movements are very quiet and uniform, the fish swimming round their tank in one shoal and one continuous stream. At night, on the contrary, the shoal is entirely broken up, each fish taking an independent path and darting from one side of the tank to the other with an amount of agility scarcely to be anticipated by a mere daylight acquaintance with the species. It was during these active nocturnal movements that the fish struck against the rockwork of their tank and came to an untimely end; this mortality, however, was soon arrested by placing a dim light over their tank, which illuminated the outline of the rockwork just sufficiently to enable them to recognise and avoid it. With this dim light, the fish still retained their active habits, and it was noticeable that during these night hours they were more than ordinarily alert for food, dashing vigorously at any entomostracan or other minute organism that passed through the water. This circumstance would seem to explain why "drift-net" fishing for herrings can only be carried on successfully at night, that being the time when the fish rise to the surface of the water, to feed on the innumerable organisms that there abound. They are, in fact, so ardent at such times in pursuit of their food that they needlessly strike into the meshes of the net and get caught, just as the individuals under artificial conditions dash against the rockwork of their tank, if sufficient light is not provided them for its avoidance. This plan of dimly illuminating the whitebait tank was practised with equal benefit in association with other species that exhibited a tendency to injure themselves during the dark hours of the night, such species again being usually free rangers of the open sea. The picked dogfish (*Acanthias vulgaris*) was one of these, and a variety so given to rendering itself an unsightly object by knocking its head against the boundaries of its tank, till it lays the cartilage of its snout quite bare, that it is frequently refused admittance in aquaria. Observations made at the Manchester Aquarium, however, revealed that this self-mutilation was invariably effected during the night, and a small light enabling the fish to see and avoid the rocks was found an effectual preventive remedy.

A remaining subject that occupied my attention at the Manchester Aquarium related to the artificial

cultivation of the lobster. A remarkably large shoal of this crustacean was hatched out from a fine hen in the summer of 1874, and a number of these were isolated in small glass vessels, and reared successfully through their numerous singular metamorphoses, until, at the end of two months, the perfect form, though small, of the adult animal was attained. At this stage, unfortunately, a fishing excursion obliged the abandonment of their personal charge for a few weeks, and during that interim the little animals died. Such, however, was the measure of success up to this point, that I feel convinced that, with intelligent superintendence and adequate appliances, the artificial culture of the lobster might, if systematically pursued, become a very highly remunerative commercial enterprise. This subject will also be prosecuted, and it is to be hoped to a still more successful issue, at the aquarium now constructing at Great Yarmouth.

In conclusion, what has been stated here this evening will, I trust, suffice to show that aquaria have a high and useful mission to perform for the public good above their mere value as profitable financial investments, and more particularly from a scientific standpoint. In this latter connection, it is worth noting that it has been already considered worth while by our leading universities to subsidise an aquarium at a foreign station, that of Naples, in order to secure to British students the opportunities of marine biological investigation, hitherto beyond their reach nearer home. After this, however, or at some early date, it is to be hoped that among the many efficient aquaria, erected or contemplated on our own sea-board, sufficient opportunities and facilities will be provided as shall permit us to dispense with the necessity for such foreign aid. So far as the furthering of such opportunities and facilities shall be associated with my position at Great Yarmouth, I need scarcely add that this important subject shall receive my warmest attention and support.

DISCUSSION.

The Chairman invited Mr. Lloyd, of the Crystal Palace Aquarium, to open the discussion, but Mr. Lloyd said he would prefer to make his reply in print.

Mr. W. S. Mitchell said that what was wanted, was to produce in an aquarium as nearly as possible the natural conditions under which the animals live. We had not yet got much information as to the different kind of treatment different animals required. The same supply of water went to the vertebrata that went to the mollusca, and in fact that did the whole work of the aquarium. Were we to suppose that the arrangements we now have were as good as could be made to meet the requirements of the different forms of life? He thought not. Vertebrate fish lived at different depths, and had requirements which the mollusca had not. Then another important question was, what was the amount of carbonate of lime that ought to be secured in the tanks for the shell-bearing molluscs to produce their shells. At present it was not known by what means the molluscs form their shells, whether or not the carbonate of lime came from the food they took. Was it from the sea water which they drank, or, if not, how was the carbonate of lime obtained? As regarded mechanical skill, we had all the power that was necessary in that direction, and could supply a large or small amount of water, and little or much oxygen, but did we really know the amount of oxygen that ought to be kept up? An article had been recently written on the subject to *Nature*, saying that very probably the water was over oxygenated, and that the proportion of carbonate of lime and oxygen were very different from what it was in the sea, but he had not seen any reply. He thought we were very much in the dark upon that point. It was to be hoped that the study of the requirements of the molluscs, their method of growth, the way they formed their shell, and so on, would form a part of the investigation, because until it was known there was liability to err. As to the question of reserve tanks, he would not venture to offer an opinion. Mr. Lloyd had said he would give his views in print, and he was far better able to offer an opinion on the subject than most gentlemen.

Mr. Gardner had paid some attention to the growth of certain shells, and in the course of his observations he was led to infer that the growth of some of them was somewhat peculiar. For instance, the ornamentation of some of them must have been deposited by one edge of the mantle and removed by the opposite edge. Being curious to observe whether there were any analogous forms of growth elsewhere, he carefully searched the literature on the subject, but found the field quite barren. He then asked some scientific friends at home and abroad, but they could give him no information. Some of the mollusca were of intermittent growth; no shell had ever been found showing an imperfect lip.

Colonel Stuart-Wortley regretted Mr. Lloyd had not made some remarks on the able paper which had been read. He believed that he (Colonel Stuart-Wortley) was one of the oldest aquarium keepers in England, having had the advantage of beginning his practice at the Cape of Good Hope, and afterwards continuing in Calcutta; and he attributed the definite success which had attended his efforts to the knowledge and experience then gained. He considered that to Mr. Lloyd was owing the present advanced state of aquarium science in a very great measure. There was no doubt the first really successful aquarium that was ever kept was the one originated and superintended by Mr. Lloyd at Hamburg. He regretted exceedingly that our own Zoological Society had not the best aquarium; but it had not, though it would have eventually, he believed, and that before very long. But that Mr. Lloyd was the pioneer of aquarium science must, he thought, be honestly admitted. He knew nothing more beautiful than an aquarium, or more productive of interest and pleasure. It was marvellous the interest with which you watched the rapidity of growth of oysters, for instance. When, some years ago, he first began keeping an aquarium, he allowed them to spat in his aquarium, and he found the greatest difficulty in rearing them; and, in fact, he had hardly any success in growing the young oyster from the egg direct; but, singularly enough, if he had one sent up direct from the sea-side, one which had already been spatted, he could get him to grow in his aquarium to almost an edible size, that was to say, an oyster the size of a split-pea grew to the size of a florin in three years. He failed with lobsters, he did not know why, except that possibly they required more space. There was one point to which he would allude in connection with the growth of the shell. If an oyster was kept in an aquarium in a very dark corner, or under the rocks, the shell would never grow to the strength it would if the young oyster were left in the light. If young oysters were put under the rocks the shell would grow white and delicate, whereas, if left to grow in the full light it would become a strong powerful shell. With regard to the question of aëration, or perpetual change of water, aëration was more important to animals kept in confinement, than mere change of water. That is to say, if you had an animal which had come a long sea voyage, and had got sick on the passage, and then

you put him in a glass of water and constantly syringed him, he would recover, but if you constantly changed the water simply he would not recover. It was not necessary to have vast reservoirs. There was one other simple question with regard to a filter—he had a large number of considerable sized aquaria round a room. There was a large cistern on the top of the house, from which water flowed, and down below there was also a large cistern into which the overflow water from the tanks ran, but previous to being delivered there it had to pass down to the bottom of a filter of charcoal and gravel, which was of the same depth, and the water was delivered by gutta-percha tubes, right down to the bottom tube, and must force its way up through the charcoal, and consequently, however filthy and unsatisfactory the water might be, it was purified. The young of animals were more difficult to bring up than to keep the old ones in confinement, the conditions under which young animals grow being quite different. He had not been successful in getting the beautiful red weeds to grow, though he had had some measure of success in that field. With regard to the growth of *confervæ*, he thought that if light were excluded, and they were kept in a dark cistern, there would be hardly anything at all, but the moment too much light was let into the tanks, everything was overwhelmed by a confervoid growth. He had a great fancy for keeping very rare crabs, and one night, when there had been a violent thunderstorm—for it could have been due to nothing else—when he went down about half-past one to see them (and that was the best time to see these animals) he found that all his crabs were lying dead upon the sand.

Mr. Frank Buckland said he considered that aquariums would be the key to the solution of many problems of the greatest national importance, and this was borne out by the observations made by Colonel Stuart-Wortley respecting the growth of oysters. A friend of his had told him that he had lost £4,000 worth of oysters on the Sunday evening recently when the snow fell and the cold thereby killed the whole of them. The Bill now before Parliament would ruin all oyster fisheries in the country, and he had told those in authority so. What was wanted was a Bill to prevent oysters being used for food in the months of May, June, July, and August. You must allow the oysters to be dredged, because if the ground were not dredged they could not live. In the future there was a great fortune to be made by somebody who could devise the means of keeping the water at a certain temperature, and make the oysters to stick. Whether that was to be done with the light of the sun or gas, he did not know, but it would be done, he was sure, and he meant to try to do it. He was surprised at the ignorance which he found prevailing on these important questions, and especially so among the population he had recently visited in Norfolk and elsewhere, and who lived by the crab and oyster fishery. People who were earning £280 to £300 a-week in the crab and oyster fisheries exhibited the most deplorable ignorance on the most simple matters, and they were killing thousands of little crabs through ignorance. The aquarium would enable us to know how long it would take a crab to become a "legal" crab of four and a-half inches across his back, and a lobster seven inches, which was to be the size of the legal lobster. He looked to the aquarium as the means to solve many difficult questions, and enable them to arrive at satisfactory data on many important points, for it was only by such a careful study of the habits of these creatures as could be had in an aquarium that they would be able to deal with it as a great food question, from which point he viewed the matter. Take, for instance, the salmon fisheries, which a few years ago were not worth £30,000 a-year, but were now worth £120,000 a-year, and that was simply because we had been making the salmon tell us what he wanted, and so had been able to provide for his requirements. We should have to do the same for many other fishes, and, till we had done that, we would not be able to solve the great problems connected with the food supply of the people.

Mr. Henry Law observed, that one of the most essential duties of the underground water tank was that of preventing a large growth of *confervæ*. As regards the question of light, it had sometimes been so arranged that by preventing the light from shining on the tanks you could not see the fish but had a pretty representation of persons passing along instead. Another important point was the being able to obtain a more uniform temperature of the water in which the fish were to live. With the extreme variations of temperature in our climate, the under water tank gave the means of increasing or decreasing the temperature as might be necessary. With regard to the aëration by pumping air into the water, and allowing it to escape in bubbles, those bubbles have a great ascentional force, occupying about half-a-minute in passing through the tank, and they escaped with almost the same quantity of air which they originally delivered. It was not so at the Crystal Palace, where a very fine pencil of water was injected with considerable force into the water, carrying with it a very large amount of air in such a minutely divided state that it remained in the water. That mode of communicating the air was much more perfect than that of pumping. Another point of importance was, to make aquaria not simply places of amusement, but fields for scientific research, and also a means of acquiring information of the habits of fish which would be useful in an economic direction.

The Chairman observed that he had a great deal to do with the Westminster Aquarium, and was in a great measure responsible for what had been done there. He had listened with very great pleasure to the paper that had been read, and the remarks which had been made thereon, and he had obtained much information which would be of great assistance to him. They had made the Westminster Aquarium as perfect as possible, not only for the good of the shareholders, but for the good of the fish. He did not agree with the observation of Mr. Kent as to a further expenditure being necessary in regard to the tanks there, as from what he had seen that morning he thought they were so perfect that no more money would be required to be spent upon them. As to the utility of aquariums he thought there could be no doubt on that point. Some gentleman had alluded to the carbonate of lime, and the form in which it was obtainable by the fish, but that was a question of such refinement, and also of such immense importance, from the very fact that our world was almost built up from the lime and chalk formations, and what the animals had deposited at the bottom of the sea, that they could not go into it there. Colonel Stuart-Wortley's observations showed the immense importance of the study of the subject, to see what every animal was about, and what could be done to keep it. And great credit was due to Mr. Buckland, who had devoted his whole life to the economic part of the question. When it was remembered that more fish was brought into the London market than beef, the importance of the question could not be over-estimated. His efforts would always be to make the aquarium at Westminster of the most thorough practical utility, and he hoped it would be of real benefit to London and the world. For every fact brought to light in the habits of these animals would be immediately in their possession, and could be made a practical service to mankind.

A vote of thanks was then passed.

Mr. Kent, in reply, expressed his thanks for the very kind and gratifying way in which his paper had been received, and remarked that he should be happy to make a reply to any observations which Mr. Lloyd might feel it his duty to make.

MISCELLANEOUS.

PAPER FROM BAMBOO.

Mr. T. Routledge, who will be remembered as the introducer of esparto grass as a material for paper-making, has recently issued a pamphlet, printed on paper made from bamboo, in which he gives an account of some experiments recently carried out by him with a view of of testing the applicability of bamboo fibre for paper-making.

Mr. Routledge believes that, with his new system of treatment, bamboo will prove to be as superior to esparto in every respect, as esparto was found to be superior to straw. The following is a brief sketch of the way in which he proposes to deal with bamboo for the manufacture of fibrous paper-stock: "First and foremost, it is essential to operate on the stems of the plant when young, and preferably when fresh cut. Brought to a factory in this condition, the stems are passed through heavy crushing rolls, in order to split and flatten them, and at the same time crush the nodes. The stems are then passed through a second series of rolls, which are channelled, or grooved, in order further to split or partially divide them longitudinally into strips or ribbons; these being cut transversely into convenient lengths by a guillotine-knife or shears, are delivered by a carrier, or automatic feeder, direct to the boiling-pans." Both the boiling and washing processes ordinarily in vogue for producing half-stuff or semi-pulp, Mr. Routledge conducts in a battery, or series of vessels connected together by pipes or channels, furnished with valves or cocks, so that communication between the vessels may be maintained, disconnected, and regulated as desired, in such manner that the vessels being methodically charged in succession, the heated lyes (composed of caustic alkali) can be conducted from vessel to vessel. The lyes are thus used again and again (each successive change or charge of lye carrying forward the extractive matters it has dissolved from the fibre with which it has been in contact) until exhausted or neutralised (when they are discharged), fresh lyes being methodically and successively supplied, until by degrees the extractive matters combined with the fibre have been rendered sufficiently soluble, when hot water for washing or rinsing is, in the same continuous manner, run from vessel to vessel, until the extractive matters rendered soluble by previous alkaline baths have been carried forward and discharged, leaving the residuary fibre sufficiently cleansed. A final cooling-water is run on and through the fibre, which is then drained, and the contents of the vessel are placed in a press, in order to abstract as much of the remaining moisture as possible. The dry or semi-dry fibre is then submitted to the action of a "willow" or "devil," by means of which it is opened or "teased" out, and converted readily into a tow-like condition, when it is dried by a current of heated air, induced by a fan-blast, and finally baled up for storage or transport. In this condition of paper-stock it may be kept for an indefinite length of time without injury; and when received by the paper-manufacturer, it has only to be soaked down and bleached, in order to fit it for making paper, either by itself or as a blend with other materials.

A second material which, in Mr. Routledge's opinion, fulfils the main conditions demanded by a paper-manufacturer, is "megasse," or "begasse," the fibrous residue of the sugar-cane after it has been crushed to extract the juice. This, when "properly prepared, affords a strong, nervous fibre, or fibrous stock, which bleaches well, and possesses all the characteristics of a first-class paper-making material." For obvious reasons, megasse would also have to be "converted into a fibrous stock at or near the sugar factory where it is produced, then dried, and put up in hydraulic-pressed bales for economical transport." At present, megasse is only made use of as fuel in the sugar factories and in some countries as manure. "As its value, thus considered, is very low," Mr. Routledge thinks that "factories established in connection with existing sugar mills for the manufacture of paper-stock, where sufficient quantities of so bulky a material could be concentrated, and where other favourable conditions exist (of which an abundant supply of water is an essential), would yield a large profit to the planter or sugar manufacturer;" indeed, he has "made both paper-stock and paper of good quality from megasse, and determined the profitable nature of such a manufacture beyond dispute." Bamboo and megasse yield sixty and forty per cent. of fibre respectively.

THE INDUSTRIES OF THE PROVINCE OF PIACENZA.

The province of Piacenza is separated on the north by the river Po from the Lombard provinces of Pavia, Milan, and Cremona; it is bounded on the west by the provinces of Pavia and Genoa; and on the south and east by those of Parma and Genoa. Its superficial area is 2,508 square kilos, of which about 1,000 are mountain territory, one half of which is covered with woods in the proportion of five-sixths coppice to one-sixth full-grown trees; 508 consist of lower hills, which with another 1,000 square kilos of fertile plain, are all, more or less, devoted to agriculture. The river Po, which is navigable, bathes the whole north frontier of the province for a length of 95 kilos, flowing from west to east. The province is divided into two districts—Piacenza and Fiorenzuola d'Arda, and contained a population in 1861 of 218,569 souls, which had increased in 1871 to 225,775 souls. The chief town is the city of Piacenza, with a population in 1871 of 34,985 inhabitants; including 2,721 soldiers. Piacenza is situate on the right bank of the Po, from which it is distant about 400 metres; it is 66·27 metres above the sea level, and it is surrounded by a wall, the lineal measurement of which is 7,015 metres.

Consul Colnaghi states that agriculture, the chief industry of the province, employing the largest amount of labour, has for some years past made real progress. The principal productions are wheat, Indian corn, and wine. Beans and other kinds of pulse, rice, oats, rye, chesnuts, potatoes, flax, hemp, fruit, vegetables, &c., although not without importance, must be considered as secondary products. The mulberry tree is extensively grown, and supplies a silk crop which is yearly increasing. The Agricultural Board of Piacenza and Fiorenzuola d'Arda have promoted conferences, in which distinguished agriculturists have diffused improved notions of farming operations generally, of the cultivation of the mulberry, the breed of silkworms, and of the important manufacture of wine. Machinery and improved implements for agricultural purposes are entering into general use, especially threshing machines, American ploughs, harrows, hay-cutters, &c. The rotation of crops is generally alternated in a manner to permit one half of the land under cultivation to be sown with wheat, one-fourth with Indian corn, and one-fourth with beans, so ordered that the beans and Indian corn occupy the same ground once every four years, while the wheat which succeeds them is grown on the same land every two years, with such modifications as the cultivation of other products may require. The cultivation of meadows is extending with the increase of stock and the profits attending the manufacture of cheese. Game is not so plentiful as formerly, when there was abundance of all kinds. Regulations to prohibit, or limit, the right of shooting would render real service. Landed properties on the hills are generally from 15 to 20 hectares in extent, and are cultivated on the metayer system. Estates on the plain average

from 50 to 100 hectares, and are cultivated under the supervision of the owner, or let out to tenants for a money rent. The average value of land is from 2,500 to 3,000 lire per hectare, except for irrigated meadow, the value of which is much greater. The average wages of day labourers are from 2 to 4 lire during harvest, and from 1 to 1 lire 50 cents. at other seasons. The condition of the peasantry on the whole is tolerable. Pellagra, a skin disease, which ends in suicidal mania, however, prevails, very probably from the too great use of Indian corn.

A great improvement has already taken place in the manufacture of wine, and now, generally speaking, great care is taken both to make it well and see that it will keep, though much still remains to be done. The breeding of cattle is an important agricultural industry in this province; the breed now preferred in the plain is the Reggian, which has taken the place of the old Piacentine race. The Reggian cattle are well looking, strong, fit for labour, and easily fattened. In the mountain territory there is a beautiful special breed, smaller than the foregoing, and called from its native district, Pontremolese. The fattening of cattle is a branch of industry that has not been neglected, and the Piacentine fat beasts are of good repute. Sheep form an article of food in the province, and a small number are exported. Their wool, of good quality, is chiefly spun by the peasantry, or used for stuffing mattresses, &c.; a small part only is bought up for the woollen manufacture. As the Piacentine wool was once considered only slightly inferior to the Apulian, it might with proper attention become an important element of local wealth. The goats are pastured on the mountains, the kids are brought to the plains in the spring to be slaughtered; their skins, valued at 3 lire 50 cents each, are exported to other provinces or to France, where they are prepared for the manufacture of gloves. Swine are found in all parts; the breed is black, with long ears, of African origin, robust, and suitable for being fattened. The hogs, under fattening, usually attain in a few months the weight of from 20 to 26 myriagrams. The plain and hill districts are rich in poultry, in which a good trade is done with Genoa and Milan; a large quantity of eggs being also sent to those markets. The turkeys succeed better on the hills than on the plain. A bee-keeping society has been established as a branch of the Milan Society, and good results have already ensued.

The centre of the industry and commerce of the province may still be said to be the city of Piacenza, although the octroi duties levied at its gates are gradually placing it at a disadvantage with the country communes which are still unburdened. While the arts most necessary to the wants and comforts of life are exercised, more or less successfully, in the provinces, those which constitute real productive industry, and which, by the export of their produce, enrich the country, still leave much to be desired. Industrial enterprises are not, however, entirely neglected; they have received an impulse of late years, and capital is beginning to turn more steadily than it previously did in the direction of manufacturing industry. The artisans are, in general, intelligent and capable, and were they but more willing and tractable, would only need direction to become first-class workmen. The silk production has been greatly affected by the silkworm disease. To maintain the yield at all recourse has been had to foreign countries to procure healthy eggs, at no small cost to the cultivator, and now the yield of cocoons is produced almost entirely from eggs of the annual green Japanese breed, with a very small proportion of yellow Italian cocoons in parts where it has been possible to preserve the breed. The art of weaving cotton and flax is carried on by the peasantry in their cottages throughout the province. About 1830, the then Chamber of Commerce reported the number of hand looms at 8,000, worked for about four months in the year, and producing chiefly cotton cloths, fustians, &c. Now the number of looms has decreased, because the peasant weavers cannot compete with the power looms; instead, therefore, of the old hand looms, fly shuttle looms have been introduced in small numbers, and a factory on this system has been established at Piacenza. Altogether the weaving of cotton may be considered to be gradually improving. Among the mineral products of the province are copper, iron, petroleum, lignite, marble, hone stones, lime, chalk, mineral waters, &c., which, if not all in a condition to yield a profit, are the subject of experimental studies, that, for some of them at least, may bear fruit in due season. The banking establishments, founded since 1830, have given a great extension to all credit operations. The cities with which Piacenza has her principal business relations are those of Genoa, Florence, Milan, Turin, Bologna, and Parma.

CORRESPONDENCE.

PATENT-LAW REFORM.

SIR,—As one of the largest investors in Patent rights, and also as a member of the Society of Arts, I beg leave to submit through you to the Council the following simple suggestion of an overlooked and easy means for solving the knotty question of Patent-law reform, and that too by the apparently paradoxical course of opposing any change whatever, for the present, in the existing Act of 1852.

The recent announcement in the House of Commons, in reply to a question by Mr. Mundella, that the Lord Chancellor's universally condemned Bill of last Session is to be again introduced, with some modification, shows that a serious injury will be done by Government to inventors and the public unless prompt action is taken to open the way for practical reform of a step by step nature. The Lord Chancellor's Bill shows the most total ignorance of the wants as well as of the real difficulties of the question, and the mistake is in attempting to work reform by meddling with the present good law, when the whole of the evil is well known to rest with its bad administration by the law officers of the Crown. Those high functionaries are too busy with other matters to take any interest in the affairs of the Patent-office, and their Patent duties, as is well known to all patentees, are done by temporary clerks of the lowest grade as their deputies.

The one thing wanted in order to render the Patent-office perfect is to withdraw it wholly from under the control of the law officers of the Crown, and to give it the power, under Commissioners of high practical scientific skill, to ascertain for itself and for Parliament what reform is really wanted. In order to carry this mode of reform into effect, I would suggest:—

1. That a Commissioner of Patents be appointed with two assistant Commissioners, none of whom shall be lawyers, but all shall be gentlemen of known practical skill in the leading branches of manufacturing industry—that is, metallurgy, machinery, and chemical technology.

2. That the present law and present official staff be continued unchanged, but that the new Commission shall be wholly independent of the law officers of the Crown, and answerable to the Treasury alone, like all other departments of the State.

3. That it shall be the duty of the Commissioners to administer the present law, with all the present powers of the existing Commissioners of Patents, and also to report annually what amendments or alterations of the law their practical experience of its daily working under their own constant supervision may, from year to year, show them to be needed and useful.

4. That the new Commissioners shall receive communications of a suggestive nature at all times from Chambers of Commerce, or other public bodies, from

inventors, from manufacturers, and all who are interested or affected by the Patent question; and that they shall thus obtain all possible information, upon every side, of that question which it shall be their duty thus gradually to solve.

5. That the annual report of the Commissioners shall be presented to the Treasury in October each year, and shall be printed and exposed for sale at the Patent-office not later than the last day of each year.

6. That, pending this method of gradual reform, free from the theories of lawyers and patent agents, who view the question in a purely selfish light, no alteration whatever of the law of Patents be made, but that it shall be the duty of the new Commissioners to submit to the Government each year a Bill asking Parliamentary authority for any change or additional power which their personal experience may have shown them to be really needful.

7. That a consulting counsel be appointed to afford the Commissioners such legal advice, if any, as they may from time to time require.

8. That any alteration of the present law, for which the new Commissioners are desirous of obtaining powers, shall be fully stated in their annual report, by embodying the text of the proposed Act therein.

It will be seen that this method of reform is precisely that which men of business always follow with perfect success, and not the unjust theorising of the Lord Chancellor's Bill, which would have done nothing but harm to inventors, and no good, except that of placing an increased amount of official patronage in the Lord Chancellor's hands, at the cost of patentees.

The great difficulty of Patent-law reform is that so many useless nostrums are advanced, each designed to bring about an inventive millenium of that special kind which would most benefit the reforming quack himself. Thus, the patent agent seeks such a complicated routine in obtaining Letters Patent that his fees shall be largely increased. The patent barrister will throw abundance of dirt on every scheme which will not land him in the office of a sinecure commissionership, with scientific assessors to do all the work. The manufacturer wants to have the right to pay patentees anything or nothing, just as he likes. The high and mighty law officer of the Crown is too busy to take any real interest in the question, and when he acts, to save appearances, he only makes bad a great deal worse, or solves his own personal difficulty of advising without knowledge by the unjust recommendation that Patent-law should be wholly abolished.

Under the circumstances, the only hope lies in the appointment of a non-legal Commission, of gentlemen possessing ripe scientific and practical experience, who will soon learn from their personal contact with the working of the present law where it wants easing.

Trusting that this obviously simple and commonsense remedy which I have suggested may meet the approval of the Council, and may be urged by them on Mr. Disraeli's early attention.—I am, &c.,

W. A. Lyttle, C.E., F.C.S.

The Grove, Hammersmith, W.,
21st February, 1876.

COMBUSTION OF COAL GAS.

Sir,—I shall esteem it a great favour if you will allow me to make a few remarks on Mr. Wallace's very instructive lecture, which I much regret not having heard.

I know from experience that the plan Mr. Wallace describes of causing the products of combustion to pass away from the bottom instead of the top of the apparatus to be warmed, is a good one, for I have for some time used a cooking-stove and a bath boiler, both constructed on this arrangement, and both answer admirably.

Mr. Wallace's cap atmospheric burners seem to be nearly perfection, and I should have been glad if he had said where they can be bought. But leaving these details, I should much like, if space allows, to say a little on the general subject. I agree with Mr. Wallace that the time is coming when gas will be the only fuel used in the metropolis, for all purposes. The chairman expressed some fear as to the enormous amount of coke which would be produced if gas were to supplant ordinary fuel in all cases. Of course, if more coke was made than the market could absorb, it would cause loss. But why must there be so much coke made? At present, in making gas, the operation is stopt when the cream of the illuminating gas has been extracted—the calorific gases are left in the coke—but if gas consuming appliances were sufficiently perfect, these calorific gases might be utilised, and the operation of gas making might go on until nearly the whole of the coal is converted into gas. The illuminating and the calorific gases should both be extracted from the coal, stored separately, and sent along separate sets of mains and pipes, to be used in our houses and elsewhere, each for their own purposes. That this will happen before the government of London makes the gas for London is not probable. We ought to have, and might have, a smokeless London, and it is an object worth trying for, and I think the day is being brought nearer by every exposition of the qualities of gas flames, such as Mr. Wallace has just given in your lecture-room.—I am, &c.,

T. M. Gisborne.

4, Upper St. Germain's-terrace, Blackheath.

RAILWAY ACCIDENTS.

Sir,—Some years ago I wrote, relative to carriages running off the line, recommending a centre rail to be laid down for the exclusive use of the carriages, by an additional fore and aft wheel, independent of the more ponderous engines now in use, considering that the weight of the engine depressed the ground and rail at some parts below the level of the lighter carriage, so as, especially at the slightest curve, to prevent the present flange being useful as a guide. The recommendation was thought to be expensive. No doubt; so will a separate line for traffic be.

As a further protection to life, and a saving of expense to the companies, I try, with regard to collisions, to make respectfully another suggestion.

If I were in command of a battalion of her Majesty's troops, and it were necessary to dispatch that battalion by rail to quell disturbances or such like, I should not risk my men without an advanced guard—that advanced guard would be a pilot-engine—(in my civil capacity as a shareholder, driven by a director). Why don't the companies send on a pilot engine a mile ahead of all express trains? I feel certain that passengers would gladly pay a few shillings extra for security so provided.—I am, &c.,

Cosmo Logie.

Brighton, 26th February.

THE "SUEZ CANAL" DISCUSSION.

Sir,—At our meetings we cannot, of course, have replies to replies, or we should become a debating society; but I am anxious to notice parts of what was said by Mr. Magniac in his reply last Thursday, and especially where he referred to what I had said. I am the more desirous of this, because I find that while I had been speaking on the subject as "the commercial aspects of the Suez Canal," the subject as given to Mr. Magniac had added to it the words, "with special reference to India," and I may, unwittingly, have appeared to be unfair in my criticism of a paper which must have cost so much time and trouble to the writer, to whom our thanks are so justly due. Mr. Magniac said that "he spoke from his brief." So did I; and I believe that I had the same brief as all others present.

I adhere most fully to my opinion that the "Com-

mercial aspects of the Suez Canal" is a question affecting the whole commercial world, and above all, the whole "British commercial world;" and I shall indorse under this head all that Sir Charles Dilke calls, "Greater Britain." But, even if limited as Mr. Magniac had meant to limit it, I cannot but think that he regarded it too much from one point of view—as the change effected the commercial and ship-owning community in the British islands—whilst he ought, in any case, to consider how it effects our "fellow subjects," and our "fellow countrymen" in India, and by these, I mean, not only Englishmen, Scotchmen, and Irishmen resident in India, but all those whom he calls "natives," who are under the rule of the Sovereign who is so soon to assume a new title in connection with that rule. The Rajah of Burdwar said truly the other day "that he and the boys of the *Goliath* are all alike, British subjects and fellow subjects," and public opinion will have followed the article in the *Times* the day that his letter appeared.

Mr. Magniac says, "although I assert, as I do, that the change has been disadvantageous to trade, I by no means wish to say that it will be permanently so." I agree with him entirely as to the future, and, partly so, as to the present, but I think he has failed to inquire if changes which, at present, injure some people, do not benefit others. Although middle men, merchants, shipowners, &c., may bo injured (supposing it is so), many, not consumers and producers, were benefited; at all events, in some cases; or even producers alone may be benefited. And who are the producers of Indian exports? Not the natives alone, but, to a very great extent, the Europeans who employ the natives. No one knows better than Mr. Magniac, that, from the commencement, the indigo factories and silk filatures have been the property of Europeans: and it is the same with the new industries of India. India now sends to England — mainly through the canal — more than 21,000,000 pounds of tea, worth more than £2,000,000 sterling, and will, I believe, send five times tbat quantity during the lives of many who were in the room the other night. To whom do the tea gardens and coffee estates in India belong, and who are the people benefited if better prices can be got, because that canal has brought the growers and drinkers so much nearer to one another? I can answer for the company of which I am a director, that in the case of our 10,000 shares of the paid value of £200,000, and present market value of half a million, nine-tenths are held in this country, and that the native holders are almost an infinitesimal quantity. In page 257 of the last *Journal* is a valuable statement from Mr. Magniac's paper of imports and exports from British India to Europe, from 1870 to 1874, and it shows very clearly, and as might be expected, that the trade of Italian and other Mediterranean ports had increased considerably, exports to £462,000, and imports to £2,232,000. The exports are not much, being only about $1\frac{1}{2}$ per cent. of the whole, but the imports are nearly 7 per cent. of the total. To whatever extent this trade between foreigners and India may have interfered with British trade I am sorry, as I think we ought to be Englishmen first, and citizens of the world afterwards. But, still, we ought to ask the question, if this diversion of trade, temporary or permanent, does not benefit people in India, either consumers or producers, and I think it must do so to a greater or less extent.

There is another part of Mr. Magniac's original paper, and of his reply, to which I am even more desirous of referring, because I cannot help fearing that they are calculated to cause "illwill among partners," a result I am sure he would greatly deprecate, himself a partner in a firm of the first class. Every man in the British empire who pays taxes is now a partner in the Suez Canal, thanks to what so many believe, and I among them, to be one of the boldest and wisest measures of a British Government for a long time past. Frenchmen and Englishmen each hold nearly half the shares, and the whole glory of what is an event in the history of the world belongs to France, and to one Frenchman among Frenchmen. I could not at all agree with Mr. Magniac when he said, first, that all connected with the canal were disappointed, and then added, that the only people pleased were the shareholders, and that "their conversion only dates from a couple of months back, when our Government made the purchase and sent the shares up in consequence." I am well aware that the French shareholders did complain of their position before the convention of Constantinople; but since then their property was greatly increasing in value. The Chancellor of the Exchequer showed in his speech that a deficit in 1870 had been converted into a surplus of £322,000 in 1874. I understood the statement for a later date, as read by Mr. Magniac the second evening, to show a large increase on that amount. I have before me a statement of tonnage passed through the canal in the months of January 1874, 1875, and 1876, 200,578, 235,911, and 281,324, and another statement which gives the prices of the shares of 500 francs each, as about 570 francs before the purchase, and about 470 francs at present. Then again, I understood Mr. Magniac to reply to Sir Stafford Northcote's figures, by saying that the increased revenue was mainly owing to the "surtax," and that this was not a fair charge—is this quite certain? We know that the concession was granted to a French company, and that it was in the French language; even if we grant that their meaning of the "tonneau de capacité" was wrong, and the "Moorsom" system right, it appears to me to amount to this—that the company brought their case before an International Convention of twelve maritime nations, a convention where we may be sure that the nation owning 73 per cent. of the shipping using the canal had great weight. Even if technically wrong, the shareholders had an equitable claim to some aid for a time, and until the traffic increased, and it was given them in the shape of this "surtax," it is to be gradually reduced and extinguished as the tonnage increases; and if this agreement between France and England, as represented by M. de Lesseps and Colonel Stokes, and reported in the newspaper I read is not yet complete, we know that Colonel Stokes is on his way home, and from the reply of the Chancellor of the Exchequer to Lord Hartington last Thursday, we may fairly hope it will soon be so. That three English directors will soon be appointed, and that other good effects will follow; the first fruits arising from the fact that our Queen is now a partner in the firm of Lesseps and Co. When I was a merchant in Calcutta, being a director of the Government bank, the "Bank of Bengal," I was in partnership with the Government, as they held from the bank's formation shares sold only a few months ago for about £220,000; it was an anomalous thing for a Government to do, but it benefited the people of India and the Government also. We have now a new anomaly; but we shall probably see before very long Lord Derby's idea realised, and the Suez Canal become an international property; meantime, there seems a fair prospect that this peaceful *coup d'état* may be profitable, even in the mere money point of view, and a benefit to this and other countries in a far higher sense.—I am, &c., William Maitland.

Oriental Club, March 2, 1876.

NOTICES.

SUBSCRIPTIONS.

The Christmas subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made :—

March 8.—"Hall Marking of Jewellery," by Alfred Lutschaunig, Esq.

March 15.—"A New Bridge for Providing for the Traffic across the Thames below London Bridge," by Frederic Barnett, Esq.

March 22.—"Railway Couplings," by F. A. Brocklebank, Esq.

March 29.—"Model Dwellings for the Rich," by T. Roger Smith, Esq., and W. H. White, Esq.

April 5.—"The Cultivation in India of Caoutchouc-yielding Trees," by Clements R. Markham, C.B.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made :—

March 14.—"The Diamond Fields of Griqualand, and their probable Influence on the Native Races of South Africa." By John B. Currey, Esq., late Secretary to the Government, at Griqualand West.

March 28.—"The Industries of South Africa." By T. B. Granville, Esq.

April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following papers will be read :—

March 24.—"The Land Revenues of India," by Major-General Marriott, C.S.I. Sir George Campbell, M.P., will preside.

April 21.—"The Sanitary Progress of India," by Captain Douglas Galton, C.B.

May 5.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

Chemical Section.

Friday evenings at 8 o'clock. The following papers will be read :—

March 10.—"The Manufacture of Citric and Tartaric Acids." By Robert Warington, Esq., F.C.S. David Howard, Esq., will preside.

March 17.—"The Preparation of Dextrine-Maltose (malt-sugar), and its Use for Brewing and other Purposes." By W. Valentin, Esq., F.C.S.

March 31.—"The Methods of Estimating the Illuminating Power and Purity of Coal Gas." By A. Vernon Harcourt, Esq., M.A., F.R.S.

April 28.—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne.

Cantor Lectures.

Monday evenings at 8 o'clock. Third Course, "On Wool Dyeing," by George Jarmain, Esq.

Lecture I.—March 6th.

Introductory remarks.—Waters most suitable for the treatment of wool.—Scouring and bleaching operations.

Lecture II.—March 20th.

Indigo and its modes of application to the dyeing of wool and woollen fabrics.

Lecture III.—March 27th.

General principles of the fixation of colour upon wool.—Wool mordants.

Lecture IV.—April 3rd.

Logwood and other woods, and their application to the dyeing of wool and woollen fabrics.

Lecture V.—April 24th.

Ditto (*continued*).

Lecture VI.—May 1st.

Aniline and other allied colours, and their application to the dyeing of wool and woollen and mixed fabrics.—Concluding remarks.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. George Jarmain, "Wool Dyeing." (Lecture I.)
Farmers' Club, Salisbury-square, E.C., 5½ p.m. Mr. Mr. Robert Russell. "Green Crops for Sheep Feeding."
Royal Institution, Albemarle-street, W. 8 p.m. General Monthly Meeting.
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Perry F. Nursey, "The Channel Railway."
Royal United Service Institution, Whitehall-yard, 8½ p.m.
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Adjourned Discussion on "The Agricultural Holdings Act."
Medical, 11, Chandos-street, W., 8 p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Mr. W. R. Cooper, "The Horus Myth."
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. St. George Mirart, "Apes."

Tues. ...Royal Institution, Albemarle-street, W., 3 p.m. Prof. A. H. Garrod, "Classification of Vertebrated Animals." (Lecture VIII.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on "Floods, Rainfall, Evaporation, and Percolation."
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.
Biblical Archæology, 9, Conduit-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. Alfred Lutschaunig, "Hall-Marking of Jewellery."
Geological, Burlington House, W., 8 p.m.
Graphic, University College, W.C., 8 p.m.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m. Annual Meeting.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.
Medical, 11, Chandos-street, W., 8 p.m. Annual Meeting.

Thurs. Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. A. J. Ellis, "English Dialects."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Conversazione.
Royal Historical Society, 11, Chandos-street, Cavendish-square, 8 p.m. 1. Mr. Gustavus G. Zerffi, "The Historical Development of Idealism and Realism." 2. Mr. James Macpherson, "Historical Notices of the North Inch of Perth." 3. Mr. William Andrews, "Funeral Garlands, an old Custom connected with the Funerals of English Maidens."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Gladstone, "Chemistry of the Non-metallic Elements." (Lecture VIII.)
Inventors' Institute, 4, St. Martin's-place, W., 8 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.
South London Photographic Society (at the House of the Society of Arts), 8 p.m.

Fri. ......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Chemical Section). Mr. Robert Warington, "The Manufacture of Citric and Tartaric Acids."
Royal Institution, Albemarle-street, W. Weekly Meeting; 9 p.m. Prof. W. F. Flower, "Extinct Animals of North America."
Astronomical, Burlington House, W.C. 8 p.m.
Quekett Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.

Sat. ......Royal Institution, Albemarle-street, W., 3 p.m. Prof. G. Croom Robertson, "Human Senses." (Lecture I.)
Physical Science Schools, South Kensington, S.W. 3 p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, MARCH 10, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1876, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (now Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., in "recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, Foreign Member of the Royal Society, Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food-economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to M. Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. Henry Bessemer, "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to M. Michel Eugène Chevreul, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Mons. Michel Chevalier, the distinguished French statesman, "who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

The Council invite members of the Society to forward to the Secretary, on or before the 16th of April, the names of such men of high distinction as they may think worthy of this honour.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The following is the Report of the Examiners at the competition for the Scholarships endowed by the Society of Arts, by Mrs. Freake and by Mr. Morrison, held at the National Training School for Music, Kensington-gore, on the 12th, 14th, 16th, 19th, and 26th days of February, 1876:—

REPORT OF MUSICAL EXAMINERS.

To the President and Council of the Society of Arts.

MAY IT PLEASE YOUR ROYAL HIGHNESS, MY LORDS AND GENTLEMEN,—We have the honour to report as follows on the Musical Examinations of candidates for Scholarships in the National Training School for Music, entrusted to us by the Society of Arts.

1. We were guided by your Secretary's letters of February 1st, to one of the Examiners, embodying the conclusions arrived at by the committee on the 28th January.

2. We were further instructed that one Scholarship should be awarded to a violinist, irrespective of sex, and in the course of the examinations we received a request from your Society to draw up a list of those who were next in merit to the elected scholars.

3. The lists furnished to us contained the names of 109 candidates.

4. Of this number 106 presented themselves for examination, and these varied greatly in age. One candidate was so young and so small (8 years old), that she had to be lifted up to the music stool, and notwithstanding her evident talent she was considered by us disqualified by her age and physique to enter a public institution. Ten of the female candidates varied in age from 22 to 33, and one male candidate, a "composer," had attained the ripe age of 50. The remainder varied from 11 to 21. It should be observed that all the candidates had been regularly nominated, and that we were therefore obliged to examine them.

5. We spent four days in examining these candidates (106), and finally fixed on 24, whom we called up for a second hearing. From these 24 we elected ten, the names and ages of whom are appended.

6. In accordance with the wishes of the Council, we add a list of a few of the next in order of merit (eight in number).

In conclusion, we would respectfully suggest that the Society of Arts would use their influence in establishing as high a musical standard as possible, in respect to

future nominations for the Scholarships in the new school; and also in laying down limits, however wide, as to the ages of candidates.

We have the honour to be,
Your Royal Highness, my Lords and Gentlemen,
Your very faithful Servants,
John Hullah.
Otto Goldschmidt.
W. G. Cusins.

London, March 4th, 1876.

Report of Examiner in Reading, &c.

Nominations had been given to 109 candidates to compete for the above-named Scholarships. Of these I have examined 106 in dictation, and reading and recitation. The remaining three failed to present themselves.

With respect to the dictation, 12 of the candidates obtained very good marks, 34 good, 31 very fair, 24 fair, and 5 were found to be unsatisfactory.

As regards the reading and recitation, 1 candidate obtained excellent marks, 14 very good, 32 good, 31 very fair, 24 fair, and 5 were unsatisfactory.

Two only of the candidates were unsatisfactory in all the subjects. John Richardson, M.A.

26th February, 1876.

The following is the list of scholars and candidates recommended as qualified for scholarships:—

lphabetical List of Candidates selected for Scholarships:—

Eugenie Bénard (11), pianist.
Gertrude Bradwen (23), vocalist.
Charlotte Rose Davis (21), vocalist.
Hélène Heale (20), pianist and composer.
Norah Hughes (16), vocalist.
Robert Jefford (14), violinist.
Lucy Riley (15), violinist (Morrison scholar).
Eugenie Sturmfels (13), pianist.
Elizabeth Turner (15), vocalist.
Marion L. Wardroper (18), vocalist.

List, in order of merit, of Candidates reported by the Examiners as qualified for Scholarships had they had more to award:—

1. Walter G. Alcock (14), pianist and composer.
2. Monimia Twist (17), pianist.
3. Helen Akroyd (19), vocalist.
4. Percy H. Mull (16), organist and pianist.
5. Marion Westmacott (22), vocalist.
6. Frederick S. Dove (13), pianist and organist.
7. Florence M. Warman (15), pianist.
8. Emilie P. Brickwell (19), pianist.

As announced in previous numbers of the *Journal* a fund is being subscribed among the members of the Society of Arts, for the purpose of establishing scholarships at the School. Members willing to make donations or give subscriptions in aid, are requested to communicate with the Secretary.

One Scholarship (of £40) has already been subscribed for as under:—

G. C. T. Bartley	£1
Mrs. Bartley	1
Edward Brooke, for five years, yearly	5
Andrew Cassels „ „ „	2
Lord Alfred Churchill (Chairman of Council), for five years, yearly	5
Sir Henry Cole, K.C.B., for five years, yearly	5
Peter Graham „ „ „	2
Edwin Lawrence „ „ „	2
R. Rawlinson, C.B. „ „ „	2
E. J. Reed, C.B. „ „ „	5
E.C. Tufnell „ „ „	2

This has been awarded to W. G. Alcock, the first on the list of qualified candidates. As other scholarships are subscribed for, they will be given in order to the seven candidates remaining, who have been recommended.

The following donations to the fund have also been made:—

F. A. Abel, F.R.S	5
Hyde Clarke	5
Seymour Teulon	5
Thomas Twining	10
Major-General F. Eardley-Wilmot, R.A., F.R.S.	5

FOOD COMMITTEE.

A meeting of this Committee was held on the 8th inst. Present—Lord Alfred S. Churchill (in the chair), Dr. Blakiston, and J. J. Manley, with P. Le Neve Foster, Secretary. The Committee inspected and tasted some specimens of fresh American beef, brought over in refrigerated chambers, according to the process described in the *Journal* of February 25th last, p. 275.

INDIAN SECTION.

A meeting of this Section was held on Friday, March 3rd, Lord Borthwick in the chair.

The paper read was—

THE FALL IN THE PRICE OF SILVER, ITS CONSEQUENCES, AND THEIR POSSIBLE AVOIDANCE.

By Ernest Seyd, F.S.S.

Preface.—*The mode in which the subject will here be introduced and explained.*

The recent heavy fall in the value of silver has become a pressing topic in England, because the equally great decline in the Indian Exchange causes heavy losses, not only to those who have investments in India, or fixed incomes therefrom, but to merchants and others dealing with the East, and the outcry is now, "What is the cause of this fall? is it temporary or is it permanent? where will it stop, and how can it be arrested?"

But although these are now the pressing questions in England, the topic is an old one as far as other nations are concerned. It is that which has occupied the economists of various countries as the controversy concerning what is called the single, *versus* the double standard, or the gold, *versus* the gold and silver valuation. In this controversy, certain economists have so far conquered the situation, inasmuch as through their peculiar doctrines, several Governments, notably that of Germany, have adopted the gold valuation, and given up, or "demonetised" silver. Hence silver has, by force of the law required for the maintenance of the gold valuation, become a "drug" in the European markets, and the surplus European stock, together with the fresh annual production of silver, is so much in excess of what the East can use, that no one can tell now to what extent silver will fall; and, what is worse still, nobody can tell what is to supply its place as money. Indian pensioners or merchants, or the Indian people themselves, are

not the only parties on behalf of whom Englishmen must interest themselves in this question. There are other countries in the same position as India. Obviously, what affects India and other countries also affects the commerce of the world at large, and so both on behalf of our Indian and universal interests, identical as they are in a great measure with our own national prosperity, we are bound to pay attention to the subject.

That would have been done before this time, before India knocks loudly at our doors, as it does at present, if England had not hitherto been the most unfavourable ground for its consideration. For England has had the gold valuation since 1816, and is not only proud of the fact, but imagines that the adoption of the same system by other nations is only an acknowledgment of English supremacy and policy. The essential error of this assumption must be made clear; but how is this to be done under the circumstances?

An investigator who, like the writer of this paper, has before this issued books on the matter, predicting years ago that which has since taken place, although he was then laughed at as a heretic, is now beset with all sorts of special questions, which he is expected to answer according to the humour of the questioners. These questioners start a special case, form an hypothesis on a single "first" principle, and forget that this is a subject in which "many first" principles must be brought together. And when such principles become international, when they involve, as in monetary problems generally, all sorts of considerations on bank notes, gold, silver coin, cheques, and kindred matters—as they happen to come uppermost with inquirers, a writer must endeavour to proceed in an orderly way, and follow out a system of explanation which experience suggests to him as the most appropriate one for covering the whole of the controversial ground.

It is for this reason that the treatise here submitted is divided into three parts, viz :—

1. Specie payments and their recovery. International wealth and international indebtedness.
2. The main question of the valuation and its present evil position.
3. Suggestions for restoring the equilibrium in the valuation.

The first subject does not appear to have any immediate connection with the Indian exchange and the fall of silver. Nevertheless it has, as will appear hereafter, a most important bearing on the main point. But besides this, as we in England are so well acquainted with and proud of our metallic valuation, we can better appreciate anything that is said on this head, and an author thereby gains the felicity of bringing into the foreground certain facts and conclusions, on which he can agree easily with his readers, and apply them hereafter to the apparently more difficult problem.

The recovery of specie payments to which certain States are bound, is one of the inevitable, and not wanton causes of the present position of the valuations, and it is best that this certain ground should first be cleared and combined with useful statements, in order to show England's interest in and relation to this part of the general cause. The consideration of the question of the valuations as founded on gold and silver—first its international aspect, and then its special importance as regards India and England combined—will lead to the suggestion for a remedy through which both India, the silver-valuing States, and the welfare of all other nations, may be secured against the immediate and uncontrollable revolution in commerce and civilisation which is now threatening the world.

PART I.—"*Specie payments*" *and their recovery. International wealth and international indebtedness.*

As stated in the preface, precedence is given to these subjects, not only because they are and will be found closely connected with the general question of the valuations and the office and value of silver, but because they give the opportunity of stating certain positions, and raise issues on which certain plain first principles can be arrived at, necessary and useful for the better understanding of the many questions indicated by the title of this treatise.

The suspension of specie payments and the consequent loss of international wealth (a term hereafter to be more distinctly defined) involves firstly that of the causes. These are wars, revolutions, general, social, and industrial decline; accompanied, usually, by maladministration of the nation's affairs of finance. The literature on this subject is varied, it need not be referred to here. Nor do I propose here to give an account of the paper issues of France during last century, or that of the United States in their War of Independence. Equally unnecessary would be an allusion to Turkey, Hayti, and the defunct Confederate States of America, and the several suspensions during the present century of certain other States, which were of a more or less spasmodic character. My object in the first instance is that of bringing before you the suspensions of specie payments (and the resumption or the progress and prospects towards it) which have taken place among the leading nations in a more or less deliberate manner. These, it will be found, have a most important bearing on the question of the universal valuation in its present stage.

The first noteworthy example of a regular recovery from suspension of specie payments is afforded by England at the beginning of the present century. In 1795 gold had already reached a premium of 5 per cent., but in 1797 the Bank of England actually suspended the payment of specie. In Tooke's "History of Prices" the quotations of gold, in bank notes, are given as—

1797	£3	17	9 per oz. standard, or par,					
1800	4	5	0	,,	,,	9	per cent.	premium.
1802	4	4	0	,,	,,	8	,,	,,
1804	4	0	0	,,	,,	3	,,	,,
1809	4	10	0	,,	,,	13½	,,	,,
1811	4	13	6	,,	,,	20	,,	,,
,,	4	17	6	,,	,,	25	,,	,,
1812	4	15	0	,,	,,	22	,,	,,
1814	5	8	0	,,	,,	40	,,	,,
,,	4	11	0	,,	,,	15½	,,	,,

In the year 1815, that of the return of Napoleon from Elba and the battle of Waterloo, the variations were :—

1 Jan.	11	per cent.	premium.
10 Feb.	14½	,,	,,
21 Mar.	20¾	,,	,,
31 ,,	37½	,,	,,

21 Apr.	36	per cent. premium.
19 May	35	" "
30 June	$33\frac{1}{2}$	" "
30 "	$28\frac{1}{2}$	" "
4 July	23	" "
11 "	$19\frac{1}{2}$	" "
4 Aug.	$\frac{1}{2}$	" "
5 Sept.	$14\frac{1}{4}$	" "
20 "	$11\frac{3}{4}$	" "
10 Oct.	9	" "
13 "	$6\frac{1}{2}$	" "
10 Nov.	$7\frac{3}{4}$	" "
15 Dec.	$5\frac{1}{4}$	" "

Then follows the period from 1816 to 1819, in quarterly quotations,

1816.—	5th January,	4	per cent. premium.
"	19th April,	$2\frac{3}{4}$	" "
"	9th July,	$1\frac{1}{2}$	" "
"	4th October,	$\frac{3}{4}$	" "
1817.—	17th January,	2	per cent. premium.
"	21st May,	$2\frac{3}{4}$	" "
"	19th August,	4	" "
"	7th November,	$3\frac{1}{4}$	" "
1818.—	10th February,	6	per cent. premium.
"	24th April,	5	" "
"	27th November,	$6\frac{1}{2}$	" "
"	15th December,	4	" "
1819.—	8th January,	$6\frac{1}{2}$	per cent. premium.
"	20th April,	$5\frac{1}{4}$	" "
"	9th July,	$\frac{1}{6}$	" "
"	20th August,	Par.	

The question might here be asked why, if peace was assured, and the premium in 1816 at $\frac{3}{4}$ per cent. only, did it again rise, until in 1819 it still stood at $6\frac{1}{2}$ per cent.? It must be remembered that England, in 1816, adopted the gold valuation and repudiated silver. It therefore took a longer while to accumulate the gold required, and to this fact I shall refer again hereafter.

After the recovery of specie payments in England, other nations also recovered their ground, from which, however, they had not so far departed. It is not necessary to refer to these matters, or to notice the paper panic in the United States in 1837, and other events of that kind; suffice it to say that from 1819 to 1848, all nations whose exchanges we cared to quote on our market, came back to the par of exchange on metal. Some had but a weak supply of gold and silver, and more bank notes than were beneficial, but there was no actual departure from the pars beyond what the conditions of international balances of trade required.

In 1848 the course of new political revolutions commenced. At the same time the Californian, and in 1852, the Australian gold-fields were opened.

Since then the following States:—

England, Germany, Holland, Belgium, Switzerland, Denmark, Sweden, and Norway—have maintained their metallic parity;

France, only for a short time (1872) nominally departed from it, and is even now stronger than ever; but the four following nations:—

Austria, Russia, Italy, and the United States—made over issues of paper money, so that specie payments had to be suspended, and they have not as yet recovered them.

Austria commenced in 1848; Russia in 1854; United States in 1862; and Italy in 1866; and the concurrence between great political events is clearly visible.

The quotations now following as regards Austria, Russia, and Italy, are not taken from actual premiums paid in these countries, for gold was scarce, and in the two former the silver valuation prevailed; they are taken from our London exchange quotations of three months' bills, and the departures from the normal rates of exchange and interest represent the actual departures from metal more truly.

Table showing the departures from Pars of Exchange (equal to premiums on gold on suspension of specie payments) of Austria, Russia, Italy, and the United States, according to the quotations of the long exchanges in London stated in per cent. of premiums at four periods of each year:—

Years	Austria.				Russia.				Italy.				United States.			
1848...	Par	9	16	5	...				...				...			
1849...	9	18	6	9	...				...				...			
1850 .	8	17	18	21	...				...				...			
1851 ..	25	28	16	25	...				...				...			
1852 ..	18	17	10	5	...				...				...			
1853...	1	7	5	9	...				...				...			
1854...	9	30	9	18	Par	15	4	17	...				...			
1855...	18	19	18	9	4	5	6	10	...				...			
1856...	6	1	2	1	9	1	Par	—	...				...			
1857...	Par	—	—	6	1	3	4	12	...				...			
1858 .	Par	—	1	3	8	7	6	9	...				...			
1859 .	1	15	39	23	5	7	13	10	...				...			
1860 ..	30	21	28	39	7	10	7	9	...				...			
1861...	49	50	38	36	10	13	14	15	...				...			
1862...	38	30	25	19	12	10	10	7	...				4	2	15	32
1863...	13	10	9	20	7	5	4	17	...				55	70	25	52
1864...	21	15	13	15	14	14	19	25	...				60	110	158	120
1865 .	13	6	9	6	25	24	24	25	...				100	65	37	47
1866...	1	34	27	29	27	47	32	25	Par	15	9	6	40	27	56	46
1867...	30	31	25	19	22	25	17	17	5	9	7	13	39	37	46	35
1868...	18	14	12	16	16	17	17	17	16	11	9	5	42	40	46	35
1869 ..	18	25	23	21	19	21	27	29	3	4	3	5	31	40	30	20
1870...	21	22	29	22	29	31	40	25	3	2	7	5	20	23	16	10
1871...	22	23	21	17	27	23	21	17	4	5	6	7	10	13	15	10
1872	14	9	11	9	17	17	19	19	8	7	9	13	8	12	4	11
1873...	8	8	11	13	19	19	20	19	12	15	15	17	14	19	10	6
1874...	9	11	9	8	17	16	15	16	15	12	10	9	10	14	9	10
1875...	9	9	10	12	15	16	21	21	9	8	6	7	12	16	17	13

Although, as you will see, there have been considerable reductions in the premiums up to the end of last year, yet all the four States are making but slow progress towards final liquidation, in comparison with what England did. And at the same time, whereas England incurred an immense debt at home out of her own resources, these four States have called largely upon the resources of other nations by giving over to them the greater part of their State debts. They have not only parted with their local wealth in metallic currency, but have used and strained their international credit. They have a paper currency awaiting replacement by metal, and they have become internationally poor.

How can the internal false valuation be set aside? How can the international indebtedness be discharged? For both evils have an influence upon each other, and require a regular process of liquidation.

Here it becomes advisable to show what is international indebtedness as against international wealth.

The so-called civilised nations of the world may be divided into two great categories:

1. The international wealthy nations: England, Germany, France, Holland, Belgium, Switzerland, with perhaps Denmark and Sweden, as creditors.

2. The international indebted nations: Austria, Russia, Italy, the United States, British colonies,

Spain, Portugal, Turkey, and the South American republics, as debtors.

The following statement will give some idea as to the relative position.

The total State debts of the nations may be given as amounting to £4,400 millions.

Of these, the following nations may be said to be the holders of their own debts, viz :—

Nations.	Debts.
England	£785 millions.
France	750 ,,
Germany	165 ,,
Holland	80 ,,
Belgium	36 ,,
Denmark	14 ,,
Total	£1,830 millions.

That is to say, although the French, Dutch, and Danish debts are dealt in on other bourses, yet substantially these nations are internationally wealthy. The French debt is now almost entirely held in France, and the English and German debts have always been kept at home.

The following nations, however, may be said to be the debtors to other nations, viz. :—

Nations.	Debts.
United States	£450 millions.
Austria—Hungary	346 ,,
Russia	275 ,,
Italy	251 ,,
Spain	260 ,,
Turkey	215 ,,
India	106 ,,
Egypt	95 ,,
Mexico	79 ,,
Brazils	68 ,,
Portugal	66 ,,
British Colonics	63 ,,
South American and other small States	295 ,,
Total	£2,570 millions.

Of this total the majority is held by the other nations. A great portion of the American debt is held by the people of the United States, but Europe holds about one-half. The bourses at Vienna, St. Petersburg, &c., deal in their own debts, but the total of the sums so held at home by these nations does not exceed the amount of £600 millions, so that deducting £570 millions, there remains £2,000 millions in which these nations are indebted to the others. That is to say, these debtor nations not only hold no foreign debts by way of investment, but their own debts are held elsewhere, and they may be described as internationally poor nations.

In juxtaposition to the internationally wealthy nations, and taking the money value of the debts (before the late Turkish collapse) as at £1,700 millions, it may be stated, according to fairly reliable estimates, that

England holds	£800 millions.
Germany ,,	400 ,,
France ,,	400 ,,
Holland, Switzerland, Belgium hold	100 ,,
	£1,700 millions

The three nations, England, Germany, and France, are consequently the chief internationally wealthy nations (Holland being the next in order).

But besides their holdings in foreign State debts, they have investments in foreign railways, &c., and there are foreign balances of trade in their favour, so that the clear international wealth may be given as—

For England	from £1,000	to £1,100	millions.
,, Germany	,, 550	,, 600	,,
,, France	,, 500	,, 550	,,

Before the war, France held the second place to England; since then some £200 millions have left the country to pay Germany, and in exchange for the French new debt, Germany has gained about £150 millions. The rapid recovery of France, and the large annual profits of its international commerce, will soon place the country again in its former position.

The importance of the item "international wealth," in its relation to the general wealth, the balance of trade, and the basis of the valuation by metallic currency of a nation, in contradistinction to the evil of international indebtedness, may now be shown by a comparison between the constituents of the wealth of England and the United States, for instance.

WEALTH OF ENGLAND.

1. Local wealth in lands, buildings, and immoveables, in occupation for the purpose of production or comfort. Among the total wealth of England, as estimated at between £8,000 and 9,000 millions, this item is a considerable one. But it has no immediate reference to international wealth, although in event of the country becoming poor, it might serve as a security to foreign investors. Happily, our local property is too well protected by other layers of wealth. The amount of such local wealth (many estimates notwithstanding) had best be expressed by £?,000 millions.

2. Internal wealth in moveable commodities, including objects of art and luxury. Although these are in local use, and their value, in great measure, dependent on our own estimation, yet they have an international value. Other commodities of the ordinary description, though saleable, constitute no element of international superiority, but their surplus is realisable. The amount of the total moveable property in England had also best be stated by an indefinite £?,000 millions.

3. Public works wealth, such as railways, canals, and other enterprises, in which certain mines might be included, constitute a property transferable by shares and obligations. The amount so available at its present value might be stated at £1,200 millions.

4. The State debt of this country does not concern the foreigner; it is immaterial to him whether one section of the nation owes money to the other. Nevertheless, inasmuch as it exists, by way of recognised credit of a nation, in an available practical contract form, it is transferable and saleable, and may be considered an item of reserve of £780 millions.

But not only does England hold its local, internal, public works wealth, and State debt, entirely free of any foreign claims whatsoever upon them, it holds also—

5. Its international wealth, *i.e.*, claims on

foreign States by debts, railway and public enterprises abroad, balances of trade, &c., amounting, as by the statement previously submitted, to say £1,100 millions, yielding an annual income of from £40 to £50 millions. This is the great reserve which, not only as long as it exists, protects the previous items of wealth against any possible encroachment, but is at the same time the extra stratum of capital at rest, and from which—

6. The active capital of the country, and the currency, can be reinstated at will. According to an estimate prepared by Mr. Richard Seyd, upon a system whose legitimate ground can be shown, and which has been subjected to the approving criticism of the most reliable authorities, the total of the active capital of the country engaged in banking, manufacturing, international and wholesale commerce (capital and commodities for retail trade being included in the former items of local and internal wealth), may be taken as amounting to £920 millions.

Finally, there is—

7. The currency, consisting at this time (1876) of—

£105	millions	of gold coin
18	,,	,, silver and copper coin
35	,,	,, Bank of England notes on £20 millions of gold bullion.
15·8	,,	,, country notes.
£173·8	millions,	of which are in circulation £162 millions, there being Bank notes of £11·8 millions not in circulation.

The actual circulation therefore consists of—

£105	millions	gold coin.
18	,,	silver and copper.
20	,,	Bank of England notes on bullion.
£143	millions	in metallic basis.
19	,,	,, Bank notes not issued on bullion.
£162	millions	good currency in circulation.

England accordingly possesses—

£?,000	millions	local immoveable wealth.
?,000	,,	internal moveable wealth.
1,200	,,	public works, &c., wealth.
780	,,	realisable State debt.

with an intervening first reserve of—

£1,100 millions of international wealth.

and for its wholesale commerce—

£520 millions of active capital.

and finally—

£162 millions of sound currency.

What now is the relationship of the currency of £162 millions to the millions of capital, international reserve, and the wealth beyond? What is its office in the system of intercourse, its origin and rightful position? In no country can this be shown more distinctly than in England; the currency occupies a definite range in the system of mutual exchange, as that on which the value of labour and of commodities ultimately depends.

The social commercial intercourse, as far as its method of procedure or settlement is concerned, may be divided into two main stages:—

1. Methods of settlement without currency.
2. ,, ,, ,, through currency.

The following strata fall under the methods of settlement,

Without Currency.

In	*By*
Financial business, public works, railways, &c.	Accounts, banking, cheques, and clearing systems.
International commerce, export and import, &c.	International bills, shipments of bullion.
Wholesale Inland trade and manufacturing.	Inland bills, cheques, and banking generally.
Large retail and professional business.	Bankers' counter business, cheques, and large notes.

involving in the settlement per annum,

£6,000	millions	London bankers' clearing,
1,200	,,	inland and foreign bills,
55	,,	bullion (1873),
?,000	,,	country banking,
?,000	,,	bankers' counter business.

Whilst the strata of business to be settled by actual money or

Through Currency.

viz., retail trade, payments from pocket, &c. Wages to industrial classes and dealings between the working classes—	are carried on by the daily turnover of £162 millions of currency now in circulation.

This distinct separation in the methods of settlement of business rests upon perfectly natural ground. All the contracts incurred, which can be discharged by accounts, banking, cheques, and clearing systems, require no currency for their conveyance from one party to another; on the contrary, the use of such currency would be an inconvenience. But just as much as the mechanical facilities afforded by such mutual exchange of contracts are a convenience up to certain amounts, so would this mechanism be inconvenient for smaller amounts; hence for a certain stratum of contracts the actual currency must be used. The degree of perfection which our banking and clearing facilities have reached in this respect may be inferred even from the recent experience of the Cheque Bank. This establishment endeavoured to fill up a gap between the clearing system and currency by the issue of small cheques. But its comparative non-success so far proves that the range of the currency is well settled and defined, and firm for the time being.

For the stratum of business, then, the circulation of actual money is regular. It depends on—

1, the number of population,
2, the production,
3, the consumption,

as the first three factors; to which, with—

4, the current prices,

it forms the fifth factor,

5, the numerical quantity of money required.

And so regular is the proportion which it assumes in this combination, that even in the event of crises no more money is required or can be used. The amount of currency may increase or decrease with the population, and the consequent increase of the other factors, but this is naturally a gradual progress. A decrease of prices will lessen the amount of money required; and *vice versa*, a decrease or increase of currency will enforce a decline or a rise in prices. In England, where the Government is not embarrassed, nor tampers with the currency through an overwhelming paper issue, where the

coinage of gold is free, the amount adjusts itself. Not only does the international trade of the country bring a profit of from £30 to £40 millions, but the increase from international investments is £40 to £50 millions per annum. This total profit goes partly in payment of commodities of necessity and luxury imported, and partly to increase of international wealth, but it always brings an importation of from £30 to £35 millions of gold and silver per annum, from which we need but hold back from £1 to £2 millions for our own currency requirements. Our superiority in commerce and manufactures is thus assured by a self-acting process of proportions between prices and currency, as the basis for the whole super-structure of value. And for the purpose of this inquiry the "numerical" character of this relationship between all the factors and the currency must be kept in view.

Thus, in all the items which constitute wealth, we in England are creditors. France and Germany are in a similar favourable condition. They own their lands and commodities, their public works and State debts, their international wealth (though not so large as ours), their capital and good currency. Holland and other small States have a balance to spare, or at the least balance their affairs.

Of the internationally indebted nations the United States of America afford the most interesting example in comparison with England, as the following statement may show:—

WEALTH OF THE UNITED STATES.

1. Local wealth in lands, buildings, and immoveables. Although the country has more lands, yet the question of its value is one for the future—the present local value at least does not constitute international superiority. The great bulk of property of this kind is held, as a matter of course, by inhabitants at home; nevertheless a number of millions of money are invested by European capitalists in lands, in mortgages, and this may fairly be taken as amounting to £20 millions. The American Government estimates the total value of properties of this kind at about £5,000 millions, but it had better be taken as £?,000 millions.

2. Internal wealth in moveable commodities and objects of art and luxury. The value of objects of art cannot be compared with those of England, but in articles of luxury the United States possess a considerable quantity; most of these articles are of a more transitory character, and more or less quickly consumed. As a reserve of international value it had better be stated by the formula £?00 millions.

3. Public works wealth, &c.—The railways in the United States are valued at 3,800 million dollars or £760 millions sterling. One-half of the sum is owing mostly to debentures, of which it is stated that more than £100 millions sterling have been placed in Europe during the last twenty years alone. Other public works in America, and mines (on which the "good" claims of European capitalists are considerable), may swell the value of this kind of property to £1,000 millions—of which between railway shares and debentures, mining shares, and various claims, a sum of £150 millions can be taken as owing to Europe.

4. The State debt of the United States amounts to £450 millions at present. It is estimated that £220 of this are held abroad (80 millions alone in Germany). Together with some of the holdings of individual State debts—the total so held in Europe is probably underestimated at £210 millions.

5. Of international wealth—in foreign State debts or claims on other nations—the Americans have none, this item being reversed to international indebtedness.

6. The active capital of the merchants and industrials of the United States must be considerable. The so-called issuing banks are returned with 485 million dollars, or £100 millions—and so must the inland traders have large means. But if this total capital, for argument's sake, be taken as high as £400 millions, it must be borne in mind that both the import and export trades are chiefly under the command of European capitalists, and that there is an international indebtedness on this account of not less than £40 millions. (The so-called "gigantic" capitalists in America and possessors of property fall under the same category as our wealthy aristocracy.) There is finally—

7. The currency of the United States, consisting of (at the end of 1875)—

dols.	347	millions	of national bank notes.
	371	,,	legal tender notes.
	41	,,	fractional currency.
	40	,,	specie (Californian currency and subsidiary coinage).
dols.	802	millions	of which, less the—

dols. 40	millions	specie currency.
20	,,	gold in banks,
60	,,	gold in treasury.
120		

Dols. 682 millions.

Dollars 682 millions, or £136 millions are pure paper money and inconvertible, the premium on gold being still at 13 per cent.

In order to bring this £136 millions of pure paper issue to the mere verge of convertibility, a minimum of £50 millions in gold would be required, and this figure is the least in which the American people, so to speak, are indebted to the universal stock of gold at this moment.

The American wealth may therefore be stated as—

£?,000	millions	of local immoveable wealth,
00	,,	of internal moveable wealth,
1,000	,,	of public works wealth,
450	,,	of State debt,
400	,,	of active capital,
30	,,	of gold,

as items of credit; against items of debt, in international indebtedness.

£	20	millions in foreign holdings of lands and mortgages, &c.
,,	150	millions in railway and public works, debentures and shares.
,,	210	millions in State debts, &c., held in Europe.
,,	40	millions in international capital.
£403		millions,

which, with £50 millions required for recovery of specie payments, give £450 millions as total international indebtedness.

I do not think that I have overstated the case, but whether the total be more or less, let me call your attention to the true nature of such international indebtedness. State debts to a larger amount than that of America can be incurred within the frontiers of the State itself; for so long as the contract involved remains "at home," it is a matter of internal consideration—of no great harm in international relationship. It is also easier to liquidate such debt by proper taxing arrangements; and the only favourable feature in the case of the United States is that so much of the debt has already been paid off "at home." But whilst at home such debt is of the nature of an irritating fleabite (as Mr. Disraeli has it), it becomes, as an external debt, an open, ever-bleeding wound to the nation. It involves not only a yearly outflow from the country of the interest due, but also the repayment of the principal, and not until this is done can the country claim to have balanced its affairs, apart from the probability of acquiring international wealth. The rough plea, "one hand washes the other, and it suits the Americans to borrow money," is that made by the usurer in reference to his client; it does not set aside the fact of the indebtedness and its consequences.

How can the United States recover from this state of indebtedness? That is easily answered. "They must turn the balance of trade in their favour by exporting more and by importing less." But that is not so easily done, for that balance is now too much against them. The points by which this can best be tested are the following:—

Previously to 1848 the United States, although always trading much on bank notes, had a metallic currency far larger than the £20 millions of gold now held by the banks and the treasury. From 1848 to 1875 the total produce of its mines (gold about £270 millions, silver about £52 millions), amounting to £322 millions, has been all exported, and, as said before, less metal is in the country now than before 1848. This is at the rate of £12 millions sterling per annum. But that is not all. The bulk of this export falls between 1862 and the present time. During the same period also the Americans remitted to Europe part of their national debt and other debentures, and making due allowance for what has been useful in this way for public purposes of development, the clear remittance is not less than £300 millions. This, together with the bullion shipments, would give an international balance of £29 millions per annum against them. And here this fact must be noted: up to the end of 1874 the remittances of debt continued; since then, on account of the prices of the bonds, they have ceased, so that the present annual tribute must be paid in something else than debt.

It may appear, in the first instance, that the principal cause of the international debt, taken at £400 millions and 6 per cent. per annum, gives a clear balance of only £24 millions, whilst £29 millions appear as the actual one. There must be a second cause for this. The fact is that the people of the United States, in spite of the immigration which has brought many millions of cash into the country, in spite of the productiveness of the soil and the advance in manufactures, have always imported more than they exported, and if they had no international indebtedness, the balance of trade would be against them. This could be borne formerly with ease, but just now it is the first thing that must be corrected, before the liquidation of the absolute indebtedness can at all begin.

It is not necessary here to refer to the moral aspect of this separate cause of the balance of trade being against America, nor need I enlarge upon the example of England, when after 1816, loaded with a heavy debt, the people recognised the burden, and under wise direction recovered their ground; or refer to the present example of France, which has so rapidly, assisted by the abnegation of the population, regained its international prosperity. What is here to the purpose is the necessity of the Americans to do so likewise. It may also be admitted that necessity and pauperism have already compelled the United States to import less and export more, but what has been done so far is but insignificant, is but the work of absolute pressure, and not that of intelligent action on the part of the people and the statesmen. Although there are many thrifty minds in America, yet the great portion of the inhabitants live too luxuriously on foreign imports. And among the statesmen of America there is too much idle phraseology current as regards "the splendid resources" of the country. Whereas England recovered specie payments within the four years after the great wars, without any assistance, America, in spite of its loans and advances from abroad, after ten years have elapsed since their gigantic struggle ceased, still suffers from a premium of 13 per cent. on gold. The President of the United States began, ten years ago, to twaddle about recovery of specie payments year after year. And although it is now proposed to reduce the paper issue by about £5 millions per annum, yet that will be too slow a process towards recovery.

For here arises this consideration; unless that paper currency is reduced more rapidly, the inflation of prices, *i.e.*, the bar to export and the encouragement of imports, will continue too long. It must not be supposed that because the Americans say "the amount of currency per head of population is not in excess of what it is in England," that therefore, there is not too much; nor must it be supposed that the mere premium on gold indicates the degree of difference in prices, it is but the point of settlement of exchanges; the inflation remains against export and for import. The premium on gold itself shows clearly that the amount current is too much. As I have before demonstrated in regard to England, the currency is a numerical factor which must be in accord with population, production, and consumption and prices, and if these prices are too high, the currency is inflated, in spite of the numbers of the population; and if the export must be encouraged, prices must be made to lower by contracting such currency.

It is obvious that this lessening of prices will create great difficulties in the internal contract system, that the value of property will decline and so create a struggle with the so-called fixed contracts in debentures, mortgages, and advances incurred upon it. Capital endeavours to save itself from these consequences, but the longer the delay, the more remote the chance of liquidating inter-

national indebtedness. Hence the recent party fight in the United States between the inflationists and the specie faction. And here one lesson must be derived from the issue of that struggle. Matters of currency are accepted by the masses of the people, *quasi* as matters of fate. Yet here in England we are prepared to admit that if the inflationist party in America had been successful, the country would have rapidly gone to further decline. It follows, then, that in matters of currency, human intelligence is a most important element, and we may remember this for a future purpose in this treatise.

In the meantime two questions here arise:—

1. What changes of prices must take place in America to encourage export and discourage import, and how will this react upon the rest of the world?

2. If America requires £50 millions of gold as the least sum upon which specie payments can be restored, what will be the effect upon the stock of gold generally?

These questions, however, are not confined to America, which I have quoted only as an example of the four principal States. Austria, Russia, and Italy are in a similar position of international indebtedness as regards State loans, public works, and commerce. Russia has a State debt of £275 millions, Austria £346 millions, and Italy £251 millions, the greater portions of which are held abroad. And the amount of inconvertible paper money in these three States may be taken at a minimum of £300 millions; so that, together with that of the United States (and irrespective of several small countries in the vortex of over-issue, irrespective also of Turkey), an amount of £450 to £500 millions of such currency struggles for recovery to specie payments. It may be assumed that with a total sum of £150 millions of gold, it would only just be possible for these countries to return to a specie basis; ultimately more would be required. The question as to the influence of this necessity on local and international prices rests in the first instance on its own merits, and in the second instance on the demand for a minimum of £150 millions of gold on the general stock of money. For whilst the indebted States must strive to lessen their imports and promote exports, prices must necessarily fall in the internationally wealthy States,—whilst the diminution of the solid currency of the latter, from the demands of the former, is a second and confirmatory cause of such fall in prices.

Before 1848 the amount of gold current in the world may be stated as having been £400 millions (independent of jewellery, &c.). Since then an amount of £350 millions has been added (the total production being about £500 millions), so that the present stock of gold coin and bar gold for banking purposes may be stated at (say) £750 millions.

At a rough estimate it may be stated that this stock is distributed as follows:—

England	£130	millions.
France	220	„
Germany	100	„
Belgium, Switzerland, Holland, Denmark, Sweden	50	„
The rest of Europe, with indebted States	60	„
United States	30	„

The balance of £160 millions being distributed in the East, Egypt, Persia, Japan, China, the British and other Colonies, South America, &c.

In considering the claim of £150 millions, which the over-issuing States will make upon this stock of gold, it is necessary first to dispose of certain idle phrases which are frequently advanced. So it is said, "Oh, the new gold found will supply the £150 millions." It is perfectly immaterial whether this requirement is satisfied from out of the stock already in hand, or by interception at the source from which the reservoir derives its accustomed supply. Others say, "Let jewellery be melted down." This is not a case where patriotic ladies come forth and supply the king with money (and such supply has always been small); on the contrary, the supposed increased value of gold will have the tendency of increasing its appreciation for ornamental purposes. Then it is said, "We can issue more bank notes." If bank notes are full equivalents in substitution for gold, there is no reason why we should not, for the purpose of turning them to account, use more now. When other nations reduce their currency of bank notes for the evil they bring, we are all the more compelled, for the maintenance of our solid stock of money, to be chary of their use. Lastly, it has been said, "Let other nations adopt our clearing system and thereby save currency, as we do here." Supposing that our clearing system is a product of our better organisation or civilisation, it is evidently wrong to make this matter turn upon the enforcement of the same on other nations. Systems akin to our clearing system have been in existence from time immemorial, and in all civilised States the bulk of commerce is conducted on similar methods of settlement. Both the French and German banks render such services to the communities; in America the clearing system is in high perfection. And moreover, plausible as it seems, the general advantage of the clearing system with us does not lessen, it rather increases the amount of circulating coin. True, if the London bankers went back to the old semi-barbaric system of carrying about notes or gold from one to the other, two or three millions more of money would be required: but by way of set-off it must be mentioned that since the perfection of our clearing system from 1844 to the present date, the circulation of actual money has increased by about £40 millions in gold and several millions in silver and bank notes—proving the rule that an improvement in one of the essential factors of commercial intercourse brings about better efficiency and an enhanced use of all the good factors of a system.

I allude to these more or less thoughtless sayings, in order to show you that they are quite inadequate to meet this case; but even if they were available, and could now be made so, they could not compensate for the "negative" involved in the demand of £150 millions upon the stock of gold. This matter remains distinct. The enormous increase of transactions and commerce since 1848 is mainly due to the continuous supply of the medium of exchange with which the labour markets have been set in motion; it is a matter of proportion in numbers. Here, then, we must face the prospect of a re-distribution and consequent proportionate lessening of the numbers involved on the one side of currency. A prognostication

as to the extent to which the whole adjustment will change, as regards prices, production, and mutual change, cannot be definite. Some conclusion might be founded on the amounts involved in the production of gold, which is now lessened, not only actually, but still more so by the lesser annual percentage on the larger stock in hand.

And from the point of the much greater extent of transactions, and their progressive reduction, the present international indebtedness acquires increasing might. In the history of commerce of former times, the indebtedness of nations seemed overwhelming, when it was expressed in millions of francs, roubles, or florins; these millions are now as large in pounds sterling. It is impossible that these nations can continue to be the bond-slaves of others, by way of annual tribute and industrial inferiority, by over-issue of paper. If hitherto they have been able to keep above absolute ruin (above the abject fate of Turkey), it has been so because there was sufficient social and political strength to spare, but the abstraction from that strength is nevertheless a fact. It is a significant fact also, that whereas since 1848 the increase of gold has almost entirely gone into the hands of internationally wealthy nations, the indebted nations have in a far greater measure increased their obligations and their paper currency, *i.e.*, instead of participating in the increase of actual money, they have widened the gap. The statesmen and social leaders of these nations, like those of America, instead of teaching all classes that a policy in favour of abnegation and encouragement of industry is the only one which can liquidate the indebtedness, have paraded "the resources of their countries and the prospects of the future;" but this must now come to an end. The tables which I have submitted to you before show how slow as been the recovery to specie payments; how at the present time, after so many years, it drags its slow length along, especially in America and Austria. They are evidence of the increasing difficulty, and lead to the suspicion that some untoward event or revolution in the present general financial situation may arise, which in some way or another, will *nolens volens* expedite the process, for the good or the evil of the prosperity of these States, and that of the commerce of the world at large.

The objects for which this part of the treatise has been written will now appear. That which has been said regarding the subtle causes which constitute international wealth and international indebtedness affords, at all events, some figures which can serve as a guide for holding in bounds the wide-mouthed phraseology which is so often inapplicable in cases of this kind. The distinction drawn between capital and currency may show that the office of the latter is one which can be defined in clear terms. It proves that the mere question of currency, in the first instance, is one of inconvertible paper issue against metallic money. In the second instance, the question of metallic currency is eminently one of due proportions or numbers, without reference to the one or other metal in use as money; for whether, for argument's sake, the amounts given before in gold, were stated in silver, that would make no difference in the general result so far. Lastly, it may have been shown that the "depreciation" of a nation's currency is in itself not only a consequence of evils, but becomes in itself an obstacle to recovery. And whether this weakness or depreciation of a currency is due to over-isue, or whether it is raised, as in the case of India and the silver-valuing States generally, by a league, so to speak, of other nations against silver, it is the most damaging thing that, short of conquest and slavery, can happen to the prosperity of a nation.

Beyond this, however, the subject of the recovery of specie payments by the States named, and the question of international indebtedness, can now at once be connected with the subject of silver, and one important conclusion drawn to save time hereafter. The question may be asked,—

"Why do the over-issuing States, instead of trying to restore their metal basis by gold, not take silver for this purpose? Silver has now fallen in price; they can have it on better terms than formerly; and the United States, for instance, might retain their large silver production, instead of exporting it."

This apparently rational and reasonable suggestion must meet at once with this categorical answer:—

"So long as these internationally indebted States have the balances of trade against them, they cannot import or retain either gold or silver—however cheap the one or the other may be; they must export both."

Further,—

"Whenever the balance of trade at some future time does turn in their favour, they would be bound to exercise its right in favour of that material which all other nations use; and if that material is then gold, they must also take it and reject silver!"

To these conclusions we must come, but they are only two of an especial bearing, spoken of here, in order to clear the way for many others resting on first principles—which may be gathered from the next following part of this treatise.

Part II.—*The "main question" of the valuation and its present evil position.*

The main question involved in the demonetisation of silver has recently attracted public attention in England, because the fall in the value of that material and the Indian exchange, to the great alarm of Indian interests, brings it under our consideration.

But India's interests are only a part of the general question, there are other nations dealing in silver, or in gold and silver combined; and further, the interests of all nations, including those dealing only in gold, are bound up with it, and the latter part of the inquiry will be found to be the most important.

What does the demonetisation of silver mean? For the information of those not already familiar with the principal facts of the case, the following remarks may be useful:—

Gold and silver have served as legal tender money from time immemorial; that is to say, payments to any extent could be legally made in either the one or the other material in proportions of weight to value, which, either upon real or assumed difference in degrees of "nobility" between the two metals, or according to national practice, influenced as much as necessary by inter-

national practice, assumed a definite figure in the coinages. Although these proportions differed at various times in different countries, within a few per cent., they may be stated as one part of gold equal to 15½ parts of silver. Until the beginning of this century silver was the principal standard for legal tender.

The French, during their great revolution, adopted both metals as legal tender in the precise proportion of 1 to 15½. France, Belgium, Italy, and Switzerland, in 1856 formed the so-called "Latin monetary union," confirming these proportions; and a few other States placed their valuation upon the same footing—the so-called gold and silver valuation.

In 1816 we in England adopted gold as the only legal standard, assigning to silver coins the office of change, or divisionary coin, limiting its tender to £2 in amount. The motives of this change in England's system were founded on a controversy which originated last century, and after the continental wars it appeared proper to the statesmen of the time to choose a valuation based upon one metal only. The propriety of this step is what we shall have to consider, at least in its relation to the present position of matters; whatever it may have been at that time. Other States, Portugal, Chili, Turkey (before 1870—and others since then), joined what is thus called the gold valuation.

In Germany and other States, the silver valuation continued. That is to say, the principal medium of exchange consisted of legal tender silver coin, besides what is called silver change, and gold coins are held at a market price, *i.e.*, everybody could give for them what was agreed on between buyer and seller. India and the East generally adhere almost entirely to silver. The States of this category were on the silver valuation.

Three principal groups were therefore formed, and existed in 1870 as—

In Metallic Currency,

ENGLAND, Portugal, Chili, Australia	the so called gold valuation.
FRANCE, Belgium, Switzerland, Spain, New Granada, Ecuador, Peru	the so-called gold and silver valuation.
GERMANY, Holland, Sweden and Norway, Denmark, Mexico, Central American, INDIA AND CHINA	the so-called silver valuation.

To this the fourth group must be added, which, belonging to either one or the other metallic group, in reality have—

No Metallic Currency.

Turkey, Brazils	Gold	having an inconvertible paper valuation at present.
United States, Italy, Greece	Gold and silver	
Austria, Russia	Silver	

The characteristic of the gold valuation as regards silver is, that for the purpose of making gold the effective legal tender, the tender of payment in silver must be restricted. Thus, whilst gold coin in England is legal tender to any amount, silver is restricted to payments up to £2. The effect of this limitation is, that comparatively little silver can be used; and so, whilst our total circulation is £162 millions, there are but £15 millions of silver. And more must not be coined for the time, because the circulation cannot take more under the above condition of tender. It is often the case now, that large sums in silver collect in the hands of bankers, and lie there idle at loss of interest to them. At the same time, such surplus amounts cannot be exported, because, just in order to avoid any exportation of the already limited amount to the great inconvenience of trade, the silver coin is issued under value—that is to say, it is coined at 66d. per oz. standard, whereas the proportion of 15½ to one of gold, gives 60⅞ pence, so that there would be a heavy loss on export. Hence our silver coinage is token money, and at the present price of silver of 53½ pence, a shilling of the nominal value of 12d. is worth about 9¾ pence in metal.

It is most essential that this characteristic of the gold valuation should be borne in mind. Most people, seeing that we use both gold and silver coin, as is done elsewhere, imagine that the conditions of their use and value are alike, and derived from the natural laws of value implied. But, as here shown, our silver coin not only lacks the element of legal tender beyond payments of £2, but must of necessity become undervalued, and what is more important still, its use is limited to a per-centage of but 10 per cent. in the total circulation. At the first glance this result, viz., the proportion of 10 per cent. to which silver can come into use in the gold valuation, appears to be a natural settlement, by way of the ordinary laws of supply and demand. But this easy view requires a modification, for it will be seen that the laws of supply and demand, as they are generally understood to be free of shackles, are here hampered by an actual law in the legislative sense, which forcibly restricts the use or demand, and deliberately deteriorates the quality, of the supply of silver coin.

Our English metallic system therefore consists of—

GOLD VALUATION.

Gold coin of full value and legal tender.

Silver coin of debased value and restricted tender, besides the copper token coinage, of which we need not take note, as it forms only about 1½ per cent. of the amount of the total circulation.

The characteristics of the gold and silver valuation, as exemplified by France, is that both gold and silver coins (excepting the smaller divisionary silver coins) are legal tender. Payments to any amount may be made either in gold coin or in five-franc silver pieces. The great stock of legal tender money, therefore, consists of gold and silver, the silver pieces below 5 francs only holding the position of subsidiary and debased coinage, limited in tender. A 5-franc silver piece, at the rate of 15½ to 1 in weight of gold, is worth fully 5 francs.

The French metallic system, therefore, consists of—

Gold and Silver Valuation.

Gold coin of full value and legal tender.

Silver coin of full value and legal tender.

Silver coin of debased value and restricted tender; and the lower subsidiary copper coinage.

The characteristics of the silver valuation, as until lately represented by Germany, and still by India, are that gold coin, although used to a certain extent, is not legal tender, but that full valued silver coins occupy the same place and position which gold coin occupies in England, and that only the smaller silver pieces are under value, as token coins and under limited tender. Thus, in all countries where the silver valuation prevails, the bulk of the current money is in full valued silver pieces, thalers, florins, silver dollars, roubles, rupees, &c., and only their subdivisionary pieces are what we should call change.

The metallic system of Germany consisted (1870) of—

Silver Valuation.

Silver coin of full value and legal tender.

Gold coin of full value, but not legal tender.

Silver coin of debased value and restricted tender, and a copper coinage as everywhere else.

Representing the cases by percentages (without accuracy, and including the bank-note issues of wealthy States as good money), the positions may be indicated as follows:—

Under the gold valuation there are in a country—

88 per cent. of gold coin, legal tender.		
10 ,,	of silver coin	token coin.
2 ,,	of copper coin	

Under the gold and silver valuation there are—

60 per cent.	of gold coin	legal tender.
28 ,,	of silver coin	
10 ,,	of silver coin	token coin.
2 ,,	of copper coin	

Under the silver valuation there are—

75 per cent. of silver coin, legal tender.		
13 ,,	of gold coin current, but not tender.	
10 ,,	of silver coin	token coin.
2 ,,	of copper coin	

The total amount of metallic money in 1870 (since which about £50 millions of gold have been added) may be stated at—

Gold coin and bullion....	£700 millions.
Silver coin and bullion ..	650 ,,
Total	£1,350 ,,

And its distribution at that time, stated (without absolute accuracy) in the table at the head of next column.

On the whole,* the form in which the matter is shown in the table illustrates the position suffi-

	Gold.	Silver.	
	Coin & bullion. Full value.	Coin & bullion. Full value.	Subsidiary coinage. Debased value.
England	£130 millions.	£— millions.	£15 millions.
France	260 ,,	70 ,,	14 ,,
Germany	30 ,,	60 ,,	16 ,,
Belgium, Holland, Portugal, Denmark, Sweden & Switzerland	40 ,,	45 ,,	10 ,,
The rest of Europe and indebted States	60 ,,	30 ,,	25 ,,
Total in Europe	£520 millions.	£205 millions.	£80 millions.
United States	30 ,,	— ,,	5 ,,
Other States in America, the Colonies, and generally distributed	140 ,,	50 ,,	10 ,,
India, China, and the East...........	10 ,,	250 ,,	40 ,,
Accession since 1871	50 ,,	— ?	— ?
	£750 millions.	£505 millions.	£145 millions.

ciently for the purposes of this inquiry. What is of interest here concerns the £505 millions of full valued silver coin, and the prospect of their continuance, or the modification they must undergo in view of the demonetisations of silver now commencing, the fall in its price, and the inevitable further decline in value.

So far as can be inferred from the statement, the general value of silver had been maintained, because although the nations were divided into the three metallic groups, these three groups between them nevertheless upheld the employment or demand for gold and silver fairly alike. But now Germany has overturned the balance, and instead of an absorber of silver it has become a seller. What is the effect of this on the three groups?

To us in England (if we leave India out of the question for the moment) it would appear at first of no consequence, for Germany cannot sell silver for circulation here, and must pay us for gold in another acceptable equivalent. Therefore, on the mere question of exchange, we suffer nothing (whatever we may afterwards undergo in reference to prices generally is another matter). And on the whole the fact that Germany and other nations adopt our own system of gold valuation seems rather flattering to us.

But with the nations of the gold and silver valuation the case is different. Certain economists, and the new German professors of monetary

* These estimates may not quite correspond with recent publications, especially those emanating from Germany, and based principally on the coinages made. It must be remembered that a good deal of both gold and silver coin is held (and hoarded, perhaps), in the internationally poor States. (Russia, for instance, holds between £20 and £30 millions of gold at present.) The late German returns, in order to make out all they can in favour of the policy of the Government, allege that there are now but £22 millions of silver to spare in Germany, leading to the supposition that there were less than £60 millions before 1870. But it must be stated that, firstly, the Prussian Bank, Hamburg, and other banks very wisely made timely sale of their silver bullion; secondly, that among the silver current before in Germany there were many millions of five-franc pieces, Dutch and Austrian florins, and other foreign coins, since then driven out by law; and thirdly, that under the enforcement of the law of tender, Germany may find that it has yet £30 millions or more of silver to sell. It must also be mentioned that the estimates of subsidiary coinage given in the table do not correspond with what is usually returned by the coinages classed as such. For in different countries, the level at which debased coins of that kind commences, varies; we in England, for instance, commencing with the 5-shilling piece, France with the 2-franc piece, and elsewhere (Germany) the pieces as low as 6d. were formerly full valued. I have therefore discriminated, and under the column of subsidiary silver coinage, stated the maximum amounts which might be considered as required to act in that character. I mention this in order to guard against certain differences of opinion which prevail on the quantities generally; and in discussions of this kind somebody may get up in order to show you that I am wrong in the one or the other detail, and consume much time in tinkering at these figures. You will find that whatever deductions from or additions to the figures some one may make within reasonable bounds, the main principle involved remains the same.

economy, assumed that even if Germany did adopt gold valuation, other nations might still retain their systems. Others (among them myself some seven years ago) pointed out this could not be. For it is obvious that if France, for instance, continued to value both gold and silver, the Germans and others would pour their silver bullion into the country and take away the gold. In order to avoid this game of "beggar my neighbour," France, together with Belgium, Switzerland, and Italy (the monetary union of joint valuation) has already been compelled to limit the coinage of five-franc pieces to an amount which is practically tantamount to a speedy cessation of the use of silver. But this is not the only consequence, for France must also endeavour, later on, to dispose of its silver to somebody else; for in the face of the rapidly falling price it cannot maintain its present stock as legal money, and cannot convert it into change; for it already has a sufficient supply of subsidiary coin.

The silver-valuing States of Europe are even in worse plight. They have no gold, or very little, and their silver coinage would not only be excluded from the rest of the world, but threatens to become altogether unavailable for the acquisition of gold. They cannot make use of their legal tender silver coinage for the purposes of change, for it is far too large, even if such subsidiary coinage did not already exist as it does in abundance. And I refer to this question of the subsidiary silver coinage again, because many of our own people are apt to suggest, "Why don't they use silver coin as change like ourselves?" ignorant of the primary law of the gold valuation, that under it a silver coinage becomes a depreciated token, and cannot circulate but within narrow limits. Thus Holland, one of the silver-valuing States, has recently been compelled, upon the threatening change in Germany, suddenly to stop the coinage of silver, and the Dutch exchange is now quoted in gold, though very little gold has yet been coined. Holland indeed stands on the brink of a precipice in this matter, together with other silver-valuing States. For the question generally is as yet on the balance, Germany has promulgated the gold valuation on the 1st January, 1876, but proceeds but slowly with exchanging gold for silver, and does not press its sales of silver at present; its financial *savants* imagining that they can for some time longer foist the silver currency, depreciated by their own act, upon the people, whereas this will only have the effect of driving gold away as soon as it enters circulation; and the withholding of the stock of silver at a loss of interest cannot avoid or even modify the inevitable result, that Europe must demonetise £200 millions of silver.

What then is to be done with the £200 millions of surplus silver in Europe? The suggestion may be made, "Let plate, utensils, knives and forks, be made of it." If people have any desire to use more silver for these purposes, they can do so now to any extent, by paying the present price; and only in the event of a very great fall in the price, say by 50 per cent., would any more extended use be made of it, but far below so large a quantity as represented by £200 millions.

It might then be said, "Oh, let the internationally poor nations take it, to use it as specie!" Independently of the fact that they can give no gold in return, none of the internationally indebted States can take either silver or gold, as shown in Part I. of this treatise, until the balance of trade turns in their favour. They cannot take silver even by way of further loan. Prussia, two years ago, endeavoured to contract with the Austrian Government for a loan at a certain rate in silver. All was arranged, when suddenly the Austrians found out that if they took the silver at any price they would almost immediately be compelled to export it at a still lower one, and so they declined the transaction. And it will be obvious to you that when an indebted State recovers its balance of trade, it will have the right to ask for gold, for if it took silver at a comparatively cheaper rate, it could not possibly maintain a coinage based upon the old value.

It might then be suggested, "Let India and China take this silver, they can absorb any quantity!" People will make such assertions about "any quantity," because they have no idea of the figures involved. Independently again of the question that India cannot return gold for silver, it will be evident that India's capacity for taking more metal depends on the balance of trade, and however low the price of silver may be in Europe, India cannot take £1 more unless the balance of trade allows it. Now it is true that India has absorbed a great deal of silver, and although during this century the current of trade has been once or twice in favour of Europe, yet a definite quantity has been absorbed. The yearly exports of silver to India reached their highest points between 1850 to 1866, when at one time, as much as £15 millions per annum were sent, the average of the period being £7 millions. But this very period was a most exceptional one. It was contemporary with the accession of gold in Europe, and an enlivening of commerce generally, in which the East took its share in silver. During the time also the Mutiny occurred, our Government sent out large sums of money for railways and other enterprises, and the American cotton famine benefited India. Since then, the export of silver to the East has much decreased. Naturally, the investments made by England begin to return an annual interest now.

It may not be generally known that some time ago the German Government, after its failure to contract for a silver loan with Austria, endeavoured to induce our India-office to take a large amount of silver (£15 millions) at a fixed price. The negotiations became serious, but our Government found out in time that under the then existing balance of trade with India it could do better in another way, so avoided a transaction at which everybody would have laughed.

And it will be readily conceived, that the balance of trade cannot permanently be in favour of one country, without causing an augmentation of currency, which must inflate prices, stop export, and encourage import. For this reason also it is impossible, again, that one part of the world can deal in silver and the other in gold; the exchange could not take place. As regards the passion of the Indian people for "bangles," the same argument applies as that before advanced for "spoons and forks" in Europe; nothing stops the people now from getting as much as they want, the

cheaper price for silver would not dispose of any sensible part of the surplus, and—notice this particularly—a serious fall in the value of silver would destroy its use as money upon the present basis, and also deteriorate its appreciation for bangles.

But let it be supposed, for argument's sake, although contrary to the nature of trade, that India and the East could absorb, say £6 millions per annum for currency and bangles. The annual production of silver from mines may be stated at a minimum of £16 millions (of which the United States furnish £8 millions, and some authorities place the total annual production as high as £20 millions). Formerly this supply was divided between Europe, America, and the East, but now Europe not only ceases to be a buyer, but is on the point of offering £200 millions, which even if they could be kept without interest during 20 years, which they cannot, would give a total supply of £26 millions per annum, against the supposititious case of the East being able permanently to take £6 millions per annum.

It follows, then, that India and the East cannot absorb but a limited percentage of the amount at best. If large quantities of silver were sent to India, the value of the rupee would still more sensibly decline than it has already. But even without such additions, the Indian currency must lose its international value. Strong, then, as the prejudice of the natives may be in favour of the material (as it has been in Germany and Holland), they may find out, before we are aware of it, that they must take to gold, and the efforts which our Government makes in bringing gold into recognition, and in issuing bank notes, may suddenly destroy the present valuation. What is then to become of the £250 millions of India silver currency, in addition to the £200 in Europe and the new supplies?*

The supposition, that on a fall of the price of silver, silver mines would lessen their production, applies only to the very poorest ores; but the great bulk of the production is from rich ores, and would pay at any price. At some of the silver mines the production only costs eighteen pence per oz., but, if as must be expected, all prices of commodities fall, the cost of production from the poorest ores will also lessen, and pay again well. But mark the remarkable nature of such a weak argument as to a possible reduction in the production; it is based upon a serious fall in the price of silver, tantamount for its enforced demonetisation, viz., the very thing which we must regret and guard against at all hazards.

For—and this carries the case of the decline of silver to a further contingency—if the price of silver falls much lower, it will not only cease as legal tender money, but it will also be impossible to maintain it as material for the subsidiary token coinage. If at the English minting rate of 66d. per oz., and the former market value of 61d., there was a margin only of 5d., or say 9 per cent. to the State, no counterfeit coiner would make sufficient profit under the limited tender of £2 per payment, for he could not pay away enough per day to make it worth while to bear the risk of discovery. But the present decline to 53½d., already makes that profit 3s. per £1; and if the price falls lower still, there being no difficulty in imitating the stamps of the Mint (and keeping the dies in the pocket), coins may be made by others than the Mint, of precisely the same metal, the test of the metal, the only one available, being thus lost. The penalty would not rest on the use of baser metal, but on an imitation of the Queen's dies only, and this would be difficult to detect. Now if a counterfeit coiner can easily be found out when he uses inferior metal, and punished accordingly, it would at least seem singular that when he uses the same metal, he should be equally liable. True, the offence, so far as the law is concerned, which permits no one but the Crown to coin, and the penalty against counterfeit coiners, might be enforced all the same. But even the criminal law should not, and practically cannot, be made to cover cases, which by another law, as that of the token coinage in this case, hold out a most deliberate temptation. This danger would become imminent, and might ultimately enforce the abandonment of the use of silver altogether for the purposes of change in its present form. But even if the pieces were made heavier (contrary to the objection raised against the general use of it on account of the weight) the decline in the value would remain indefinite.

Having laid the case before you so far, you will probably admit that the fall in silver is inevitable. The losses which the nations who now hold silver must experience may appear very serious to you. But the losses to such other nations are but the smaller portion of the evil. Germany, for instance, has £30 millions yet to dispose of. It has also received during the last five years £250 millions from France in money and valuables. That is sufficient to cover the loss of the £30 millions, even if they were made into spoons and forks for mutual presents, or converted into a column of victory of solid silver 100 feet high and ten feet in diameter. With other silver-valuing States the case is already more serious, for they have not received £250 millions; but Holland, for instance, is an internationally wealthy country, and if it came to the push could lose £4 or £5 millions in order to obtain gold. India, however, is not an internationally wealthy country, and the question, "who will take the £250 millions of silver and furnish gold for it?" is one that must be based on considerations even far beyond the fiscal or national loss to which India would be exposed.

For serious as all this is, the far greater damage would be done to all nations, including, of course, ourselves, by the inevitable fall in prices all over the world, enforced upon ourselves by the re-distribution of gold, of which we must surrender a share, and by the case generally, beyond this necessity.

I have stated before that the internationally indebted nations may require £150 millions by way of the demand for specie payments. Now, here it may be mentioned, that when in 1816 England

* So desperate a question has lately even led to the suggestion that the United States should rescind their resolution in favour of gold, and adopt silver for specie payments, so that they might enter into closer relationship with China and India for the special advantage of American, and to the exclusion of European produce. Independently of the fact that, even in that case of union between the extreme east and west, the supply of silver would be extensive, independently of the impossibility of separating the world into two irreconcilable halves of valuation, I must remind you that the United States can do nothing until the balance of trade is in their favour, and so this proposal must at all events be postponed, with or without reference to its practicability or absurdity.

resolved to adopt gold as a standard, whilst all other nations were most willing to accept silver, it took more than three years before a sufficiency of gold was acquired by England. The comparatively lesser amount of gold then in the world is fully balanced by the great increase of population and commerce since. And now there are four large States in the field, and all the nations threaten to repudiate silver; what will be the difficulties now, and the degrees of force required to overcome them?

But this is again but part of the question; the effect of the total requirements for gold in substitution for silver and for specie payments on the world at large can be stated as follows:—

There are now in the world in full legal tender money—

In gold coin and bank bullion......	£750	millions.
In legal tender silver in Europe and elsewhere	255	"
In legal tender silver in the East ..	250	"
Present total of legal tender metallic money	£1,255	millions.
besides in silver tokens........	145	"

Now if the £505 millions of silver are demonetised there will remain—

Future total of legal tender metallic money	£750	millions.
If from this is deducted the amount required for the recovery of specie payments......	150	"
there remains	£600	"

in the hands of the other nations instead of the previous £1,255 millions.

It might be said that this states the case in an extreme aspect, but in reality it is not yet the most extreme that can be stated, for there are yet the £145 millions of silver change, whose maintenance is in jeopardy by the fall in the value of silver. And if the bank notes, not issued on bullion, of civilised internationally wealthy States (England, France, Germany, Holland, Belgium, &c.) be taken at £135 millions, and those of the over-issuing States at £480 millions, the former, on the lesser bullion basis, might decline by say one-third, the latter by one-half.

The full statement might then appear as—

Gold coin legal tender money	£720	millions.
Silver coin " " "	505	"
Silver subsidiary coin	145	"
Bank notes of wealthy States	135	"
Ditto of over issuing States	480	"
Total money now in use	£2,015	millions.

The future available legal tender money, however, would consist of—

Gold coin legal tender money	£750	millions.
Silver change..............	—?	"
Bank notes of wealthy States	90	"
Ditto of indebted "	240	"
Total money in future use ..	£1,080	millions.

The matter must be reduced to this point in order to show that it allows plenty of margin for modification. And so, whether it be deemed that India will not be compelled to give up her silver valuation, that the silver change will not also become impossible to maintain—that more bank notes will be issued—although all these modifications are contrary to the absoluteness of the laws of equilibrium, there remains sufficient negative to raise the question, "What will be the effect of these reductions in the circulating mediums on prices, on commerce, and on civilisation?" And this, as I have said before, is the far graver part of this inquiry; exceeding in gravity the mere fiscal or national loss which the silver-holding nations would experience, if by some stroke all the legal tender silver they now hold were to vanish away bodily.

Some guiding idea for the appreciation of this effect might be formed on the experience made in the other direction, viz., the rise in prices, and extension of commerce from 1848 to 1872. Since 1848, when the total metallic currency of the world consisted of—

Gold coin and bullion........	£400	millions.
Silver coin and bullion, including subsidiary coinage..	600	"
Total in 1848	£1,000	"
The new supplies from California and Australia, and in gold converted into money (besides jewellery), amounted to up to 1875	£350	millions.
and in silver, about........	50	"
Total in 1875	£1,400	"

an increase of 40 per cent. in 27 years.

During the same period, also, the world's progress and development of commerce have made great strides. Our outward trade has increased from £165 millions in 1848, to £682 millions in 1873, and this more than fourfold increase has been participated in by many nations. In all directions, in banking, insurance, manufacturing, and commercial matters, in the comparative well-being of people, the progress of civilisation, the increase has been most marked. Now it may be alleged that this general fourfold advance is due to the great development of machinery and inventions, but be it remembered that the chief inventions (such as steam) were known and utilised for many years before. It was the supply of actual money which gave this extraordinary impulse to the utilisation of inventions, for it furnished the means of stimulating the labour market both for production and consumption. And all the features of the case as depending upon "the number" of pieces of money equitably obtained, in their relation to higher prices, to more production and consumption, are in accord with the truth that the legitimate basis of prices rests on the factor of actual money, or means of contract in the wider and the particular sense. Hence, not only the ordinary industry and intercourse became enlivened, but public works, railways, were stimulated in all directions.

The question here now is:—

"If an addition of 40 per cent. to the existing stock of money, from 1848 to 1876—*i.e.*, in 28 years—has so materially (fourfold) advanced progress in commerce, if all contracts now rest on the basis of prices thereby established, what will be the consequences, if that stock of money becomes reduced in the manner the change in the systems of valuation must bring about?" If, then, the

most extreme estimate made before, of a reduction from £2,015 millions to £1,080 millions, equal to 100 per cent. upon the remainder, be taken as exaggerated in the proportion of 2½ to 1, it would still yield the full negative to the previous increase. The same would be the case on the mere metallic basis of £1,400 to £750 millions. And, above all, this must be borne in mind, the increase of 40 per cent. from 1848 to 1875 occurred year by year in a more or less regular ratio during twenty-seven years. This matter of the diminution of silver, when it has once started over the precipice, is a more violent one. The event must come with great rapidity, as the great fall in silver during the last few months foreshadows. For when once the decision for the gold valuation is taken by a State, no transition period can take place without seriously hampering the acquisition or retention of gold. The law of limited tender for silver must come into force at once, and thus throw the masses of legal tender silver out of use immediately.

On whom rests the responsibility of exposing the world to this precarious state and its dire and immeasurable consequences, but on the reckless advocates of the gold valuation?

In submitting these considerations, it is not my object to re-open the discussion on the gold valuation *versus* the gold and silver valuation. That controversy has reached a stage in which the disputants have called each other "fanatics," and our advocates in favour of the gold valuation are rather pleased at seeing that the current in Germany and elsewhere has apparently turned in their favour. But I permit myself here to place one matter before you bearing on this controversy.

The minor objection to silver on account of its greater bulk and weight, of which even Indian officers have complained when in charge of transports, is now removed by the use of steam and railways, and the coin in the hands of the people is of no greater weight than the silver tokens.

The main argument used in favour of the gold valuation is this:—

"If a creditor, having stipulated for a fixed payment, may be paid by the debtor in either gold or silver, the latter chooses the material which comes cheapest to him, and the creditor suffers an injustice." Without inquiring whether the creditor, on entering upon the contract, also exercises his option in furnishing the debtor with either material, and therefore cannot claim another treatment—without inquiring whether, as he can also part with the material received on the same terms, and must do so, I can show you that the dogma is one untrue both in practice and in theory. From the statement on the methods of settlement before submitted of the various strata of intercourse (see Part I. p. 310), you will be confirmed in the view that the large business of exchanging contracts, as well as all such dealings in capital and commodities, in which the "creditor" stands in the position assumed above, is carried on by accounts, cheques, and clearing systems, without the use of any currency; and so the great system depends upon the exchange of equivalents of value alone. The currency is required only to be in accord with the strata which cannot be settled by these methods, where pieces of money must convey the contract from one to another; and its level is a question of proportions of numbers only, the due proportions forming the basis of prices in accord with the upper strata. It is, as the French so characteristically say, the question of *numeraire.*

And where, as in the case of the gold and silver valuation, both metals have a fixed value of say 1 to 15½, whether the justice of this proportion be founded on first principles of practice, or is confirmed by law, whenever either of the metals appears in the form of coin, there can be no question of any difference or disproportionate "cheapness" between them. The debtor, in order to obtain either gold or silver coin, must render up the same equivalent for either. In reality actual money does not even affect the settlement of contracts before the courts of law; the settlement is effected by cheques and otherwise. The term "legal tender" arose practically in cases where, in order to prove willingness to settle a dispute, the one party offers, in his open hand, gold coin or Bank of England notes, taken for a moment only from the circulation.

If during the time the contract between creditor and debtor lasts, the State should decree a change in the valuation from gold to silver, or *vice versâ*, the debtor would be bound to pay the creditor in the new legal tender. If any creditor, on receiving a payment in cash, either gold or silver, chooses to withhold it from the circulation, he either converts it to some other use, or does a thing which, although he has the perfect right to do it, is not in accord with the rules of commerce. But even in that event, if he chooses to withdraw it, with a view of returning it to the circulation hereafter, he does not even run the risk of a change in the valuation decreed by the State during the period he thus chooses to hoard the money, for the State would give timely notice of the change, and effect it at its own charge. You may, therefore, not consent to judge this case by what may be called the foolish humour of a creditor; the great intercourse of the world is not conducted on fancies and remote contingencies which are without the range of reality.

And here a singular characteristic may be pointed out as regards the action taken by certain statesmen and economists upon this unreal doctrine on which the single valuation chiefly rests. The controversy on the point arose in England during the last century, and in 1816 gold was chosen as the valuator, because the practical state of matters then tended to show that gold was likely to become more scarce. If the authorities of that time had known of the prospect of the Californian and Australian gold-fields, would they have chosen gold? The question is thoroughly legitimate, because, when the second phase of the inquiry arose, through Michel Chevalier in 1858, that economist actually recommended the demonetisation of gold; and nothing is more significant of the looseness and baselessness of the above-mentioned theory than the fact that this gentlemen has since turned his coat in favour of the demonetisation of silver.

This looseness or contradiction of purpose is absolute proof of the nonentity of truth in the dogma founded upon the former fluctuations between gold and silver. The advocates of the dogma are apt to cite, for instance, the example of the United States, where under the previous

valuation the American silver dollar rapidly disappeared. This was owing simply to the fact that America had coined that dollar in the proportions of value of 16 parts silver to 1 gold, whereas elsewhere that proportion was $15\frac{1}{2}$ to 1, or 3 per cent. better. Of course the dollar was exported at this profit and recoined abroad. The example is also quoted of France, which parted rapidly with its silver to India, against gold from England, in payment of English balances of trade to India. Situated between the gold valuation of England and silver valuation of India this was but natural, but France only profited by it, and lost none of its real metallic strength.

If all nations were to agree upon the proportionate value of gold *versus* silver as 1 to $15\frac{1}{2}$, they would certainly be in accord with the average from time immemorial. The occasional unimportant fluctuations were due to want of agreement and insufficient international intercourse of former times. If, upon the plain truth that all substances derive their intrinsic value from their chemical "nobility," and complete fitness for specific purposes, the practice fully confirms these proportions, any supposed influence of force of supply and demand in either direction can well be kept under control by a general understanding based on law. For the main force here operating is always that of demand, the fluctuations in the prices of commodities represent the matter of supply against the number of pieces of money. And the denial of this effect and continuous force of demand on the part of the advocates of the gold valuation is a curious feature. As we now see, the very first step towards the demonetisation of silver, brings with it a great fall in its value. Is this not evidence, that if such as yet slight cause has so powerful an effect in the one direction, the actual law must on the whole have a force far superior in the other, in the maintenance of the just balance? Yet so infatuated are the gold fanatics, that, after having partially succeeded in turning the law against the demand for silver and debased its value, they now say: "You see silver falls in price, the demand is lessened, and so we are right in recommending the gold valuation!"

Where are the statesmen who will rescue the world from this fallacy? Nowadays the international interests are in closer relationship to each other than were formerly the provinces of a single nation, and statesmen and economists begin to see, that however "national" must be their individual tendencies, yet that this national interest itself is dependent on the cosmopolitan welfare. And here in this question of the valuation stands the dogma founded on the theory of wrong which a creditor is supposed to suffer from the employment of both gold and silver as legal tender money, as that on behalf of which all this "negative," all this destruction is to take place. Is this dogma a true one, founded on real practice and theory? This is the point which statesmen and economists must examine, the general public and phraseologists cannot deal with it, it is a matter where the *noblesse oblige* must come to the rescue. Such nobility of intelligence must not only be able to deal in first principles generally, but must consent to look at figures and proportions, as the necessary offshoots of principles, the practical machinery, without which first principles cannot be made available. In order to show you what I mean, I may be allowed to mention that a little while ago I had a visit from a statesman (not now in office) who wanted to discuss this subject with me. The gentleman was full of phrases respecting supply and demand, but was unable to deal with other practical matters resting on equally important first principles. I put figures before him, asking him to explain to me, for instance, how India could get rid of £200 millions of silver, and who would furnish the gold? This was "going into details," and finally he exclaimed, "If the silver States and India are forced to sell their silver, they must get something else instead of it, that is all I can say about it!" I agreed with him that that was all he could say about it. But you may agree with me, that something more than this style of thing is required in this problem, for unless that is speedily done, the consequences of the present conflict will become uncontrollable.

The first effects of the enforced diminution of the number of pieces, through the demonetisation of silver, of legal tender money in the world, will be the stoppage of works of public utility in which the combination between capital and labour has done so much during the last twenty-five years. Simultaneously, the availability and value of labour will decline, and wages as well as the production and consumption will become less. Now there are some people who will regard this effect upon labour as a deserved punishment for strikes, and as a check upon the wise or unwise methods in which labour has striven to secure its interest. That view is a blind one, for in this case the wealthy will suffer an equal deduction. The value of all property, lands, houses, and commodities of all kinds, must also decline, and so the rich will suffer equal loss.

But there is one class of the "wealthy," which, at the first glance, would seem to benefit by the decline in prices; namely, that class which derives an annual fixed income from the fixed investment of capital, or by way of annual stipend or salary. A clear distinction must be drawn between this and the other wealthy classes. The latter, the majority, hold their property free, subject to rise or decline of prices; the other, the minority, have engaged their capital at a fixed return by way of interest, or contracted for their years of life by way of fixed salary. It may, perhaps, be remembered that when the Chevalier controversy on the supply of gold arose, this very subject came to the foreground. It was then said that, because the prices of goods had risen, the value of money had declined—that the fixed income had lost part of its purchasing power. This is in accord with the whole theory that prices rise through the acquisition of more actual money; and so, through the contemplated reduction in actual money, the fixed income must derive great advantages at first. But the advantage does not stop there. For what may here be overlooked, is that by the same theory the advance in prices enhanced production in a much greater degree, and so has brought prices down to their previous level. Proof positive of this rule is furnished by the fact that with the exceptional reasons, the majority of all productions, especially the staple goods, have regained the basis before 1848, and many are even lower in price.

In the case of salaries it is an undisputed fact

that on the pleas advanced of higher prices, they have been materially increased. Unfortunately, the problem here in hand is one much under the control of Government officials, who, without wishing to do wrong, see matters in their own light. But if they, at the expense of the great commonwealth, the people, the industrial, and commercial, and the owners of saleable and valuable property, on whose well-being and tax-bearing capacity their incomes are after all dependent, derive such advantages, the case looks very much like starving the goose which lays the golden eggs.

The cases of fixed interest derived from capital offers still greater anomalies. The whole of the investments in State and other obligations, in mortgages and advances on property, during the last 25 years, have been increased and enlarged upon the basis of prices established on the £1,400 millions of currency (leaving out of the question the inflations by paper currency previously spoken of). If then upon so enormous a reduction in current money as the demonetisation of silver will bring about, all prices must fall to a considerable extent, it is so obvious that the advances made upon property cannot be liquidated, and that capital itself must suffer heavy losses. State debts will weigh much heavier on the people, and at the same time it will be impossible to levy the same amount of taxes on the diminished value of property and labour. The fearful confusion to which this will lead, its influence on political and social life, is beyond the range of an estimate now, it can be likened only to an indistinct future, in which we know that the direst mischief is awaiting us. If it be alleged that the fixed income from capital will at first, like the salaries, derive advantages from lower prices, it is still more evident, that besides the ruin of the debtors, capital itself must suffer enormous losses.

There are some people who on this occasion will say, "Oh, that will correct itself, capital will become dearer at first, and then all will come to a level again." But this level can only be regained upon the distinct levelling down of industry and commerce. Interest on capital represents but the share of profit which commerce and industry can afford to surrender, therefore capital cannot exceed the usual rate of interest without destroying industry and commerce; and so in the "minus" which appears on all sides of this matter, capital itself must lessen.

The writer is aware now that the representations which he has made here, especially to those who have as yet paid little attention to the gravity of the case, expose him to the imputation that he sees matters in a dark light. But whilst he admits that it is not a difficult task to cry "wolf," he must here at once state, that no mere reiteration of dogmas on the point, combined with the twang of a joke, as is so often done in economical discussions of this kind, should be allowed to turn your attention from the figures and the general principles laid before you. Unless "equivalents" can be produced, clearly defined in extent and correct in principle, completely filling the gaps, the validity of these views cannot be disputed by mere phrascology.

And this is important for an essential reason. In matters of this kind, the great mass of the people are, so to speak, under the sway of a fate, and even among the educated—among those who write on finance—there are not many whose foresight goes beyond mere symptoms. Accordingly, when such evils as are here predicted begin to set in, the writers on finance, instead of recognising the true cause, will quarrel with such symptoms. There will be appeals to supply and demand, the decline of prices and bad trade will be ascribed to "things having being overdone," the good British and other publics will be soundly rated, and the preachers on financial morality will revel in a paradise full of material. Anything but the real cause of these indications will be commented on.

Yet this cause is a matter in which human intelligence plays the principal part. We here in England, for instance, agree that if the Americans had decided in favour of more paper issue, they would have been ruined. Now whether the decision in such cases is gained by way of popular vote, or by Parliament, or a concentrated governing power, it is all a question of human intelligent decision for good or for evil, and this problem falls under this head with far greater weight than any problem that has ever occurred in the history of commerce and civilisation.

And the shadow of the coming evil is now upon us. So far the shadow only, for, as has been stated before, Germany alone has overthrown the international balance, has promulgated the gold valuation only two months ago, and does not hurry the exchange. Other States hold the matter in abeyance, standing, so to speak, at the brink of the abyss. But already since 1872 there has been an almost sudden cessation of works of public utility, railways and other undertakings. It will be said, of course, "Oh, it was overdone;" but others think that the withdrawal of gold by Germany is the cause of lessening the means which capital requires for the enlivenment of the labour market.

Our own international commerce shows signs of a serious decline, as the following statistics show:—

	Imports. (All).	Exports.		Total Imports and Exports.
		British Produce.	Foreign and Colonial.	
1854	£152 millions.	£97 millions.	£18 millions.	£268 millions.
1855	143 ,,	96 ,,	21 ,,	260 ,,
1856	172 ,,	115 ,,	23 ,,	311 ,,
1857	187 ,,	122 ,,	24 ,,	334 ,,
1858	164 ,,	116 ,,	23 ,,	304 ,,
1859	179 ,,	130 ,,	25 ,,	334 ,,
1860	210 ,,	135 ,,	28 ,,	373 ,,
1861	217 ,,	125 ,,	34 ,,	377 ,,
1862	225 ,,	123 ,,	42 ,,	391 ,,
1863	248 ,,	146 ,,	50 ,,	445 ,,
1864	274 ,,	160 ,,	52 ,,	487 ,,
1865	271 ,,	165 ,,	53 ,,	489 ,,
1866	295 ,,	188 ,,	50 ,,	534 ,,
1867	275 ,,	180 ,,	44 ,,	500 ,,
1868	294 ,,	179 ,,	48 ,,	522 ,,
1869	295 ,,	189 ,,	47 ,,	532 ,,
1870	303 ,,	199 ,,	44 ,,	547 ,,
1871	331 ,,	223 ,,	60 ,,	614 ,,
1872	354 ,,	256 ,,	58 ,,	669 ,,
1873	371 ,,	255 ,,	55 ,,	682 ,,
1874	370 ,,	239 ,,	58 ,,	667 ,,
1875	373 ,,	223 ,,	52 ,,	648 ,,

That our imports have not fallen off is nothing to the point, our accrued national wealth fully

enables us to consume even more. But the decline of our exports in British produce is most marked, as either in quality or value, or both combined. The argument again, "things have been overdone," does not suffice, for during the last thirty years we have had three severe crises, when the same saying prevailed, and yet twelve months after every crisis the steady increase was there again. But now three years of positive decrease have set in, simultaneous with the mere commencement of the demonetisation of silver in Germany, and the indication of the present year, according to what appears on all sides, are even more unfavourable.

In Germany itself, although it conquered £250 millions sterling, commerce and industry suffer from an unheard-of depression. What will it be in other countries if the cause is not arrested by timely action? Permit me again here to ask you not to be satisfied with any phrases which scepticism as to the weight of this matter may utter. Unless such phrases are accompanied by figures, then "this will not be so" is of no value as compared to what I say, "this will be so," upon the figures shown. The common economical sense of this country keeps too watchful and jealous an eye upon practical results to allow itself to be hoodwinked by mere words.

But that which goes nearest to our interests at the present moment is India. The ordinary Englishman knows not of it, and may not care, but the retired officers, the numerous families depending upon a fixed income from India in rupees, know that whereas when formerly 1,000 rupees in India at the exchange of 2s. per rupee gave them £100 here, the present sight exchange of 1s. 8d. from thence only gives £83 6s. 8d., or less by 18 per cent. in sterling. The Indian banker, with millions of money invested in India, finds that they are worth less now by 15 to 20 per cent.; and the prudent Manchester merchant, who has contracted to furnish goods, taking the current present rate as 1s. 10½d. per rupee, gets remittances in return at but 1s. 8½d. and 1s. 8d. in short bills, and loses 10 per cent. in spite of his caution. The bullion broker knows that this low exchange is caused by the fall in the price of silver in Europe, and he does not know what there is to stop a further greater fall, and when that fall will end in a definite figure. Grievous as is the case, as far as fixed incomes from India is concerned, that of its active commerce is still more precarious. It may be said, "Oh, the East Indians must pay more rupees for English goods, so that the English manufacturer is compensated in the exchange!" Just so, and that means the inflation of prices in India, the depreciation of their currency for both imports and exports, without any fault of the Indian people; and under the "bottomless" aspect of the matter, it is impossible to predict to what extent this depreciation will ultimately go. The "light-hearted" embryo economist may here say, "Oh, when silver becomes cheaper, India will obtain all the more of it." Silver will be cheaper, but India cannot take an ounce more than its balance of trade warrants, and the depreciation of its currency will lessen its power to maintain that balance. "Well," another will say, "then let them make the rupee larger—put more silver into it." That means that an East Indian must bring to the mints there, say 100 rupees to be recoined, say into eighty, and that he will be told then eighty heavier rupees are only worth eighty of the former. It may subsequently be necessary to coin the eighty heavy new rupees into fifty still more heavy, and even that may be wrong ultimately. All these suggestions are thoughtless and valueless; the fact that the Indian currency is in the greatest jeopardy to become immeasurably depreciated through its loss of international value, wantonly brought about, remains undoubted. And it must not be supposed, because the appreciation in which India holds silver now, is a mere local fancy or mistake, or that because they "take" the coin now, there is any surety of the stability of this fancy—that therefore the silver can remain "in use" there; all such words as "take" or "in use" are parts only of mere phrases. The value of silver in India depends upon the local appreciation as well as its international value. Withdraw the latter, and it must at once collapse by one-half, and, as has been shown before, the strongest balance of trade in India or desire for bangles could only absorb a small part of the supply.

There are some people who affect to believe that the present rapid decline of silver is but a temporary matter, due to the dulness of trade, and that the exchange will recover. It may be pointed out here, that never in the history of the world has silver been so low. As before stated, the variations have not departed much from the proportions of 1 of gold to 15½ of silver, but in the Middle Ages gold rose in certain States to the proportion of 1 to 16½. This lasted but a short time, and was due chiefly to the absence of an international understanding; and during last century the definite proportion of 1 to 15½ was adopted by France, and followed elsewhere as a foundation. The present price of silver of 53½d., makes the proportion 1 to 17¾! You will admit that this cannot be a mere temporary thing, and the reasons given will be sufficient to show you its real cause. If Europe had no silver to spare, if the lately enlarged fresh supply of silver were but one-half of what it is, silver in India would have to decline, simply because the legislative law elsewhere repudiates it, and for no other reason. Some people recommend that a fresh loan should be raised for India at this moment. It is true that would for a time stop the drawing of Government bills on India, and the price of silver might rise again above 53d. against the temporary supply of silver in London. But such loan would only add to the Indian indebtedness, increase the drawings, without stopping or affording any indication as to the ultimate extent of the mischief.

The effect of this mischief on the political and social life and loyalty of India involves a fearful prospect which India does not deserve. To us in England, India and her 200 millions of people are a great trust. Compare India with the United States. The latter country struggles with heavy international indebtedness and a wretched paper currency. India, from whom during the last century we drew millions upon millions of money, unfairly or fairly, has always kept its head above water, in spite of the bleeding. At the present time it pays to England £15 millions per annum for the privilege of being governed by us; and

although part of this is income on railways and public works, yet there are thousands in this country who derive an income from thence, so that, with banking and other profits, the balance of trade in favour of the country is reduced by say £20 millions per annum. Yet India has enough to spare to be still an importer of silver bullion to a moderate extent. All the twaddle about difference in civilisation between America and India cannot deny India's superiority in this respect, and we in England should most carefully guard this position, do nothing which can endanger it, and we should even be willing to make a sacrifice of certain of our prejudices in our monetary system for the sake of this great trust.

Part III.—*Suggestions for Restoring the Equilibrium in the Valuation.*

What is to be done by England to rescue India and other countries from these dangers? The question states the case correctly, for India and England are naturally the two countries between whom this matter must be decided for the rest of the world, India taking the lead in silver, England in gold.

In venturing upon the proposal now following, permit me to call your attention to the method in which an inquiry into such proposals should be conducted.

There are, firstly, certain leading general principles and large facts, some of which I have endeavoured to lay before you, upon which we must be agreed, and which brook no modification. If we become agreed upon these, we must be able to come quickly to certain conclusions, and use these as landmarks, whose boundaries, for the sake of order, we must not again exceed.

Secondly, we must avoid the tendency of passing lightly over certain matters of account in coinage which appear as small differences. Thus, many people say, "Oh, the £1 is 25 francs; why not use it as such? The difference is not much! The difference is but 22 centimes, or about 2d.!" This is just the trouble. If the sovereign were worth 24 or 26 francs exactly, there would at once be some basis of round agreement, but these angry little differences are all the difficulty, and have hitherto rendered a universal system impossible. The question is not one for a few pieces in the pocket, but one for the vast sums of international and local accounts, in which the "about" 2d. per piece makes hundreds and thousands of difference. And so it is as regards the Indian rupee. Many people say, "It is 'about' two shillings, why not proclaim it as worth that?" The case of the rupee is even more complicated, because it contains about 165 grains of fine silver, and our florin 161·44 grains; and this seems in favour of the suggestion. But that the rupee is a full legal tender coin, the English florin but a token, and the two foundations are irreconcilable. And all proposals based upon "scignorage" for equalising these differences, must be repudiated, so long indeed as the world believes that 100 minus 2 makes 98, and not 100, as the "hocus-pocus" of seignorage asserts.

Suggestions of this kind are most troublesome in an inquiry like this, and a lecturer cannot undertake to teach these elements of the matter. Further, when changes in monetary systems are spoken of, people are apt to dictate to others. Thus, while we in England hesitate to change our system, even to a decimal division, we scruple not peremptorily to ask other nations to do so, and throw aside old habits. And this wholesale style of asking others to do this has often been displayed as regards India. Changes in the arithmetical reform of a coinage system can never succeed if they are radical both as regards the standard pieces and the subdivision, either the one or the other must be maintained as the connecting link; and I shall show you shortly how important this is as regards India.

Now to the first category, that of the principles and large facts, belongs the question—Shall India at once go over to the gold valuation? I have been asked to show the way to do this, without that India should undergo what is called "the inconvenience of an intermediate double valuation." Of the general principles involved in the question I have said enough, but here is the large fact, "Who will take £100 or £150 or £200 millions of the silver of India, and who will surrender the corresponding amount in gold, either at once or in course of time?" As this is a question which our common sense can answer, or rather not answer, you will not accuse me of dogmatic tendencies when I say that we must, for the present at least, discharge even the consideration of the possibility of introducing the full gold valuation into India now; that this conclusion must be one of our landmarks, and that all suggestions referring to it are out of court. Unless that is done the discussion becomes endless and useless.

If that question becomes settled so far, it follows that we must respect the silver valuation in India, and try to introduce gold by means of giving to both metals legal tender. You are aware, no doubt, that we introduced the gold mohur of 180 grains, 22 carats fine, but that it has not succeeded. One reason is obviously this—the mohur did not correspond in any rounded manner with the rupee. Coined of the same weight and fineness in gold, as the rupee in silver, the numerical valuation made the relative value $15\frac{1}{2}$ rupees. That is inconvenient, and the endeavour to pass it at 16 rupees failed as a matter of course, whilst at 15 rupees it went at once into the melting-pot. It might now be suggested that India should coin a gold piece of, say, 20 rupees. That would raise the question of what shall be the proportion between gold and silver? If we again adopt 1 to 16, or worse, 1 to 17, we should not only uselessly lower silver, and bring it into conflict with the system of valuation in other countries, to their mutual disorganisation, but, as before said, we have tried this with the mohur and failed, and should fail again as certainly. And the adoption of a lower figure than 1 to $15\frac{1}{2}$, say 1 to 15 or 1 to $14\frac{1}{2}$, or making silver dearer, would be a positive contradiction of purpose, and be absolutely impossible. Besides this, any form of new gold coin in India, considering the tenacity of India as to silver, would still be uncertain of reception, unless something more were used to strengthen its hold upon the people, both natives and Europeans.

This something may be found in the adoption of the English sovereign, and I need not enlarge upon the fact that our own wish to see this coin become active in India is not one of natural sym-

pathy with the living sovereign and the golden ones, but one founded on sound commercial, social, and political instinct.

If, then, it should appear to you that we had better come to this next conclusion and make it carry out our aim, the question arises again, why has this not succeeded before? As stated before, there are many people who cannot understand why, as the rupee is "about" two shillings, the mere law or dictum cannot do this. The truth is, the rupee is not two shillings. At its fine silver contents of 165 grains, in the proportion of $15\frac{1}{2}$ to 1 of gold, the rupee is worth but 1s. $10\frac{5}{8}$d., making the £1 equal to $10\frac{2}{3}$ rupees. This cannot be made to agree. Now if by proclamation or law the thing were rounded, by declaring that the sovereign should be 10 rupees, English merchants and bankers would rather keep the gold at home, or if any sovereigns were brought to or coined in India, and put into circulation, the bazaar people would chuckle and take them readily, for the immediate melting down and the sale of the bars back to Europe or elsewhere. It might then be said, let us raise the sovereign to 11 or 12 rupees. This suggestion seems a feasible one because the price of silver has now fallen. But that would not only be the enforced depreciation of the rupee, and injure Anglo-Indian incomes, but the Indian people themselves would naturally refuse to take the sovereign at this higher value.

It is necessary, therefore, that a change should be introduced in the coinage of the rupee itself, say by new silver pieces, which will round off these differences, and become at the same time a subdivision of the £1. Such a new coin must also remain on the proportionate basis of 1 to $15\frac{1}{2}$, for if it were made dearer than at the present fine grain contents of the rupee it would be refused; if it were made cheaper, it would at once be melted down for bullion. And such new coin must, as far as possible, agree without fractions, but in units, with the now existing subdivisions of the rupee, as the connecting link. When the connection is established, the reform of the subdivision afterwards is easy.

Here, now, I venture to make a proposal to you, which requires a little technical consideration.

The rupee of 165 grains fine silver is divided into 16 annas of 12 pice each, or 192 pice, equal to 10·3125 grains of silver per anna. Now, if one more anna, or 10·3125 grains, were added for a new coin, that piece would weigh 175·3125 grains, and at exactly two shillings would give a proportion of 1 gold to 15·515 of silver, and be worth precisely 17 annas or 204 pice.

Two considerations now arise:—Firstly, how shall this change in the coinage be brought about? 2ndly, how shall the conversion of accounts be conducted?

In answer to the first question, postponing for the moment the "work" thrown thereby on the mints, it must be said that the coinage of such a piece of 17 annas, and its circulation alongside of the present piece of 16 annas, is not expedient, although there would be no practical difficulty whatever about it; the people would soon learn to deal with the fact that the new piece is worth one anna more than the old one. It is better, therefore, that this new coin should be a heavier one, say of 350·625 grains fine, equal to four full-valued shillings sterling. Such a piece might be called the new double rupee, or Indian dollar, or the "Albert." The suggestion as to the name of this piece is not made in order to bring about some hocus-pocus connection with the dollar coinage, or the five-franc silver piece, as is so often uselessly proposed, nor must the attempt be made to make India the stepping-stone for some kind of international scheme—the difficulties are serious enough without this; the suggestion as to this four-shilling piece is entirely one of convenience between the sterling and rupee system.

The Indian mints should cease to coin the present rupee, and make, for the present, the new piece only, on the legal tender basis of 2 rupees 2 annas, or 34 annas, per "Albert." The first important point would then be this: How would the bazaar bullion dealers receive this piece? Few people, excepting perhaps the mint masters and European bullion importers in India are aware that the native bazaars are the guardians of the people of India in regard to coinage, and that they control and direct the matter on plain principles of both native and European mathematical truth. If they found that this new piece is in accord with the present rupee, viz., worth exactly 34 annas in silver, and legal tender, they would unquestionably accept and favour the coin. It might even here be suggested, by way of objection, that they would melt the new pieces to some extent. But that is now also done with fresh rupees, and if the mints ceased to coin the latter, the new piece would of necessity be spared, when the circulation requires it.

It might be alleged that, as far as the people of India are concerned, the size of the rupee is a better customary standard for prices. That was the case centuries ago, when prices were but one-fourth or one-half of what they are now; the fact that prices have risen since renders this new piece more appropriate. The coins of the dollar size have always been in favour with the Eastern nations. The people of India would soon learn that the new piece was worth exactly 2 rupees 2 annas, that 8 of them were 17 rupees, and no difficulty whatever would be experienced in the handling of the coins themselves upon this basis, alongside of the present system, for the time being.

And when a fair supply of these pieces has been distributed throughout India, it can be made the stepping-stone for a comparatively easy reform of the subsidiary division of the coinage. An objection may be made to the new coin starting with a division of the inconvenient number of 17 or 34 of the present annas. True, if a more even number of annas could be chosen, it would be better still; but upon close investigation it will be found, that no combination of that kind is possible without utterly disturbing the other absolutely necessary factors of the problem; after all, the addition of 1 or 2—to 16 and 32, are simple in their nature. In any case, both for accounts and practical coinage, the present divison of the rupee into 16 annas, and 12 pice per anna—or 192 pice per rupee, is one that requires reform.

The new piece would have 34 annas, or 408 pice. When it has gained a footing, there will be no difficulty in commencing this reform by reducing the 408 pice to 400. This would cause no inconvenience to prices or the subsidiary coinage. (The

German Government has maintained the groschen or one-tenth mark of 12 pfennige, and now divides it into 10 pfennige without a murmur being heard.) And as the subsidiary coinage is not large in actual gross sum, the poorer classes, as holders of the pieces, would be rather pleased to find that their value was raised by 2 per cent., and the lower subsidiary copper need not be changed at all. But this is now of great importance in the way of reform; the new silver piece of 350⅝ fine grains would be worth one-fifth of a pound, and the £1 in silver = 2,000 pice—(or if 2-pice pieces were made, exactly 1,000 of them)—in easy decimal division.

The divisor of 17, though practicable at least, would then, on account of its slight inconvenience, give the legitimate impulse for the change in the anna system. The new coin could be divided into 20 subdivisions, each of 10 pieces of the value of 2 pice; the system becoming—

	£1 =	5 alberts (of 4 shillings each.)
	1 =	10 half-alberts.
half-albert	1 =	10 subdivisions.
subdivision	1 =	10 copper pieces of the value of 2 pice.

The £1 would be 1,000 of such pieces, of which halves or quarters, as the present 1 or ½ pice, would still be maintained.

I have said before that it would not be expedient to issue the 2s. piece, or half of the new heavier coin at once (although it is quite practicable). But when of the 4s. pieces there are a sufficient number in circulation, the conversion of the present rupee into this half-piece might begin. Simultaneously with the change from 408 pice to the 400 basis, when the present rupee, now worth 192 pice, would be worth an equivalent of 188¼ of the new division, the current rupee pieces might be called in by proclamation, and exchanged at the rate of 17 for 8 of the new coins. After a time the proclamation might fix the legal tender of the rupee at 188 new divisions; this would expedite the process of exchange, when the one-half and quarter rupees may also be withdrawn. The point would then arise—shall we, in lieu of the old full-valued rupee, re-issue the 2s. piece also as full-valued, or as token, under limited tender, as in England? Presuming that the distinction between full-valued silver and token silver coins is now fully understood, I am inclined to think that the new half-piece, or "rupee," should be issued as a token only, and placed under the limit of £2 per payment, as the 2s. piece is in England. The bazaar people, having the whole full-valued 4s. piece to fall back upon, would easily understand and favour this proposal; and its advantages are obvious, for not only would a comparatively more limited re-coinage of this token and its subdivisions in silver be required, but the melting down of lower pieces would cease, and entail less work on the mints. Above all, the profit to be made by the mint thereby would probably be in excess of the whole cost of conversion of the old coin. The new half-Albert piece might contain, like our own florin, 161·44 grains fine silver, thus leaving a profit of 8 per cent. on the whole subsidiary silver coinage; and if it was made at 900 fine, it would yet be "apart" from our own British tokens. The lower silver coinage would thus be on the same footing of tender as ours and that of France.

The coinage of the one-thousandth part of the £1 in copper, equal to a 2-pice piece (not coined hitherto), would greatly facilitate the reform in the lowest divisions.

The introduction of this new piece of four shillings of the dollar type would meet with a special advantage. Those acquainted with the history of the Spanish, Carolus, and Mexican dollars know that their acceptance, even above value, was due not only to the authority, but to the quantity available; and just because these elements were absent in the late Hong-Kong dollar, the mint there did not succeed. It may be said that the Mexican mints now coin almost expressly for the far East, but if this new piece, recognised by the Indian bazaars, backed by Indian legal tender, became soon to be present in quantity, it would no doubt become the favourite in all countries near India, including China. And as in Western China small bars of gold are much used, there is every probability that they may be exchanged for these dollars, and thus give the Indian bazaar people even more desire to see gold recognised in India. The British sovereign, introduced as legal tender, could then be defended on the ground of its exact and manageable division in silver, and as the proportion between gold and silver would be upheld on the same basis as in France and elsewhere, the differences in exchanging the one material for the other from one country to another, would give so much occasion for disturbances and uncertainties in price would disappear. Under such circumstances the British sovereign would make way in India, and the new valuation, based at first on more silver than gold, might change more and more in favour of the latter. And although it is my conviction that the abolition of silver at some future time would be as baneful and ruinous a feat as it appears now, that therefore practical results will enforce the restoration of silver—yet, if at some future time the gold valuation should, *nolens volens*, be enforced upon the world, India would be better prepared for the event.

As far as the change of accounts is concerned, it may reasonably be supposed that European Indians and educated natives will find no difficulty in adopting the pound sterling system so decimalised, and that all contracts and Government debts, &c., can speedily be converted. The natives may find greater difficulty in the conversion rate of 17 to 8, or 85 present rupees to 8 pounds sterling, but whatever other combination may be tried so as to bring about the sterling system, it will be found to give more fractional and more difficult divisions. Native ingenuity will soon deal with the 2 rupees 2 annas for the new piece, or 10 rupees 10 annas per £1, and ready reckoners or tables can be officially supplied to the people. In any case, if a change is to be made, this matter of accounts presents difficulties which energetic and intelligent action of the Government must meet, and in this instance the inconvenient, yet simple figure, pushes the reform.

The technical proceeding of re-minting requires some consideration. The calling in and receiving of £100 or £150 millions of silver coins being one of the "large facts" of the case, on which mint masters would have a good deal to say. The Indian

mints are powerful institutions, that of Calcutta especially so, and with extra machinery designed purposely to work this one piece, there should be no difficulty in turning out five millions of pieces, or 1 million per week, say 50 millions per annum. Anglo-Indian energy has performed comparatively greater feats in other matters. Besides, for as much silver as India, when rescued from its present danger, can still take from Europe, pieces may be coined in England, either by the Royal Mint, or, under the supervision of the India-office, by the private mints in Birmingham. These coins could be sent out by Anglo-Indian banks in lieu of bar silver. Again, a great portion of the subsidiary token coinage, and later on the copper coins, could be made in England and used as remittances, or accumulate in India in the bullion stock for bank notes, until there was sufficient for the withdrawal of the old silver pieces. For all these technical points the proper arrangements can be made.

It is possible now that the plan here recommended for an alteration in the Indian coinage towards the sterling system appears practicable, but whether this or any other method be adopted, one thing must now be borne in mind :—

All such proposals are of no good, no system based on the double valuation, temporarily or definitely, as far as India is concerned, can be maintained, unless all other nations come to an international agreement on the matter at large; and you will now perceive that in bringing the subject before you in its reference to bank notes, to the various systems of metallic valuations, I may not have occupied your time in vain. All nations must agree, not only in the first instance in bringing back the *status quo* before the recent changes and demonetisation of silver, but in taking steps to assure its maintenance for the future. Unless this is done, and speedily, the muddle will become irreparable, and the universal panic unavoidable.

England, as the first representative of the gold valuation, with India, as holding the first rank in the silver valuation, has the greatest interest in the matter generally, and should therefore take the lead in calling an international conference. It has been said before that Germany, by its recent change from silver to gold, has overturned the balance of silver, and so forced other silver-valuing States to prepare for the same thing, compelling the States of the double valuation to limit the coinage of full-valued silver pieces, preparatory to the final enforced abandonment. As yet, although the price of silver has already fallen so greatly, the whole subject is in abeyance, so to speak, the other nations standing on the brink of an abyss to which Germany is driving them.

The first object of this international conference must be that of restoring the equilibrium between gold and silver in Europe. As far as Europe is concerned, the three nations, England, Germany, and France, practically command the situation.

Before 1870 the equilibrium was upheld because it was divided between—

England with gold valuation,
Germany with silver valuation,
France with gold and silver valuation;

as if by three systems of equal mutual importance.

Since then Germany has adopted the gold valuation, and the position now is—

England with gold valuation,
Germany with gold valuation,
France with gold and silver valuation;

and France has already been compelled to guard itself against being swamped with German and other silver.

To us, as Englishmen, it would be easy to suggest that Germany should retrace its steps, and readopt silver; we are so very ready and willing to dictate to other nations in matters of this kind. It has also been said in England that Germany being, according to our views, a poor country, where prices are so much lower than here, ought to have retained silver, as better suited to these prices. The fact is, that prices of commodities in Germany are higher, and the value of labour very little less, than in England; labour being at least double as high as the rate of wages existing here when we ourselves adopted the gold valuation in 1816. But the Germans will laugh at our advice for other reasons than this. They have already sufficient gold, and disposed of enough silver, to be able to hold their own on the mere score of possession of currency. Beyond this still they would say to us, "No, we are not going to take to silver again for the special benefit of England and India!" and they would be right. For it is England which, since 1816, has always played upon the silver currencies of the Continent. Although England at home deals only in gold, yet, in her international trade, especially that with India, she is the greatest dealer in silver. When the exchange with India is low, England has crammed the Continental currencies with silver; when that exchange is high, it has just as violently subtracted millions from them. In the case of France under the gold and silver valuation, this was of little consequence, for England had to give France gold instead; but for the European silver-valuing States this was intolerable. Many millions of thalers were melted in Hamburg for export through London to India, as Germany then had no fixed price for gold; confusion in their money markets, panics in Hamburg, and disorder in their currency, through the spasmodic issue of bank notes, took place. Even if Germany had not already succeeded in securing herself by gold, and still held its full store of silver, it would be the duty of her statesmen to guard against the danger and inconvenience to which the attitude of England continually exposed the country. And although Germany has been precipitate, and might have called an international conference before making this change, yet as she had the means on hand, nobody can blame her for having so far secured her interest, and for laughing at the unsophisticated suggestion that she should return to her old system for the benefit of others who are unwilling even slightly to modify their own systems for this purpose.

The suggestion might than be made; if Germany cannot return to her old silver valuation, let her at all events adopt the gold and silver valuation, when the European systems would stand as—

England with gold valuation.
Germany with gold and silver valuation.
France with gold and silver valuation.

Those who understand the simple problem of equilibrium involved in the position previous to 1870, will recognise that this plan is insufficient, for the weight in favour of gold would still suppress silver in almost the same ratio. If Germany retained all the silver she now holds, so as to bring about a fair proportion of legal tender gold and silver coin in her currency, she could only absorb a small quantity of silver in future, and for maintaining such proportion, the great bulk of the new supplies of silver would have to be offered in vain to India, and the depreciation of the material would become as certain as it seems to be now, rendering the maintenance of a joint valuation impossible.

And even if that were not the case, neither Germany nor France would care to have the gold and silver valuation, unless England joined them. For they would say to us, 'It is perfectly characteristic of you English to say to us, "You, France and Germany, must adopt the gold and silver valuation, but we English must remain on the gold basis.' Although you may be compelled to give us gold for silver when you want the latter for India, yet we are not going to have our currencies played with in this way, or subject ourselves to the risk of your succeeding in introducing gold as the sole standard in India, and so cut us off altogether. Unless you join us and do yourselves what you want us to do, we prefer to suffer the consequences of the general demonetisation of silver altogether, and it remains to be seen whether you in England, together with India, will not lose far more in this reckless tumble-down than anybody else!"

This is what they would say with perfect justice, and so it would appear that no good whatever can be done unless the systems become—

Germany with gold and silver valuation.
France with gold and silver valuation.
England with gold and silver valuation.

In other words, the universal adoption of both gold and silver as legal tender money, is the only means of restoring and maintaining the equilibrium between gold and silver, and arresting the downward and uncontrollable movement now preparing for vast ruin. And "unless England is prepared to enter upon such international conference with the view of the adoption of the gold and silver valuation, with such modification as may meet the case, it is perfectly useless to make the attempt."

It is now that we must assert our ideas as to the kind of difficulties which stand in the way of this proposal as far as England's theoretical and practical economy is concerned.

The bare suggestion that England should modify its present system in favour of the gold and silver valuation will lead to a kind of war-dance by the party which has been designated as the "fanatical" advocates of the gold valuation, against which that carried on by the opponents of other wise measures in the history of England is but child's play. This party will not only parade the fluctuation theory, and all the phraseology connected with "civilised nations," which the controversy has called into some sort of fashion, but there will be bank directors, and others of exceedingly "national" views and "patriotic" habits, who will scorn any departure by England from its policy, and who will endeavour to bring forth numerous "practical" objections. Granted that any change of this kind is naturally subject to several practical objections, yet it remains to be seen whether they are not trifling as compared with the great main object, and whether, as will presently be shown, they are not easily overcome. What we must here desire now, firstly, is this: "If the uncompromising spirit of the advocates of the gold valuation not only for England, but for all the rest of the world, is allowed to prevail without further inquiry, it follows, not only that nothing whatever can be done, but that the full extent of the demonetisation of silver and all its dire consequences must be borne by the world.

But fortunately there are others of sufficient thoughtfulness, whose foresight makes them see the fatal effects of such orthodoxy, not only abroad, but also in England, and the recent fall in the price of silver, together with the interests of India, has roused a vein of reflection which bids fair to admit of a re-opening of the question, "Shall England join other nations in again using silver as well as gold for legal tender purposes?"

There can be no doubt that the objection to silver by certain classes of Englishmen is due to a prejudice on account of the argument founded on its comparatively greater weight. But this is not an objection which the common people make. Before the adoption of the gold valuation, during last century, there was plenty of silver in England, and the habits of the people did not change suddenly in 1816. The labouring classes now deal in silver chiefly, and the use of a four-shilling piece, as suggested before, would be most acceptable to them. As far as the prejudices of the somewhat wealthier classes are concerned, they are founded on a singular matter. Whenever the discussion on the use of silver coin as legal tender is raised in company of educated Englishmen, one of them is sure to say, "When I was in France in the year 183—, and travelled in my coach with post-horses, I was obliged to carry with me a bag of five-franc silver pieces to pay my way;" and thereupon he will launch out into praise of his own system, and condemn the French for want of civilisation in their arrangements. Now at the time even of 1830—1840 there was plenty of gold and bank notes to be had in the larger towns of France, but it is true that travellers, for small and frequent expenses on a journey by post-horses, found it more convenient to furnish themselves with silver pieces, although as in Germany, where silver also circulated, they could take credits and notes. All this has since been changed. Railways, bank notes, credits, circular notes, have lifted the English traveller over this previous difficulty, if ever it was one. But even if it still existed, is the interest of the British occasional traveller that which is paramount? Yet so strong is this favourite argument on the part of the ordinary English gentleman, that, through it, he is apt to overlook entirely the economical aspect of the whole subject. He might be asked to decide here whether if England, through the demonetisation of and decline in silver, is threatened to lose, to commence with the least important item :—

Firstly, the value of many millions of pounds now possessed by the country in silver plate; secondly, the value of dividends and capital of

many millions of English interests in silver mines; thirdly, its international claims on nations which have contracted in silver; fourthly, the value of hundreds of millions of Indian currency—and beyond this; fifthly, the prospective loss and decline in prices to which England's commerce chiefly, and that of the world at large, are exposed —would it not be better on his part to give up this trivial objection as to what happened to English travellers in 1830—1840 in France, or to use it as a reason why he should set his face against the reasonable consideration of the subject at large. The objection then as to the weight of silver for travellers in France being entirely removed, it would be still more frivolous to raise it for England, where cheques, bank notes, and gold are in abundant use, and nobody can allege that if we in England had say £10 or £15 millions in four-shilling silver pieces, any inconvenience would arise on that score.

Accordingly, England might well admit to legal tender a certain quantity of such full valued silver pieces for interior circulation, so as to assist in maintaining the equilibrium of the price of silver for the sake of India. It is said advisedly here "a certain quantity of such silver pieces," because it would scarcely be requisite for England to adopt the full gold and silver valuation at once, the legal tender limit for silver pieces of this kind might be put at such a figure above £2 (the present limit for the undervalued silver tokens) as expediency would suggest at first, so as to prevent any too sudden change or large coinage of these pieces. The legal tender limit might at first be stated at £10 or £20 or £50 or £100 (subject to proclamation by her Majesty), but practically it would be found that when the valuation by gold and silver becomes universal in Europe, no limitation whatever is ultimately necessary.

It has already been shown in previous parts of this treatise that the settlement of almost all large payments takes place in accounts, cheques, and clearing systems.*

The currency itself occupies the strata for which it is designed, and if for argument's sake—instead of the

£105	millions	of legal tender sovereigns,
15	,,	of silver tokens and copper coin,
2	,,	of copper coin, and
40	,,	of bank notes,
£165	millions,	

we had in circulation in England,

£95	millions	of sovereigns legal tender,
10	,,	of full-valued silver pieces,
15	,,	of silver tokens and copper coin, and
40	,,	of bank notes,
£162	millions,	

the £10 millions of four-shilling pieces, together with the present £15 millions of tokens, would remain chiefly in the hands of the lower strata, leaving an ample quantity of gold for all the purposes that gold, besides bank notes, could serve; indeed, the whole system would settle into its own channels by a perfectly natural process. It may be remembered that some years ago the question was raised, whether the industrial classes, dealing in silver chiefly, did not suffer injustice through the fact that its supply is optional on the part of the State, and enforced only by imperative demand. The sophistical doctrines of the gold valuation stifled this question, yet it has a foundation which must not be despised, and the supply of this new coin would tend to remove the reality of this complaint.

But there is one objection which bankers may raise. They may say, "We are so much accustomed to gold, and so much troubled with silver now, that we should not like to have more silver to deal with."

What is their real objection to silver? Although the quantity would be increased, the counting and verifying of single pieces of four shillings each would be easy enough; the real objection to the present token silver coinage, besides the difficulty of handling and counting its subdivisions, which will always remain, is this:—The present silver coinage, frequently accumulates in the hands of bankers at a great loss of interest, for it cannot, at its limit of tender, be brought into circulation easily, and it cannot be exported. Bankers frequently offer such a surplus of silver at 1 to 2 per cent. discount, and the Bank of England itself, some time ago, offered in vain to sell several hundred thousand pounds, at a reduction of one per cent.

This full-valued coin, however, even if our circulation could not immediately absorb a banker's surplus, could always be sold for its full value in silver, either for melting into bars at home or for export. And therein lies not only the full compensation to bankers, for the token coinage need not then be increased; but here the matter comes into direct connection with the valuations abroad, and offers us numerous advantages both for holding and modifying a fair proportion of these full-valued pieces for our own purposes and for India.

For the piece could be issued here in England and sent to India in lieu of bar silver. The Bank of England, which under the Act of 1844 has the right of holding 20 per cent. of its bullion store in silver (a right which it would not properly exercise with the token coinage), might hold £3 or £4 millions of the full-valued pieces, so as to be able to supply India direct, without disturbing the silver coinage of France (as England has done hitherto) and parting with gold. This reservoir would not only enable us to conduct our Indian exchange business at much less cost to ourselves, but it would serve for the absorption of any temporary surplus of their coins in our own circulation, and thus become an equaliser or go-between ourselves, India, and other nations. Coupled with the fact that this 4s. piece offers the only practicable means of reforming the Indian valuation, so as to bring it into accord with our sterling system for the ultimate regulation by gold in India, this is perhaps one of the most important and beneficial uses which England could derive from the

* Where large tenders of actual money must be made in courts of law, Bank of England notes or gold are as convenient to the debtor as to the creditor, and instantly return to the circulation. And if for the purpose of vexation a debtor were to carry bags of silver to the court, he could be subjected to the reprimand which fools deserve; but upon such hypothesis the whole case must not be pitted.

practical re-adoption of silver within her own realm.*

Assuming now that England were at least inclined to enter upon the proposed international conference on the question, with the intention on her part to further the case according to the indications here given, what would other nations do? Would they be willing to follow the same course? The writer, fairly acquainted with the development of the subject in various countries, the economical truths or errors upon which matters have drifted into their present unfortunate relative position, may shortly review the actual state of the controversy in the important countries.

In France, the full gold and silver valuation prevailed until 1867, when under the monetary convention with Belgium, Italy, and Switzerland, the full-valued two-franc pieces and the coinage below were withdrawn, and a subsidiary debased coinage, similar in principle to our own, and under the same restriction in tender (50 frs.), substituted. But the five-franc silver piece continues as full legal tender, and thus the gold and silver valuation remains, for the smaller coinage, as has been said before here (and recommended for India), can well be placed upon the token footing in all countries. In the meantime, however, the controversy started by Michel Chevalier was kept alive, the strong demand made by England on French silver for India continued to arouse attention, and although France only profited by the transaction, for it obtained a premium on silver and an equivalent in gold, an inquiry by Imperial Commission was instituted in the early part of 1870, shortly before the war. This commission, on most conflicting evidence, decided in favour of gold, but no action was taken, for the war began soon after. Since then, Germany having gone over to gold, France has still maintained both gold and silver as before, but has been compelled, in order to avoid being swamped by German and other silver, to limit its coinage of five-franc pieces to 60 millions of francs per annum. The question now arises, what will France do in future? This means firstly: will the present France respect the decision arrived at under Imperial auspices in 1870? The answer is an emphatic "no." Those who watched the evidence at the sitting of the Imperial Commission soon saw that the doctrine started by Michel Chevalier (upon the truth or applicability of what that eminent economist himself showed his doubt, by recommending first one thing and then the very opposite thereto, and is probably as yet undecided) imported into that evidence all the customary phraseology and "civilised nation" talk, of which so much use has been made without reference to figures; and in this school several pupil economists outbid Chevalier himself in extreme views. Besides this, there prevailed in Imperial circles a kind of Anglomania in financial matters, which though flattering to ourselves, might even make us laugh, as many little adoptions from us, including the British bull-dog in the Bois de Boulogne, do now. But far beyond this, it soon became evident that the members of the Imperial Commission had a political design, that they had in view the forging of another weapon against Germany. For there cannot be the slightest doubt, that if the Emperor had beaten Germany and exacted a war indemnity, he would have used that war indemnity for the purpose of paying for the adoption of the gold valuation, and weakening Germany further by the demonetisation of silver. But it so happened that the tables were turned, and that Germany has now done for France what the late Emperor or his councillors contemplated to do; and were it not for the remarkable financial strength, the solidity and uprightness of the French, this matter might have been an event more serious to them than Sedan. The writer, from personal conversation with members of the Commission, and from observations made, can vouch for the fact that this design upon Germany was underlying the inquiry as one of its chief, though not avowed motives.*

Since then a change has come over France. It must be mentioned, in the first place, that although for the reasons given, the Commission finally decided for the gold valuation, there were plenty of serious men occupying the highest position in finance and economy, who saw the evil that was coming, and protested against the decision. At the present moment, when, since 1872, France has been compelled to limit its silver coinage, whereby the evils predicted begin to manifest themselves, the party in favour of the maintenance of the gold and silver valuation has regained its former strength, and although a few fanatics for the single gold valuation are still ready to parade phrases, the reasonable and calculating portion of French economists, bankers, and merchants, will be ready to hail any suggestion, by way of an international conference in favour of a possible full restoration of the original constituents of their valuation. And if this conference should make the use of gold and silver universal, if England and India should adopt the same system, the invidious play carried on between England and India upon the French coinage would no longer be required, the real cause of the fluctuations would cease, and each section of the commerce of France (and the world generally) would fall within the ranges of value for which either gold or silver are mutually

* It has been suggested that if the Government abolished the duty of 1s. 6d. per ounce now levied on sterling silver plate, there would be a much greater consumption. The quantity of silver now used for plate is about one million ounces per annum, and if the average price of silver goods be taken at 10s. per oz., and a reduction to 8s. 6d. doubled the consumption, it would only absorb 1 per cent. of the 100 million ounces of supply per annum. Nevertheless, as the tax was levied originally to prevent silver being withheld from circulation, as this is now no longer required, and the income to the State less than £70,000 per annum, it might as well be abolished, so as to allow more wealth in silver to accumulate here, and to assist in upholding its value.

* Several of the witnesses at these meetings also fell into the vulgar error of charging so-called bullion dealers with making undue profits on the exchange between gold and silver, by way of speculation. Nothing betrays greater ignorance on monetary matters, or is more contemptible, than the unbounded assurance with which *savants* of this class utter such things, without being ever able to bring figures for their support. Gold and silver cannot be "speculated" in, for they are not commodities which can be stored under an advance or held without loss of interest; their value is mathematically ascertainable to the most minute fractions. If, in exchange matters, dealings in gold or silver become necessary, these must be instantaneous, and their motives are but the exchanges themselves. To the arbitrating banker it is quiet immaterial whether he deals in exchanges by bills or by bullion, he simply chooses that which at the moment seems the more likely to answer. Statesmen and economists, ignorant of the simple logic involved in the business of exchanges, should learn to understand that it is nothing more than a great inter ational clearing system, conducted on the highest principles of economy and adjustment, requiring only the quick intelligence of a calculator. Because they have not got the inclination to follow out these calculations, they throw dirt at the bankers who carry on the superior business.

fit, in a natural way, and so do away with the present enforced disturbances.

Belgium, Switzerland, and Italy would follow the footsteps of France in such conference. In Belgium the subject has caused much discussion; the chief point under consideration was the absolute necessity of Belgium being compelled, in order to avoid a worse contingency, to follow the general indications so far. A decision preparatory to the breaking up of the monetary union between the four States, and for the abandonment of silver, has been come to with great regret, but so far the four States have agreed yet to coin together this year between £4 and £5 millions sterling, and this, by the way, is the reason why silver has not already fallen much lower in the market than at present. Belgium will be quite ready to restore its system in accord with others.*

Holland has made preparations for giving up silver and adopting gold with even much greater regret than other States. This country is internationally wealthy, and surrounded as it is by gold-valuing States, it can as a small one, obtain the gold required. Dutch economists recognise that this mere loss on currency is nothing as compared to the gigantic consequences which the interests of all nations must suffer through the general demonetisation of silver.

Of Germany, as of the three leading wealthy and metallic nations, a portion of what is required has already been said. No doubt Germany has been, if not too precipitate in saving itself, at all events inconsiderate. This is also owing to a tendency on part of some of her economists, on whom the subject of monetary matters has recently dawned, to imitate England. Flattering again as this may seem to us, even Richard Cobden himself would probably admit that these imitators have caricatured English economical principles. The French fancy for English "bull-dogs" is ludicrous but innocent, but the German imitation of English methods is ludicrous and baneful to the people at the same time. The new German bank note law, and the bayonet fashion proceeding in the whole matter of reform of their coinage, are evidence of this. But at this moment a certain want of decision manifests itself in Germany. Here is a country which has just conquered £250 millions of money at a swoop, or more than the whole amount contributed to the entire world by California in twenty-five years, and yet it suffers from a depression of trade and industry, from misery and complaints on the part of the people, such as the country has rarely seen in the worst stages of national life. There must be some "pretty" management, some very clever heads in a Government which can bring about such a result; English common sense would have driven these financial *gens d'armes* into oblivion long ago, upon the mere face of the absurdity. But although this evil now exists in Germany, there are many gentlemen of high position and thoughtfulness, who well know to what it is due, and who would only be too ready to recommend so much of a return to the *status quo* as will admit of a retention of legal tender in the country for the national as well as the international good. And even the men now in power, seeing that they have yet from £20 to £30 millions of silver to sell at a low and still more ruinous price, may be brought to stop wasting part of the indemnity acquired from France, and listen to a proposal for an international conference. But this much is quite certain, unless England herself takes the lead in the conference, the whole case comes to that of attempting to construct an arch without a keystone—that keystone being in reality England.

The cases of the internationally indebted and overissuing States remain to be considered. The United States, as already shown, have lost their old silver dollars because, without reference to the international agreement of 1 to $15\frac{1}{2}$, they coined it at 1 to 16, and thereby lost that dollar by undue export. Pending their recovery to specie payments, they have thereupon resolved upon the future gold valuation. Within the last three years they undertook to coin a new silver dollar, not for legal circulation, but for export to China and India—and for the purpose of its driving out and taking the place of the Spanish and Mexican dollars there current, they made that dollar of 420 grains, 900 fine, or 378 grains fine, thereby wantonly debasing silver to $16\frac{1}{4}$ to 1 of gold. In 1874 about £700,000 of these pieces were coined; in 1875 a much larger quantity went to China. A more mischievous and wanton proceeding than the coinage of this piece, directly injuring the silver mining interests in the debased price, cannot well be imagined; it is yet time to stop this bad policy.

The legislative controversy in the United States of America as regards the question of the valuation has, on the whole, been a less searching one after economical principles than elsewhere. Resolutions were taken by the rule of thumb, and in accord with common phrases quoted from Europe; the experimental nature of the proceeding shows this—so long as the United States remain on the paper basis, they cannot themselves judge of the practical effects of these resolves for the future. It may, however, be obvious to others, that if the United States are bound to return to the specie basis, they have themselves created the greatest bar to this aim, by demonetising silver, debasing the proportion, and by assisting the tendency displayed in Europe against silver. If the rich supplies of silver now found in America, instead of being wildly exported, could be partially retained, the restoration of specie payments now rendered so precarious and so injurious to prices and contracts in the country, so influential as regards general commerce, as pointed out in the first part of this treatise, could be accomplished in a short time and with comparatively less painful efforts and consequences. A proposal has recently been brought before the United States Senate by Mr. Sherman for the reduction of the present half-eagle, or five-dollar gold piece, from its present fine gold contents of 116 grains to 113 grains, the fine gold contents of the British sovereign, and that this piece should be divided into five dollars. Now, although this change would require an alteration in the accounts in America, by an addition to each present dollar of $2\frac{3}{4}$ cents, there would be no difficulty whatever as to the coinage. The United States,

* It must not be supposed that because here it is proposed that England should coin a four-shilling piece, therefore the present five-franc silver piece will be in correspondence with it beyond the mere metallic basis, or of equal value as basis for international coinage. Such an attempt must not be made at present. The four-shilling piece would contain $350\frac{5}{8}$ grains of fine silver, the five-franc piece contains $347\frac{1}{4}$ fine grains, and no agreement to pass for equal value is possible on this point.

excepting the stores of coin held in the Treasury or by banks, have no gold coin in circulation, and therefore no withdrawal or re-coinage is required, the Mint might coin the proposed piece as easily as the old. In that case the identical four-shilling piece of 350⅝ grains fine silver, recommended for India and England, would be the new American silver dollar. The opportunity thus offered to America of bringing her coinage system into accord with England* and India is a most advantageous one, which may never occur again. And if America thus recovered its specie basis, and if all the nations agreed on the same valuation, the wanton import or export of the one material over the other would cease, and all would settle down within its natural ranges.

Russia, Italy, and Austria have still stronger interest in the maintenance of silver, not only because it will enable them much sooner to recover specie payments, but they are all holders of silver to some extent at least. Austria especially and its national bank hold silver; and although, according to the terms of its silver loans, it might pay English and other international creditors in depreciated silver (and this is an item of loss which we in England must also bear in mind, as applying to all other debtors on the silver basis to us), yet that would not mend the matter in the main—it would only increase the distrust and confusion. It may be reasonably presumed that all these States would only be glad enough to have this question settled as it has here been presumed.

If, then, that international conference be held, how should our Government prepare itself for the position to be assumed? As stated before, England cannot remain on the pure gold valuation, and recommend others to adopt the gold and silver valuation chiefly on behalf of India. The thing is impossible and untenable as far as the equilibrium is concerned; for independently of what might be called the selfish unfairness of the thing, which other nations would deem preposterous, and which in reality would be ludicrous, the balance against silver, even if Germany adopts it again alongside of gold, will remain absolute, unless England joins the system by way of set-off.

The great difficulty of our Government would be that of dealing with our home habits, and the violent opposition which will be displayed by certain parties against such a reasonable proceeding. It must be the duty of our Governments to make clear these facts and its consequences, not only for the purpose of appealing to the common sense of all Englishmen, as for the proper choice between practical evil or good is concerned, but also in order to overcome what is the main objection of our gold economists to the gold and silver system, viz., the theory of fluctuations between gold and silver, and the consequent seeming injustice to the creditor. Those who are aware that these fluctuations are mainly due to the conflict between the present three groups of the gold, the gold and silver, and silver valuation, and moreover chiefly due to the play of England and India on the Continental valuations which lie between them, will admit that if in future the systems become alike, this conflict will necessarily end. Accordingly, if the doctrine of the injustice to the creditor were actually true, it would weigh little against the enormous sacrifices to be made on its behalf; or it would at all events be greatly modified in its application through the universal agreement. But, as has been shown here before, this doctrine is neither true in theory nor fact. The settlements of credits and debits do not take place by currency, but by a species of barter of value which has no further connection with currency than that its own basis of value depends upon the number of pieces of money with which the labour markets can be enlivened, and production and consumption and general welfare of mankind advanced. If our Government and the real economists of the country can rise to this plain and truthful conception of the real nature of the case, the false doctrine is scattered to the winds.

Our special English economists opposed to silver may be still powerful, but they are not paramount. There is, at all events, one authority in this country which is not bigoted on this point—and that is the present Prime Minister, Mr. Disraeli. On the 19th November, 1873, when Mr. Disraeli was installed as Rector of the University of Glasgow, he chose for one of his subjects an allusion to this very matter, and the parts of his speech referring to it are worth repeating here. At the banquet he said:—

"I attribute the great monetary disturbance that has occurred, and is now to a certain degree acting very injuriously to trade—I attribute it to the great changes which our Governments in Europe are making with reference to their standard of value. You, of course, are perfectly acquained with all these circumstances to which I allude. I attribute the present state of affairs very much to a Commission that was sitting in Paris at the time of the great Exhibition. That was a Commission the object of which was to establish a uniform coinage throughout the world—a very beautiful idea of cosmopolitan philanthropy, and probably, if it could be fulfilled, would do no great harm, but I think it would be very difficult to attain. The Commission of Paris never came to a definite recommendation on this subject, but they did on another subject, and that was that no time should be lost by any of the States of Europe in taking steps to establish a uniform gold standard of value. This, I know myself, arose from an opinion extremely prevalent among the Government statesmen of Europe, and among distinguished economists and merchants abroad, that the commercial prosperity and preponderance of England were to be attributed to her gold standard. Now our gold standard is, I think, a most invaluable arrangement. I think that any country which has a gold standard of value should, to use a celebrated expression, think once, twice, and thrice, before it gives up. But it is the greatest delusion in the world to attribute the commercial preponderance and prosperity of England to our having a gold standard. Our gold standard is not the cause of our commercial prosperity, but the consequence of our commercial prosperity, and it is very well for us to have it; but you cannot establish a gold standard by violent means. It must arise gradually from the large transactions of the country, and the consequent command it may have of the precious metals. When the various States of Europe suddenly determined to have a gold standard, and took steps to carry it into effect, it was quite evident we must prepare ourselves for great convulsions in the

* This identity of coinage need not lead to the mutual legal tender of the coins. American new five-dollar pieces, or the proposed silver dollar may be admitted into England, and should not be legal tender. If the balance of trade requires their permanent stay here, they can easily be recoined; if they come here incidentally they can be used for re-export. The withholding of the legal tender would keep this matter under proper control without destroying its usefulness to account-keeping and to travellers.

money market, not occasioned by speculation or any old cause, which has been alleged, but to a new cause with which we are not yet sufficiently acquainted, and the consequences of which are very embarrassing; and that is the cause I have taken the opportunity of calling your attention to. Take the case of Germany. At this moment it is most remarkable when there has been such a want of gold standard in various parts of Europe, and in England, where the strain has been so great, Germany has at this moment fifty millions sterling of gold coin virtually locked up; and it is locked up because it is the object of Germany to substitute a gold coinage for a silver coinage. While it has fifty millions value in gold coinage locked up, it has eighty millions of silver circulating; and they know very well if they were to attempt to substitute violently the gold for the silver coinage—fifty millions of gold against eighty millions of silver—the consequence would be that the silver already reduced in value would become reduced still more, and the fifty millions of gold would all leave Germany. The consequence is that Germany is taking violent steps to get rid of this silver. The other day Germany sent a large amount of silver to Calcutta, and Germany could only have an artificial means of forwarding it; and the result was, for a considerable time you could not buy a single bill on England. These are all circumstances calculated to disturb the course of commerce and manufacturing arrangements. Then, again, take the case of France and America, which are floating an inconvertible paper; but France has also at this moment ninety millions sterling of French pieces. What must be the position of France with all that silver already depreciated, when Germany is acting on France, as she can, by getting rid of her silver coinage? By that throwing it into France, France would be in a position of great embarrassment, and would make violent efforts to establish as soon as she can a gold coinage at any cost. Great disturbance and immense fluctuations must arise from circumstances of this kind. I regret to treat matters of this kind at a moment like this, because they require to be treated with more precision of language and with greater patience than either I or you can afford at this moment, but it did appear to me a subject to which I ought to call your attention. You are commercial men interested in the monetary system of the world; you ought to have your eye carefully upon the efforts which are making to establish a gold standard of value in Germany, in France, and soon you will find also in America. Legally, of course, there is a gold standard in America, but virtually there is not, in consequence of its present state of depression. Holland and all the Scandinavian States are also bent on establishing a gold standard; and when countries inundated with silver are trying to get rid of it, convulsions must come, and no one would be able to form an adequate idea of the monetary arrangements of the times in which he lives if he omits from his consideration the important subject to which I have called your attention. I have drawn your attention to it to-day because you must know it is very difficult for me to address you under the conditions in which I meet you to-day."

Some of the passages in this speech are most significant as showing how the mind of the speaker was ready to throw, and to receive further light on the question. The cautious allusion to the gold valuation in England, as being a consequence of, and not the cause of our prosperity, is most characteristic of the statesmen, who is probably well aware of the violent outcry which might be raised against him if he gave it but the appearance of a party question, if he had then become its champion. But this should not be a party matter, it should be removed to a higher sphere of consideration. If it be borne in mind that in November, 1873, when Mr. Disraeli said "that we ought to think once, twice, and thrice, before we made a change," silver stood still at the fairly normal price of 59½ pence, and that it has since, within 25 months, fallen to 53 pence, or by 12 per cent. If Mr. Disraeli prognosticated these convulsions at that time, has he not greater reasons now for urging the consideration of this matter upon the public? Is there now, since India's interest knocks loudly at the door, since Indian bankers, merchants, retired pensioners, are at their wits' end, a better chance of the voices of reason and deliberation being heard, in preference to the cries founded on false doctrines, or mere habits of a practice of no greater length than 60 years in the life of a single nation? I have said before, this subject is not one upon which the great public itself can decide; matters of this kind cannot be popularised, the educated alone may be able to see its vast importance. It depends on the superiority of the intelligence of thinking men in England whether they will give to Mr. Disraeli, if he should hold these views and determine to act upon them at this important decisive moment, sufficient support on behalf of the subject at large; and for this purpose let me hope the material furnished in this treatise will at least awaken the sensibility of the most orthodox believers in the gold valuation, and induce them to respect that which our Government may possibly, or ought to, propose to do under the circumstances.

England could do no nobler thing, one in which not only India, but all the British empire and influence, besides the world at large, has a greater stake, than initiate this international conference. Let sceptics on the importance of this subject ignore, if they like, all that has been said as to the revolutions and difficulties which are here predicted. The history of commerce has phases, which, with or without traceable connection with political and social welfare, afford us example of what is now in prospect. Between the acquisition of treasures by Rome to the Middle Ages, when Spain brought the immense metallic treasures to Europe, a period of 1,500 years elapsed. The effect on the civilisation of the world is on record. The next great historical event, 350 years later, was the discovery of gold in California and Australia. What that has done in multiplying commerce, including development of civilisation, within the last 30 years, is under our eyes at present. It is idle to say other Californias will be discovered. The world has been sufficiently explored, and although other gold-fields may exist, they can only be in the icy north or the fever-breeding tropics, and therefore inaccessible to Europeans. On the contrary, the production of gold has declined by one-half.

Mark then, that which threatens to take place now, viz., the demonetisation of silver, is an equally important and quite a new historical event in the opposite direction. If the balance is upset by one nation, and not restored by the international agreement of all, it is tantamount not only to an absolute destruction of more actual money than has accumulated within the last 200 years, but beyond this, it would annihilate the use of the fresh supplies of silver from which commerce might benefit hereafter; and both the already increased population, and their future increase, enlarge the proportions of the abstraction in a still greater ratio. Is this

a matter which can be lightly passed over by a scepticism and phraseology about cheques, bank notes, and all sorts of expedients? Without reference to the connection between such expedients, and the law that in the great system of intercourse all factors rise and fall according to their respective level, and the fact that actual money is the main factor in this equilibrium, there is sufficient "negative" in this historical event, *i.e.*, the wanton demonetisation of silver, to rouse the attention of the most sluggish intellect.

The writer of this paper says all this, well aware that a prophet of evil is not a welcome personage; but in this case the evil is not one of unavoidable fate; it turns on the decision which reflecting human intelligence will take for either evil or good. The allusion to the wider historical aspect of this matter may therefore not be out of place. What we have to decide here, is whether the future of commerce and industry, the chief objects and agents of civilisation, is to be left to the at least "happy-go-lucky" fate which the advocates of the gold valuation prepare for it, without showing us figures—or whether we have grasp of mind sufficient to combine these higher general reflections with the intensively practical figures and detailed proceedings required. Thinking men may therefore not scorn that which has been laid before them on the score of facts, to the best ability of the writer, and the arguments and conclusions which he has ventured to advance. They can bear any reasonable reduction, and leave sufficient margin for serious reflection and proper action.

And finally I repeat, unless this international conference be held speedily, unless England takes the lead, and unless a full restoration of the general valuation takes place, the downward course of the decline of silver will continue, until within the next few years, all the evils and consequences are upon us, and have inflicted incalculable damage, which cannot be repaired, and which will render the satisfactory settlement of the matter almost impossible.

The discussion was adjourned until Tuesday, March 7th, when it was again adjourned to Monday, the 13th inst. The report of the proceedings will appear in the next *Journal*.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 8th; Major-General Fred. C. Cotton, R.E., C.S.I., Member of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Banmann, F. W., Neva-cottage, Clapham-park, S.W.
Borthwick, Lord, F.S.A., 35, Hertford-street, W.
Brett, Robert W., Gas Works, Hertford.
Brothers, Francis William, 16, Priory-street, Cheltenham.
Curtis, James, Alpha-villa, Stanstead-road, Forest-hill, S.E.
Furnival, Thomas, junr., The Brampton, Newcastle-under-Lyme.
Hancock, Peter, Gas Works, Sandbach, Cheshire.
Jones, Charles Edwin, Tintern-villa, Compton-street, Chesterfield.
Martin, Josiah, Model Training School, Auckland, New Zealand.
Nicholson, Benjamin, Annan, N.B.
Pixley, Stewart, 21, Leinster-gardens, Hyde-park, W.
Stewart, Duncan, London-road Iron Works, Glasgow.
Walduck, Charles Edward, 148, Gresham-house, Old Broad-street, E.C.

The following candidates were balloted for and duly elected members of the Society:—

Backler, Henry McLauchlan, F.R.G.S., 11, Austin-friars, E.C.
Boese, Waldemar, Memel-villa, Dulwich-road, Herne-hill, and 22, Great St. Helen's, E.C.
Cadman, Major William Edwin, 28, Upper Park-road, Haverstock-hill, N.W.
Carter, R. Brudenell, 69, Wimpole-street, Cavendish-square, W.
Heath, Arthur Henry, C.E., Royal Engineering College, Cooper's-hill, near Staines, Middlesex.
Peebles, D. Bruce, The Fountain Bridge Works, Edinburgh.
Rosebery, The Earl of, 2, Berkeley-square, W.
Wilkinson, Thomas Read, Manchester.

The paper read was—

HALL-MARKING OF JEWELLERY.

By Alfred Lutschaunig.

The paper I have the honour of reading to you to-night, on the subject of Hall-marks, has for its object, not merely to lay before you the general outlines of the system at present in operation, but also to make some remarks on the manufacture of jewellery, and the abuses which are practised by unprincipled manufacturers and traders on the ignorance and good faith of the public. The subject, though at first sight insignificant, assumes, when carefully looked into, great importance, and culminates, when thoroughly examined, into a veritable national question, as I shall endeavour to show further on.

I shall also, after touching upon all points, propose the outlines of a new system, which should take the place of the old one, and this, I believe, will form the debateable ground.

We all know that the love of ornamentation is a passion which has to be gratified, and we cannot say to the public, "If you are not satisfied with what is offered to you in the way of jewellery, do without the gewgaws." The craving after ornamentation is almost a vice. The passion can be traced back through all ages, and to all nations, whether savage or civilised, in all countries, and in all climates. Naked humanity ornaments its skin; dressed humanity adorns its dress. But nature in all cases, according to the views of humanity, requires a little touching up.

This admitted, then, that ornament, and particularly gold ornaments, are absolutely necessary to the well-being of society, let us examine them. I have but a short time allowed me this evening, and I can only just lightly touch upon every point. The main and principal object of this paper is, after showing up the actual state of the jewellery trade, and proving, if possible, the thorough inadequacy of the present system of Hall-marking, and the action of the Goldsmiths Company as a protection to the public, to excite a discussion which may lead to a remodelling of the at present existing state of things.

Of the ten assay towns of the United Kingdom, we may safely say that three or four almost monopolise the marking of the whole of the jewellery manufactured in this country, and when we consider what millions of articles are produced, it is at once evident that each article cannot be properly and separately examined. The moment we admit this fact, we also admit that a system requiring a separate examination of every small object, and a separate stamping, say even of every link of a chain, is a thing impossible, and must, sooner or later, make way to a simpler and more efficacious system, embracing the whole of the goods, large and small, manufactured of gold and silver. We will say nothing of the great temptation to forgery which the present system affords, and which is so common that the Hall-mark is as good as no guarantee at all. The Goldsmiths' Company hardly ever prosecutes; there must be an instinctive dread of touching upon this tremendous question. It feels that if the question were once fully started, it could not face the astonished and indignant British public.

Then, as if to invite and make forgery easy, and bewilder the public, look at the extraordinary varieties of marks which we have here represented. You see it requires a special study to understand them. Of course, when the marks are genuine, the parts on which they are struck are also of the quality indicated by the marks. I do not wish to attack the honesty of the assay, but then there is no safeguard against what is called transposition and addition. The piece of metal immediately adjoining the piece marked may be of a different quality altogether. There was a letter in the *Times*, only a few days ago, from "A Bond-street Goldsmith." It is quite short, and I will read it, as it confirms what I say:—

"Permit me to say that I most heartily endorse the remarks in your leading article on Mr. Gladstone's speech relative to the duties of our great City companies. Surely, after such a note of warning, the masters and wardens of the various guilds will put their 'shoulders to the wheel.' Foremost among them ought to stand the Goldsmiths' Company. Their charter gives them power 'to send wardens from shop to shop among the goldsmiths, to assay if their gold be of the touch specified in the statute.' If they would but exercise this privilege, and visit all shops occasionally, the public would benefit immensely. Frequently goods are brought to me stamped 18 carat, maker's mark, &c., under an impression that they are Hall-marked, but they in reality are only colourable imitations, base metal invariably being found between the gold parts. So extensively is this practice carried on, that there are hundreds of watch-chains now in circulation, one link bearing the mark 18-carat, the next link, not marked, quality about 6-carats; and so on throughout the chain. It is impossible for the public generally to detect these frauds, and I assert that it is, therefore, the absolute duty of the Goldsmiths' Company to search out and prosecute all and any person making, selling, or otherwise disposing of such spurious articles. I trust some real good in this direction may yet be effected by the Goldsmiths' Company."

Then, there is another complaint against the present method of Hall-marking; the punches are clumsy, and spoil and disfigure the work—can in fact not be used at all on fine work. Watch-case makers have frequently told me that they have sometimes the greatest trouble in flattening down the metal that has been made to project by the rough use of the punch. A delicate outline punch would be far preferable.

You are aware that the Goldsmiths' Company recognises three lower standards and three higher standards.

The numbers	9 = 0·375 = 37½	per cent.	of gold.			
	12 = 0·500 = 50	,,	,,			
	15 = 0·625 = 62½	,,	,,			French.
	18 = 0·750 = 75	,,	,,			0·750
	20 = 0·833 = 83⅓	,,	,,			0·840
	22 = 0·017 = 91¾	,,	,,			0·920

If we examine these figures in another way, we find that, though in decimal form, and in the form of per-centage, they are very irrational; yet, when viewed in another way, they show a certain method.

If we take, for instance—

9 carats	= 9-24ths	= $\frac{3}{8}$	
12 ,,	= 12-24ths	= $\frac{4}{8}$	
15 ,,	= 15-24ths	= $\frac{5}{8}$	
18 ,,	= 9-12ths	= 9	oz. gold in 12 oz. or 1 lb troy.
20 ,,	= 10-12ths	= 10	,, ,, ,,
22 ,,	= 11-12ths	= 11	,, ,, ,,

In the first instance we have 3, 4, and 5-eighths, for the lower standards.

In the second instance we have 9, 10, and 11 ounces of gold in the pound troy.

These calculations are, however, old-fashioned and complicated. I may be permitted to remark here that, amongst other things, our weights and measures require also a thorough revision. A pound troy, for instance, is less than a pound avoirdupois, but an ounce troy is more than an ounce avoirdupois, for the one pound has 12 ounces, whereas the other is divided into 16.

To return to the gold standards, I will remark that 22-carat is only used for the coin of the realm and for wedding rings. 18-carat is the most suitable for working. And 12-carat ought to be the lowest, as the metal would then be half-and-half, and has as much right to be termed gold as brass.

I pass over the marking of silver, as I shall have no time to enter upon that subject this evening. It is, besides, of minor importance.

We have now superficially glanced at the theory of Hall-marking, we will pass to see how it works in practice.

I must really, at reaching this point, pay a tribute of justice to Mr. Edwin W. Streeter, of New Bond-street, who, indignant at the discredit that was being brought on the jewellery trade, called together, on the 6th of April, 1873, a select number of friends and the members of the press, and exhibited a number of articles bearing the mark of the Hall. The articles were picked specimens of ingenious swindling. The subject was readily taken up by the press, and very able writers have done their best to excite public attention, and call special notice to the growing evil. Mr. Streeter, for thus stepping prominently forward as the champion of honest jewellery, deserves the greatest credit, and I am sure the public of London will show a due appreciation of his exertions.

I will now read to you extracts from a few of the leading papers, written under the impression of what had been seen in Conduit-street on the afore-mentioned 6th of April. These extracts chime in so remarkably with the subject of my paper, that I have decided to embody them. There is, besides,

much valuable moralising; and coming, as they do, from able writers of the press, and corroborating all my statments, I have considered it very advisable to quote them :—

"On Saturday evening, a considerable number of gentlemen connected with the jewellery trade, including the President of the Pawnbrokers' Association, attended the conference at the establishment of Mr. Streeter, Bond-street, for the purpose of inspecting a large quantity of spurious Hall-marked jewellery, with a view to proving that the process of Hall-marking, adopted by the Goldsmiths' Company, is no protection to the public, in the purchase of what they are led to believe to be a guarantee that the articles so purchased are genuine. A large collection of articles was produced and examined, but the selection of two or three will suffice to illustrate the fact that the public are subjected to the most astounding frauds, even with respect to that which is looked upon as jewellery of first-class character, and for which the highest price is paid. A lady's elastic neckchain, bearing the hall-mark as 18-carat gold, the value of which, if genuine, would be £11, was found to consist mainly of silver and red lead. A pawnbroker had lent £6 10s. upon it, and when assayed its intrinsic value was found to be 22s.

"A chain on which a pawnbroker was induced to lend £7, was found to be worth 36s.

"Another chain, every link of which is stamped as 18-carat gold, and on which £10 had been lent, was found, on being assayed, to be but 11¼ carat."

This article was reprinted in the *Times*.

The *Daily Courier*, of Liverpool, April 8th, 1873, says :—

"The process of Hall-marking adopted by the Goldsmiths' Company is no protection to the public, in the purchase of what they are led to believe to be a guarantee that the article so purchased is genuine. A large collection of articles were produced at Mr. Streeter's, in London, and examined, to illustrate the fact that the public are subjected to the most astounding frauds, even with respect to that which is looked upon as jewellery of a first-class character, and for which the highest price is paid. An advertisement from an East-end jeweller was produced, offering to supply Hall-marked gold rings to the public at 5s. each and upwards, and a ring with his invoice was produced, which, although bearing the Hall-mark, was found to be filled with cement.

"A brooch, the outer casing of which was thin gold, and Hall-marked, was filled with copper exactly fitting the mould of the brooch. These frauds, it is contended, are committed by working jewellers, to whom the West-end firms entrust their gold to be manufactured, and it is argued that, so long as the Goldsmiths' Company consent to Hall-mark unfinished and hollow jewellery, there is no check. In France and America the Hall-marking is done by Government, and they refuse to affix the mark until the article is completed. If that system were adopted, and every shopkeeper compelled to guarantee the quality of the gold he sells, the public would be protected."

The following is from the *Standard*, April 7, 1873 :—

"The question of the Hall-marking of jewellery is one of the greatest importance to the public The amount spent yearly in gold and silver articles is immense, and there are few who do not, at some period of their life, expend money in watches or jewellery for themselves or others. The belief in so doing they are buying articles of an intrinsic value, approaching at least to the sum paid for them, and that the goods will retain their value for a long period, and be thus a sort of investment for money, operates in a large number of cases as an inducement to people to spend more money upon jewellery than they could otherwise afford to do. Good jewellery indeed is always within a small amount worth the money given for it, and should approach nearly to its weight in sterling gold. In the days of our forefathers this was so. No gold was allowed to be sold under sterling, a severity which afterwards relaxed to 18-carat gold being permitted. With 18-carat gold people at least knew that they were getting goods containing three-fourths of their weight in gold. Now, however, the Halls mark 15, 12, and 9-carat, while articles are exposed in the windows of the jewellers' shops called gold, but containing only one-twentieth part of the precious metal.

This is a very important fact, and I wish to bring it out most emphatically. Whether this immoral system of cheating should be permitted, may be a question, but it is one into which I do not purpose entering. The more urgent question of Hall-marking is now before us.

"People who really wish to buy good articles always ask if they are Hall-marked. To them the unintelligible hieroglyphics convey no more distinct idea than if they were arrowheaded characters.

On the important question of so-called "duffing"* jewellery I can only venture a few remarks in passing; it is a wide field, too extensive for me to-night. It embraces not only the metal but also the stones. It consists chiefly of goods thickly gilt, containing an alloy which is anything but precious metal, and with a forged Hall-mark.

A few words more from the *Standard*, and I have done with my quotations.

"The articles exhibited at Bond-street were all genuine Hall-marked articles, articles which a careful purchaser, armed with a treatise on Hall-marks, a powerful magnifying glass, would have bought fearlessly, and would have taken home under a profound conviction that he had received full value for his money."

The present system of marking any pieces of unmade-up jewellery, and of hollow pieces evidently intended to be filled up with base metal is offering a premium to dishonesty. In fact, as it stands at present the Hall-marking does more harm than good. For if there were no Hall-marking the purchaser would only go to tradesmen of known respectability, and take his guarantee as to the quality of the gold, whereas at present he is careless, relying on the Hall-mark. It may be said that the halls prosecute in cases of forgery. That they have the power to do so is undoubted; but when we consider the fact that we are inundated with worthless jewellery, and that we scarcely ever hear of a prosecution, it is evident that, in the first place, they are so wealthy that they do not care about the trouble of prosecuting; and that, in the second place, they do not desire it to be made public how little purchasers can rely upon the hieroglyphics known as Hall-marks. Even the members of the Goldsmiths' Company, the ultimate arbiters in such matters, confess that they are powerless in many cases. It is not very long since they issued a regulation not to mark chains, except of a specified weight and character, in consequence—to use their own words—"of having discovered that extensive frauds were being committed" in the matter of gold chains, which, if the present practice of marking were continued, they could see no means of preventing.

Here we have it, on their own showing. Any-one looking at the daily police reports, cannot fail to notice the frequent cases of base coinage. The

* "Duffing" is a slang word for cheating.

solicitor to the Treasury would attest to the extreme difficulty of keeping even the coin of the realm unsullied.

The anomaly of the law on the subject of Hall-marking will be readily understood, from a decision given by Commissioner Kerr, in the case of Defries v. Dalton and others, heard in the City of London Court. The plaintiff had purchased some goods Hall-marked, 15-carat, which, on testing, were found to be 9-carat. The Commissioner decided that the plaintiff could not recover against the defendant, but could recover against the Goldsmiths' Company, who had put on the goods stamps defining weight and value which were wrong. Such a judgment offers no relief. No one in the trade would bring an action against that corporation. It would be fighting against tremendous odds. There is another case where the law, and consequent justice in England, is too weak for the rich, too dear for the poor.

We find, on the one hand, too much importance attached to the Hall-mark, and on the other a great prevailing ignorance as to its real meaning. What with date letters, municipal marks, lions rampant, and lions passant, makers' marks, and duty marks, there are about 250 cabalistic signs, unintelligible to the British public.

It has long been my idea that the time has arrived to do away with the action of the Goldsmiths' Company altogether. The Goldsmiths' Company is an obsolete institution, one of those remnants of the dark ages, incompetent to cope with the present state of things. The impotency of the Company to meet the evil is apparent by the number of charters which have been found necessary to be granted to it ever since the year 1392. The first charter to the Company was in the reign of Richard II., 1392, bearing date 6th of February, and we may consider that this corporation here first steps forward on to the stage. It grants and gives license to the men of the said craft of goldsmiths of the City of London, to be a perpetual community or society of themselves, aud elect yearly out of themselves four wardens, to oversee, rule, and duly govern the said craft and community. This is the beginning of the Right Worshipful Company of Goldsmiths of the City of London.

In 1462, Edward IV., another charter was granted. In 1504, Henry VII., a further charter was found necessary.

But the natural tendency to mix too much alloy seems ever to have been very great, for as far back as 1238, frauds are recorded as having been practised by gold and silversmiths, and it became necessary to introduce some legislation to prevent this practice.

The great mischief, however, as far as we are concerned, begins with the passing of the Bill allowing articles of the three lower standards to be stamped—reign of Queen Victoria, 1854. Here the reins seems to have dropped from the hands of the Goldsmiths' Company altogether, and it has lost all control over the millions of articles flooded into the market. Forgeries, transpositions, additions, loading, filling, and all the clever swindling that clever craftsmen can devise, have been adopted with impunity.

Then, again, the charter of the Goldsmiths' Company make no provision for the frauds now being practised in our colonies. Of course all has changed, and the old body cannot march with the times. Watch-cases are sent from Switzerland and America with forged English Hall-marks, and are sold in India, China, Australia, Japan, and the rest of the world. What control can the Goldsmiths' Company possibly have in these cases?

Nothing short of a clearly defined and a clearly expressed personal guarantee of a jeweller of established reputation will meet the evil. The company can no longer control the immensity of the jewellery trade, and a new Act of Parliament is absolutely indispensable, relieving this body of its duties, and taking the supervision into its own hands. This duty will devolve naturally on the Mint. The revenue which Government derives from the assay offices, for duty on gold and silver stamped, might be also greatly increased, and levied in a simpler manner; and the public would be satisfied as to the quality of the goods they buy.

I have consulted many friends as to the possible modifications in the present system, and all agree with me that the time has come for the old edifice to be pulled down, and for a more modern structure to take its place. No half-measures will meet the evil. Never mind the vested interests of a wealthy corporation. The battle will be fierce, but the victory will be to public opinion.

Jewellery, as I have already said, is a vanity and a luxury, and is purchased only by people who have money to spare. A tax upon jewellery, therefore, would be felt by no one. This is necessary, in order to replace the small revenue to Government, I have already mentioned. An intending purchaser, who has made up his mind to spend, say, about £100, will just as readily spend £110 as £100, for a jewel. It seems, therefore, very rational to tax such a pure luxury, instead of burthening the very necessaries of life. And were this scheme to succeed, as I think it must, what a pleasant satisfaction it would afford to think that an impost upon what we have to spare can successfully compete with the crushing duties on the most needful for the sustenance and comfort of life of other nations. I sincerely hope this will be a hint to legislation. I shall endeavour to show also what the probable financial result would be of the introduction of such a new scheme.

Inspectors of weights and measures go their rounds, Custom-house officers are on the constant look-out to protect the revenue, fussy analysts annoy well-meaning tradesmen, but it seems nobody's business to look after the adulteration of the precious metals. There is no established legal definition of the word "gold;" nobody to prosecute forgeries. The Goldsmiths' Company is too busy, and shrinks from being brought prominently forward, for a thorough investigation of the present state of things would hasten that inevitable fate which cannot be far off.

I will quote an example of the indifference with which this corporation treats complaints respecting forgeries. The Secretary of the Liverpool Pawnbrokers' Association, Mr. Alfred Hardaker, had once occasion to present himself to the Goldsmiths' Company with a gold chain bearing a forged 18-carat mark. The metal only assayed $11\frac{3}{4}$ carats. A promise was given then that the matter should be investigated, but, after some delay, it was

decided to let the matter drop, on the ground that the marks were not forgeries of *their* Hall.

On the 4th of February, 1856, it was ordered by the House of Commons that a Select Committee be appointed to inquire into the offices for assaying silver and gold wares in the United Kingdom. The members nominated for the Committee were:—Messrs. Wilson, Liddell, Stanley, Hankey, George Alex. Hamilton, Spooner, Brand, Wilkinson, William Ewart, Bentinck, Peacocke, Muntz, Dunlop, and Masterman.

Persons, papers, and records were sent for from the assay towns of the United Kingdom, and the following report, after a good deal of discussion, agreed to:—

Report.

The Select Committee appointed to inquire into the offices for assaying gold and silver wares in the United Kingdom, have considered the matters to them referred, and have agreed to the following report:—

"1. Your Committee have examined a large number of witnesses from the principal assay towns throughout the United Kingdom.

"2. The existing assay offices are ten in number, and are established at the following places, setting them down in order according to the amount of assaying performed at each office:—London, Birmingham, Sheffield, Exeter, Chester, Glasgow, Dublin, Edinburgh, Newcastle-on-Tyne, York.

"3. The state of these offices, as to management and efficiency, differs widely. Your Committee find that those offices, in which a larger amount of assaying is performed, are conducted in a satisfactory manner; while the smaller offices are, generally speaking, in an inefficient condition, and do not afford proper security to the public for the accuracy of their work."

[There is an admission at once, after a careful investigation, that they do not afford proper security to the public.]

"4. Your Committee are of opinion that the inferior condition of the smaller offices may be accounted for by their imperfect constitution, and by the absence of effective regulations, existing in the larger offices, for the testing the accuracy of assays—[and the public is expected to place faith in the Hall-mark in the face of this admission]—and partly by the more limited income which the smaller offices derive from assaying, and the consequent want of funds to place them in a superior condition.

"5. In the progress of their inquiry it has been made manifest that the laws regulating the assaying of gold and silver are in a most confused and unsatisfactory state."

[I shall not be accused, I hope, of libelling the Company, and my object, partly, in reading to you this rather dry report, is to protect myself. The proofs of the correctness of my assertions are numerous enough.]

"These laws are scattered throughout a multitude of statutes, some of which are of very ancient date. Almost every assay office is established and regulated by statutes or charters, exclusively applicable to itself. Thus the assay offices at London, Birmingham, Sheffield, Chester, Edinburgh, Glasgow and Dublin, are regulated by separate statutes, differing more or less widely in their provisions.

"6. Your Committee are of opinion that the practice of assaying is calculated to afford protection to the public against fraud, and ought to be maintained, and they regard it also as a convenient mode of collecting the revenue.

"7. Your Committee strongly recommend that the several statutes by which the assay offices are now governed should be repealed, with a view to removing the anomalies and confusion of the existing law, by consolidating into one statute all the provisions requisite for the establishment and regulation of assay offices throughout the United Kingdom, whereby their constitution may be placed upon a sound footing, and full security afforded to the public for the the correctness of assays in all offices without exception."

[From this, it is apparent that the Committee were not satisfied as to the correctness of the assays.]

"8. Your Committee further recommend that, among other provisions of such a statute, power be given to open new offices at any place in the United Kingdom, where it can be shown, to the satisfaction of the Treasury, that the manufacture of gold and silver wares requires such establishment for the convenience of trade, and where the income derived therefrom would be sufficient to defray the expenses; and to close any office where the amount of work is insuffcient to support it, or where the work is inefficiently performed.

"9. Your Committee do not apprehend any serious difficulty in framing a comprehensive measure, by which all assay offices shall be placed upon a uniform and well-regulated system, applicable alike to England, Scotland and Ireland."

May 1, 1856.

The Remedy.

I have laid before you, to the best of my abilities, the system of Hall-marking at present in operation, and have pointed out its many shortcomings. I will now venture to suggest a new scheme, which is to supplant the action of the obsolete and badly-regulated Goldsmiths' Company.

In framing the new scheme I shall have to bear in mind not only the protection of the public, but also the revenue to the Government.

Before even attempting to grapple with the evil, we must begin by—

1. Complete abolition of the action and interference of the Goldsmiths' Company. The grievances against this company, shortly summed up, are:—Nonfulfilment of duty; inability to devise a simple, practicable and rational method of control over the ever-increasing manufacture of jewellery; and a drowsiness of action as regards all innovations required by the altered state of things. I will add, that in the face of the present progress, the Goldsmiths' Company stands like an old dilapidated house in the midst of modern, handsome buildings.

2. The adoption of only three standards, 12 carats (articles to melt down to 11 carats), 18 carats (articles to melt down to 17 carats), 22 carats (articles to melt down to 21 carats.)

I would here remark that 12-carat ought to be the lowest that should bear the name of gold. A legal definition of the word might here be inserted, namely, any article which is not all through alike, and does not melt down to 11 carats, is not to be termed gold.

3. Government inspectors to be appointed, with power to buy at fixed prices any article in any stage of manufacture, at any time, from the jeweller's workshop, for the purpose of having them assayed. (The Factory Act now in force gives this power in other instances.)

The manufacturer would have to send a batch of goods to be inspected and examined, the inspector reserving unto himself the right of breaking up the

whole, should one piece be found defective as to quality.

What a risk an attempt at fraud would here involve. The touchstone might be used by the assayer, as in France; but this is a purely technical question.

A new Act of Parliament should be passed, which might be called "The Gold Adulteration Act."

All articles that are plated should be marked plated.

No doubtful unintelligible cabalistic signs, imitating as closely as is safe the real Hall-mark, would then be practicable. The simple word plated would say all, its absence would be misdemeanor.

4. Every jeweller to give a written guarantee or invoice; and all jewels to bear the jeweller's or manufacturer's mark for identification.

5. Every jeweller or dealer in jewellery to have a license, forfeitable in case of misdemeanor.

6. An *ad valorem* duty to be imposed on all jewellery manufactured, and charged on the gross proceeds of every jeweller's yearly sales, value of gem jewellery included.

We will now enter upon a rough calculation as to how much a duty of 10 per cent. would produce every year to the Treasury. It is a rough and approximate calculation merely, and nearer guess-work than anything else; but the difficulty is in this instance no greater than in the first estimate of the probable yield of the income-tax.

I estimate the number of first-class jewellers in the United Kingdom at 2,400 (there would be as many more small ones), each selling yearly, on an average, to the value of £5,000 (gross value).

This would give £12,000,000 for money expended every year by the British public on jewellery. Ten per cent. on this amount would yield £1,200,000, which, of course, the public would be charged with by the jeweller.

Watches and gem jewellery are here included. There exists no good reason why watches should not pay duty.

The jewellery from Germany and France should pay a proportionate duty.

All wrought silver should pay an *ad valorem* duty, which on 3,000,000 ounces yearly, would be at, say 1s. per ounce, £150,000.

Goldbeaters' leaf, which is mostly imported, should also pay duty, in the form of a stamp on every book.

In short, I think that, with the existing machinery for collecting the revenue, such as income-tax collectors and others, with perhaps an additional slight expenditure, the trade in jewellery and gold might be taxed, to the detriment of really nobody, so as to yield a million and a half sterling every year to the Treasury.

DISCUSSION.

The Chairman said the demoralisation arising from the present state of things was very great, and it was very evident that the present state of the law left the public open to any amount of deception.

Mr. Edward J. Watherston, while thanking Mr. Lutschaunig for his able paper, and acknowledging his facts, came to very different conclusions. He was a member of the obsolete corporation to which reference had been made, and might make this remark with reference to it, that considering the enormous increase of the population over which they now presided, it was no wonder that the Goldsmiths' Company did not now answer the purposes for which it was intended, when founded in the reign of Richard II. He felt certain the time was come when there ought to be no Hall-marks at all, when, in fact, they should be replaced by the reputation and character of the maker. It would never do to go back to the old-fashioned legislation now recommended, which had been completely overturned at the abolition of the corn laws, and could never be re-introduced. It was impossible in these days of free trade, when the commerce of the country had so enormously increased, to go back to a state of protection. His opinion was, that any one should make chains of 1-carat quality if he liked, though, of course, he preferred the high-class trade, with which he hoped his name would always be connected. People came to him, and to other first-class manufacturers, and never asked for any Hall-mark; they could not get Hall-marked lobsters, carpets, pianofortes, coats, or other articles, and he thought the trade of a goldsmith should be as free as that of a fishmonger or any other. He had heard the report of the committee, and felt sure that if the question was put before them now they would make no such foolish suggestions as that there should be any kind of espionage over the trade. In fact, with the present population it would be impossible; it would keep the whole of Scotland-yard going to look after the goldsmiths. If you wanted to buy good furniture you must go to a first-class shop, and if you did not you might get chairs which would not bear sitting on. He believed he spoke the sentiments of the trade, when he said that the Legislature ought to make it incumbent on every man to give a guarantee for what he sold, and then fine him by the criminal law if he cheated. If a man sold an article as 15-carat which was only 6, the county court or police court would be the proper place for him.

Mr. Streeter asked how a jeweller could give a guarantee that an article was, say 15-carat gold, when, as often happened with lockets, the box was of copper. Some of the first houses used copper boxes with gold lockets; and much of the so-called 15-carat gold would not assay more than 12.

Mr. Watherston said he only stood up for free trade. Let every man make what he pleased, if he could find buyers.

Mr. Webber said copper boxes did occur certainly, but he very seldom met with them. He did not think there was much value in Hall-marks in a good class trade; at any rate he had not found it so in twenty years' experience. If he stated that his goods were 16, 18, or 20-carats, it was accepted without a question, and there was an end of it. Practically he found the Hall-mark an encumbrance, especially when an article was wanted in a great hurry, because they took the best part of a working day to stamp and examine the article. He had been much interested by the figures given in the paper as to the proportion of gold in 15, 18, and 22-carat quality, and thought the numbers were simple and easily remembered. He chiefly differed from him as to the duty, which he thought would never be accepted. It was perhaps not generally known that at present the duty was only levied on wedding and mourning rings, though others might be Hall-marked. The time was gone by for levying a duty on one particular trade, and he could not find words to express his feeling of the inquity of any much measure. The figures given, however, as to the amount of business done by jewellers were very much under-stated.

Mr. White asked if he had rightly understood Mr. Lutschaunig to say that he heard of jewellery containing red lead?

Mr. Lutschaunig said he had had to take to pieces at the Liverpool Assizes a lady's bracelet, composed of a

very thin band of gold, under which was soldered a very thin band of silver, it thus formed a kind of tube, of the snake pattern, the interior of which was filled with red lead putty. The value of the gold in the bracelet was about 16s., whereas if it had been what it professed to be it would have been worth £9 or £10.

Mr. White thought the man who made it deserved something for his ingenuity. He held that the public were very much to blame for their own want of enlightenment in this matter, and suggested that the simplest way of testing the quality of jewellery would be by taking the specific gravity. York, which was his native town, was no longer a place of assay, and it was not right that such small places should be; when he lived there, there were two jewellers, and one assayer, and he was so intelligent that he did not know prussiate of potash under the name of ferricyanide of potassium. If he was a fair specimen of provincial assayers it was no wonder that jewellery of a doubtful character was produced. He must say he should not like such a system of *espionage* as was carried on in some places under the auspices of district analysts, whose powers in many cases led to great abuses.

Mr. H. T. Wood wished to ask Mr. Lutschaunig what system of marking he proposed for adoption when the Goldsmiths' Company was abolished. The great fault in the present system was that it was exercised by a series of absolutely irresponsible bodies, for he believed only the Assay-office in Birmingham was in any way responsible for its actions, its assays being tested every year at the Royal Mint. He was not aware whether the same thing prevailed at Sheffield. It appeared to him that what the trade had to complain of was the present defective system of Hall-marking rather than the thing itself. There was a natural feeling in every tradesman that he was insulted if his wares were tested, and a mark put upon them; but that was quite a mistaken feeling. Those who understood the matter could take up a chain and ascertain its quality, but the public had no means of knowing, and it was not everyone who had the opportunity and means of dealing only with first-class tradesmen. There was a great difference between jewellery and such things as coats and carpets, because of the intrinsic value. A person who bought a gold watch or chain looked upon it as a sort of investment, and expected to get nearly as much as he gave for it if he wanted to sell it, and therefore he required some kind of guarantee of its value. This the Hall-mark as at present existing did not seem to provide for; but a simple and proper system would. He should be glad, therefore, to hear any plan proposed which the public could easily understand, and which should take the place of the bewildering hieroglyphics now made use of.

The Chairman proposed a vote of thanks to Mr Lutschaunig, who had brought forward a most important subject, whether they agreed with him or not as to the remedy he proposed. He did not think it possible nowadays to introduce a tax upon the goods sold in any man's shop, but it seemed quite reasonable to forbid any Hall-mark on gold below a certain standard. It also seemed pretty clear that the Goldsmiths' Company were no longer equal to the task imposed upon them, and that some further legislation on the subject was needed.

Mr. Watherston felt sure the general feeling of the trade would be that no gold below 18-carat should be marked. 12-carat gold was altogether an anomaly.

The Chairman thought it would be well to abolish the carat system altogether, and speak of it as a percentage.

Mr. I. Chapman said he believed the lower qualities were allowed to be introduced in order to assist the country watchmakers at a time of great depression, when they were suffering considerably from foreign competition.

The vote of thanks having been passed,

Mr. Lutschaunig said gold and silver had never been classed with those articles which were within the province of free trade. Ever since the year 1200 they had been considered as equivalent to the coin of the realm, weight for weight, and free trade in such articles was impossible. There were many honest jewellers, but also many dishonest ones, and articles were palmed off for gold, which were only partially made of that metal. This sort of lie was doubly dangerous, because it contained a particle of truth in it. The public were safe as long as they had to do with honest men, but they were exceedingly credulous, and required to be protected. It would not do to allow the market to be inundated with doubtful articles, for it was a dangerous principle to allow of any sophistication in articles so nearly allied to the coinage. The trade was free at present, and how did it work? Ever since the year 1200 the Government had been trying to prevent this adulteration of precious metals.

Mr. Watherston said the era of protection was finished with the abolition of the corn laws, and he believed before long the duty on silver plate would be taken off, for the amount paid now was very little more than it was half a century ago, and the export trade was almost nil.

Mr. Lutschaunig said his proposal was that every manufacturer should be compelled to produce all articles he manufactured, small or large, and deliver them to the inspector in bulk; the latter should then take one at random and assay it, and if it were defective in quality he should be authorised to break up the whole. The Hall-mark should be abolished, but you must replace the revenue to the Government, and he could not see any objection to a tax on what was a pure luxury. The public would pay the duty, not the jeweller, though of course it would be levied on him in the first instance. If fifty millions worth of jewellery were sold annually, so much the better, it would produce a large revenue. Only silver was stamped at York, but he believed the charter was not withdrawn, as the name was mentioned in the House of Commons report. He did not propose any marks, but thought a law should be passed that all jewellery should be of a certain standard, that the definition of the word gold should be established, and that competent inspectors should be appointed with the power of visiting manufactories, which would be no more inquisitorial than other cases under the Factory Acts.

Mr. Streeter suggested in conclusion that the difficulty might be met by every jeweller being required to state the quality of the goods on the invoice.

The Haarlem *Société pour le progrès de l'Industrie* are about to establish a Museum of Applied Art. The classes to be represented are arranged as follows:—1. Reproduction in plaster. 2. Works in Metal and Electrotypes. 3. Textile fabrics. 4. Glass. 5. Pottery and Porcelain.

In 1874 there were taken out, in France, 5,746 patents: 4,202 for 15 years, 54 for for 10 years, 32 for 5 years, 283 foreign patents, and 1,175 extensions of former patents. The objects for which patents were taken out were in the following order for number: chemical industry, including food and drinks; machinery, textile industry, agriculture, domestic appliances. The average number of patents per annum, in the ten years before the Franco-Prussian war, was 5,300.

A proposal has been made that Queensland should enter into an arrangement with South Australia to construct a railway to Cooper's Creek from Dalby *via* Roma, Charleville, and Bulloo, and South Australia, to cut a canal *via* the lakes and valley of Cooper's Creek to the Queensland Railway terminus on Cooper's Creek, the canal to be so constructed as to allow of steamboat navigation, unless the South Australian Government prefer building a railway to the Queensland terminus.

CORRESPONDENCE.

THE PURCHASE OF THE SUEZ CANAL.

SIR,—I regret my inability to attend the discussions upon Mr. Magniac's paper on this question, on which I beg to advert to some elementary principles of political economy bearing upon it, as they may serve at least further to illustrate the public importance of providing for instruction in that science, in superior as well as in secondary education. The terms used by some noble lords and right honourable gentlemen in relation to the purchase of the shares in the Suez Canal, show that their knowledge of the principles of political economy applicable to it may be challenged as very defective. Thus Lord Sandhurst, in a letter to the *Times*, states that "In the first place it may be said that of all the traditions of Government, and more especially with regard to the principles on which as a nation we are accustomed to act, it is contrary to State policy that the Government of England should be a part owner, whether great or small, in a great commercial undertaking." As a nation, we have been accustomed to act for long periods in violation of the principles of political economy, but not until late times as respects the internal means of communication. As to tradition, it may be asked whether from the time of Pharaoh Necho, who cut canals near Suez, or the Romans with their great lines of communication, or our own "king's highways," they were formed by joint-stock companies for a commercial profit on shares—whether the tendency in most recent times has not been to abolish tolls even for the cost of maintenance, and to place the means of communication on the widest and cheapest public basis?

Adam Smith lays it down (Book V., chap. 1) as an axiom of political economy, "That the tolls for the maintenance of a high-road cannot with any safety be made the property of private individuals;" and he gave good reasons why they ought not to be committed to the uncontrolled charge of local authorities.

Now, the principles of political economy which stand opposed to the noble lord's assumption, are these—

First, that all taxes on the means of transit of persons, goods, or of information; all charges for highways beyond, at most, the cost of construction and maintenance—and usually not even those—are of the most wasteful and worst of charges, as commonly excluding more than the works are constructed to accommodate. Thus it may be stated, in illustration, that on the construction of the railway from Liverpool to Manchester the canal company, which had for a length of transit charged a rate of two shillings a ton—in desperation of utter desuetude from the competition of the railway, reduced the rate to sixpence; but it was in time found that the rate of sixpence produced much more than the rate at two shillings. Thus the rate at two shillings, whilst it accommodated one, hindered three. How much more would have been accommodated had the canal been made entirely free, trial only could determine. To take the example of a small rate. The penny toll on the Waterloo-bridge was reduced to a halfpenny, and the halfpenny produced much more than the penny. Hence the penny toll hindered more than it accommodated. The toll on the Southwark-bridge was abolished, when the traffic increased tenfold. In this instance the toll may be stated to have hindered ten times more than it accommodated. The Waterloo-bridge was a total loss to the shareholders; but its construction occasioned the formation of streets, and such an amalgamation of the rental of the land on the south side of the river, and probably some on the north, as would have made it remunerative to the owners.

I may greatly extend, with variations, the illustrations of the principle, comprising instances of railways where a total loss to the shareholders has been accompanied by a remunerative augmentation of value to the owners and occupiers of contiguous lands. The formation of the Suez Canal brought an increment of public value to the British exchequer, with the speeding of transit, by telegraph, in the creation of a three or four-fold "turn-over" of tea and other duty-paying commodities, which is to be taken into account against any risk of loss of interest from tolls. It follows, from the principle stated, that every effort should be made to remove "commercial" profits, and insure cheapness of transit by all public means.

It must be stated in the next place, that it is demonstrable as an economical principle, that the intrusion of the "commercial" principle, for the construction and maintenance of public means of transit, must make transit unnecessarily dear, and must be obstructive to the freedom of trade. For, on the so-called "commercial" principle, the works must be raised by private capital; and private capital must be dear—while public capital may be, and usually will be, cheap. Private capital is usually only "financed" for such purposes, at some ten per cent.;—everywhere, almost, it is raised on the promise of ten per cent. Public capital is raised at 3½ per cent. As a rule, even here, public capital is one-third cheaper than private capital. It follows, therefore, that on the public footing, such means of transit may be effected one-third cheaper than on the "commercial" footing. But a reduction of one-third in the rate will be productive of more than a third of benefit in the result.

It is obvious, however, that in the low condition of intelligence, and of public administrative capacity and perception of economic principle, and it may be added, from the prevalence of active sinister interests in legislation, that had it not been for the intrusion of the "commercial" principle on public functions, in late times the great works of improved means of communication, as well as of others, would yet have to be made. But where there is a disposition to revert to the correct economical principle and public duty, the opposition to it by the maintenance of the intrusion of the "commercial" principle into the public service, becomes protectionism of the worst sort;—protectionism and opposition to the freedom of trade for the profit of directorates and the profit of financiers;—often at the expense of the shareholders and the private money-lenders. This protectionism now obstructs the freedom of trade and internal means of transit in this country with some seven millions of extra charges, beyond what the service may be obtained for, by reverting to correct administrative principles. It is restrictive by its expense of branch extensions and developments needed for commerce.

The term "commercial" is indeed as little applicable with economical propriety to such undertakings as the one in question, as it would be to the direct lines of communication from Parliament House to Parliament-street, to the Thames Embankment, or to Westminster-bridge. It is now generally admitted by economists, other than directors—it was indeed admitted by the late Robert Stephenson, and is admitted by persons who have participated in the commercial and private proprietary principle—that there has been a large default in political economy, a default that must sooner or later be retrieved. At the outset of the system, and in correspondence with economists on the Continent, I gave forewarning against it, which I hope contributed to the maintenance of correct principles there. In Belgium the default first committed by the influence of example in England has been retrieved, to a great extent, with considerable advantage to its Arts, Manufactures, and Commerce. In Italy it has recently been retrieved very completely. In Germany it is about to be retrieved. In France it would have been obviated by the correct course of making out the lines to be formed and maintained by companies on competition for terms of years, and had not that course been departed from by undue extensions of the period of the concessions, the railways of

France would soon have been in the possession of the public. Indeed, it is reported that the noble Lord Sandhurst himself, as an Indian administrator, has joined in urging that the railways of India should be placed on an entirely public footing. Whether he has done so or not, it is now the general opinion of other distinguished Indian administrators that the principle contended for should be carried out completely. In India, the Government has been compelled to undertake irrigation works, and to take part in banking operations, and it has done so with more or less of public advantage; and there is a growing opinion at home, in commercial circles as well as amongst economists, that the functions of the Bank of England should be taken out of private hands and placed on a more responsible public footing.

It is asked by members of directorates in the House of Commoms, and by private financiers, "If the Government is allowed to enter into commercial affairs" (which, in the instance in question, it does not, but into the exclusive legitimate affairs of State, for the promotion of commerce), "where is it to stop?" The short answer may be where public economy and public utility stops. A pupil of a lower form in a political econony class might answer, "It will stop at the port, or at the door of the warehouse to which the public means of conveyance leads; or at the door of the commercial office, or of the private to which in time it may carry an ocean telegraph message, as well as a letter. It clearly and decidedly stops just where your legitimate occupation begins."

When it was announced that the whole of the property of the Suez Canal was about to be taken by France—that is to say, as private property by private French shareholders, to be wielded by them for private French profit—the dangers of the conditions were at once seen. But if it had all been taken "by England" — that is, by English shareholders, worked as a joint-stock company—though the evils might have been actually less to England under her condition of preponderant traffic, and less visible to us, the measure would have been, though in a less degree, obnoxious to foreigners, as the entire French holding was to us. Nevertheless, there could be no doubt that the English private joint-stock holding would altogether have been fraught with obstruction and increasing inconvenience to our commerce, calling for public intervention. If there had been an actuating perception of the applicable principles of political economy at the outset, the canal might have been formed under the auspices of a syndicate of the commercial nations, for mutual accommodation, and it would have been accomplished by cheap public capital instead of dear private capital—that is to say, at about one-third less of cost—and would have been formed on contract for maintenance as well as for formation, on the footing of a public service, instead of a private commercial undertaking for a private profit upon the private dear capital. The service would certainly have been obtained for commerce at one-third lower rates than those which now obtain.

The proposed purchase of shares in the canal by our Government appears, then, to be an important advance, on sound economical principles, towards getting the undertaking upon a legitimate public footing. But there are new conditions of the commerce of England and of Europe of which no account appears to be taken in public discussions, that render a proceeding for averting increased charges, and tending to the reduction of present charges and to the cheapening the cost of transit by all possible means, of peculiar importance at the present time.

"Look at the great increase of our commerce, at the increase of our imports and of our exports, especially through the Suez Canal; how prosperous it is," has been the exclamation at home. "Look at the progress of the British commerce in the East," is the exclamation in France. "They have got 75 per cent. of the traffic there; it seems as if the canal were made for them; what fortunes their merchants must be getting; they must be made to pay extra tonnage, and remunerate the constructors, which they can abundantly well afford to do."

"Our Indian commerce is being cut up, ruined; it is miserable," exclaim the old Indian houses, and in fact two of the most eminent have nearly discontinued business. Speed of transit by steam and telegraph is revolutionising all the Indian and Eastern commerce (and indeed our foreign commerce generally), and is reducing charges and profits to the disadvantage of merchants and shipowners; it is superseding intermediate agencies by enabling parties to deal with each other direct, to the advantage of the consumers on both sides. The foundation for their exclamations is evident from patent facts, *i.e.*, the great reductions of freights and commissions. It was lately announced that the great Peninsular and Oriental Company must now carry four times the cargo to get the same amount of dividend as they did ten years ago; and this same great company, with upwards of three millions of capital, and fifty large ships, with an organisation then deemed unexceptional, does not pay more than three and a-half per cent. A small venture, by a mercantile house with only two or three ships, would give up business rather than carry it on at such a miserable remuneration. French mercantile houses have given it up. The British ships are carrying goods from the French ports to India, and the British mercantile marine is carrying more goods than any othor, because it is doing it less than any other, being obliged to fight for anything it can get for existence. But the great company cannot give up as the small establishment might, for if it were to disband its selected crews and lay up its ships, it might never get them together again. This company and others are obliged to fight on in hope to live until better times. The commissions of Indian commission agents, which were five per cent., have been reduced to one and a-half per cent., and even in some instances to three quarter per cent., and so with other places.

Under these conditions of the reduction of profits, the proportions and pressure of all collateral charges are now all augmented. The extra charge attempted to be imposed by M. de Lesseps and the French company for the tonnage measured instead of the tonnage actually carried would have gone to the quick of the carriers' dividend of only three and a-half per cent., and therefore it was strenuously resisted. At the commencement of the ocean electric telegraph to India, the great commercial houses, by whom the telegraphs were used, would have been willing, many of them, to pay a pound a word if they could have been sure of keeping the information to themselves, but as commissions and profits were reduced, they found five shillings a word too heavy a charge, and they began to devise symbols and use carefully packed messages; and not content with effecting considerable reductions of the charges in very ingenious ways, they are beginning to cry out that the telegraph companies ought to be forced to still further reduce their charges, now stigmatised as oppressive obstructions to commerce, to which the telegraph companies answer that they are doing their work for a very moderate dividend, of one-half what their shareholders were promised and had a right to expect.

It may be taken for granted that the immediate future of our commerce will be in operations conducted on a large scale for small returns, by quick "turn-overs." But on examination of its present condition of sharp distress, with a large proportion of the great ship-building operations at the chief ports suspended, with ship-building companies paying no dividends, every relief, every stimulus by the reduction of factitious charges is of pressing necessity, and of peculiar value at this time. It is the course of the history of such commercial depressions in this country that the manufacturing and mercantile community will be driven themselves to stimulate a palled and slackened consumption by a production cheapened to the uttermost, by every

device; and that they will reduce establishment charges by distributing them over larger and larger operations, and by striving for new sources of consumption and supply. In other words, the direction of effort following such commercial and manufacturing depressions as are at present experienced, is to regain profits by increased sales at reduced prices and quickened operations. In such course it is probable that increased accommodation will be early required for an increased traffic, but at reduced prices. It is stated that the enlargement of the canal will be early required to accommodate the demands of increased traffic.

For the elucidation of the economical principles applicable to the question, the work of the proposed enlargement may be treated as the construction of a canal *de novo;* and it may be asked how, on economical principle, may this best be done? I beg to repeat the questions for consideration—Shall it be done on a public footing at the cost of the service? or shall, what economists consider the duties of the Government to provide—the cheapest and best means of transit, at most at the cost of the service—be abandoned, and the means of transit left to be accomplished as a commercial undertaking for the sake of a commercial profit on the necessities of the public? Shall the extended construction be paid for by cheap public capital, raised, say, at 3½ per cent., or by dear private capital, that of a private company raised upon shares, and for the payment of an interest upon that dear capital? Remember that on the private footing the capital must be dear to raise, and on account of the risks dear to pay for, in the shape of dividend, and dear to work. On the public footing it may be cheap, being at the rate of public securities, and cheap to work at the cost of the service, and safe to work by a responsible agency. It may be averred that on the correct public footing, and with cheap public capital, future extensions may be made at one-third less of cost, than on the private commercial footing. And this difference of rate might have been attained with the present work.

Now, if the matter were referred to a syndicate of the chambers of commerce of the several nations chiefly concerned, and they were left to determine the work entirely on their own commercial interests, there could be no doubt as to the course they would take. They, if they could, would at once and decidedly reject the treatment of the work "as a commercial undertaking," as being obstructive of their legitimate object of cheap and responsible service, as being repugnant in principle, and they would proceed to get it done on a public footing. The foreign chambers, looking to common commercial ends alone, would naturally say, "We had better leave it to England—she has the greatest amount of traffic, seventy-five per cent. of the whole, upwards of seventy millions in value passing through the canal annually; she has the greatest interest in the work; the interests of each of us is trivial as compared with hers; she has the cheapest capital; she has given us admission and fair participation in the commerce of the ports of China and Japan, which she has opened by war, and she may be most fully relied upon for working the canal most completely on commercial interests alone, and what she does for herself will be the best for us all."

On a consideration of the correct principles of political economy applicable to the case, it will be found that, instead of blame being justly attributable to the measure as one for the adoption of private commercial principles, blame would, on strict economical principles, be attributable to it as a half measure, for not earlier having gone into it as a whole, for not superseding the "private enterprise and commercial element," more completely, as being wholly unfittted for it—as being an abandonment of public administrative duty and responsibility to private and comparatively irresponsible enterprise for a profit on the necessities of trade; as being in fact protectionism of the worst sort, as creating monopolies of the extra charges on transit, and obstructions to the freedom of trade, greater than the obstructions of money of the import duties, which were once ignorantly regarded as its sole impediments.

It is not necessary to carry the doctrine of doing the work at the cost of the service rigidly, to exclude all profit whatsoever over and above the absolute and direct cost. It may be submitted that it would be well to provide an option for private or foreign shareholders to sell their shares to the Government at a price stated, and that price a moderately paying one to us, as apparently is the case with the measure proposed.

It is stated that the Khedive wishes to sell his railway. If this were referred to the supposed syndicate of the chambers of commerce of Europe, it being determined that in the interests of commerce it is important that the work should be placed on a public footing, and the charges on traffic reduced to the lowest, the question before any supposed commercial syndicate would be—how and by whom shall this be done? Shall it be by France, with its 5 per cent. capital, or by England, with its cheaper 3½ per cent. capital; by France, the smallest user, or by England, the greatest user of the line? and there would be little doubt of the independent decision upon that question also. I confine myself to the vindication of economical principles, and to present commercial necessities, and do not pretend to enter into speculative questions of future political probabilities.

On the whole, the measure in question, tried on the most strict principles of political economy, is in principle —whatever it may be in executive details—an advanced measure of free trade, rescuing the commerce of India from impending obstructions of excessive charges on transit, and peculiarly befitting its present exigencies, and conducive to further commercial development.

A precedent of what may be called an international syndicate, for ensuring the freedom of communication by an international highway, may be said to have been adopted by a commission of the chief States appointed to keep open the mouth of the Danube. The foundation of such a syndicate may be said to have been laid by treaty, between this country and the United States, for the formation of an international highway across the Isthmus of Panama.—I am, &c., Edwin Chadwick.

East Sheen, Mortlake, March 4th, 1876.

GENERAL NOTES.

The Patent Bill.—The new Patent Bill has been printed. It in nearly all respects resembles the Bill of last year, except that the portions referring to the proposed referees are omitted, and no alteration is made in the existing term of a patent. There are also a few minor alterations, one of the most important, perhaps, of which is the substitution of a stamp for the Great Seal. It is down for reading next Tuesday. The resignation of Mr. Woodcroft, the Clerk to the Commissioners of Patents, is announced. There appears some doubt as to whether this post will be filled up pending the fate of the Bill.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

March 15.—"A New Bridge for Providing for the Traffic across the Thames below London Bridge," by Frederic Barnett, Esq.

March 22.—"Railway Couplings," by F. A. Brocklebank, Esq.

March 29.—"Model Dwellings for the Rich," by T. Roger Smith, Esq., and W. H. White, Esq. Lord Alfred Churchill will preside.

April 5.—"The Cultivation in India of Caoutchouc-yielding Trees," by Clements R. Markham, C.B.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

March 14.—"The Diamond Fields of Griqualand, and their probable Influence on the Native Races of South Africa." By John B. Currey, Esq., late Secretary to the Government, at Griqualand West. Nevil Maskelyne, Esq., F.R.S., will preside.

March 28.—"The Industries of South Africa." By T. B. Granville, Esq.

April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

Monday, March 13.—Adjourned Discussion on Mr. Seyd's paper on "The Fall in the Price of Silver."

March 24.—"The Land Revenues of India," by Major-General Marriott, C.S.I. Sir George Campbell, M.P., will preside.

April 21.—"The Sanitary Progress of India," by Captain Douglas Galton, C.B.

May 5.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

Chemical Section.

Friday evenings at 8 o'clock. The following papers will be read:—

March 17.—"The Preparation of Dextrine-Maltose (malt-sugar), and its Use for Brewing and other Purposes." By W. Valentin, Esq., F.C.S.

March 31.—"The Methods of Estimating the Illuminating Power and Purity of Coal Gas." By A. Vernon Harcourt, Esq., M.A., F.R.S.

April 28.—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne.

Cantor Lectures.

Monday evenings at 8 o'clock. Third Course, "On Wool Dyeing," by George Jarmain, Esq.

Lecture II.—March 20th.

Indigo and its modes of application to the dyeing of wool and woollen fabrics.

Lecture III.—March 27th.

General principles of the fixation of colour upon wool.—Wool mordants.

Lecture IV.—April 3rd.

Logwood and other woods, and their application to the dyeing of wool and woollen fabrics.

Lecture V.—April 24th.

Ditto (*continued*).

Lecture VI.—May 1st.

Aniline and other allied colours, and their application to the dyeing of wool and woollen and mixed fabrics.—Concluding remarks.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Adjourned Discussion on Mr. Ernest Seyd's Paper, "The Fall in the Price of Silver; its Causes, its Consequences, and their possible Avoidance; with Special Reference to India."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Mr. Octavius C. Stone, "Excursions into the Interior of New Guinea from Port Moresby." 2. Mr. J. W. Wells, "Journey from San Francisco to the Tocantins, and thence to Maranham, in Brazil."
British Architects, 9, Conduit-street, W., 8 p.m. 1. Mr. J. D. Sedding, "Some Sixteenth Century Chantries." 2. Mr. P. Cockerell, "Biographical Notices of Deceased Foreign Members."
Medical, 11, Chandos-street, W., 8 p.m.
London Institution, Finsbury-circus, E.C., 4 p.m. Mr. W. Spottiswoode, "The Polarisation of Light."

Tues. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (African Section.) Mr. John B. Currey, "The Diamond Fields of Griqualand, and their probable Influence on the Native Races of South Africa."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "Classification of Vertebrated Animals." (Lecture IX.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Renewed Discussion on "Floods, Rainfall, Evaporation, and Percolation."
Photographic, 9, Conduit-street, W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C.

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. Frederick Barnett, "A New Bridge for Providing for the Traffic across the Thames below London-bridge."
Meteorological, 25, Great George-street, S.W., 7 p.m.
Ethnological and Art Historical Lectures, 11, Chandos-street, 3 p.m. Mr. G. Browning, "Holland and Belgium."
Archæological Association, 32, Sackville-street, W., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m.

Thurs...Royal, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. J. N. Pollen, "Art in Domestic Furniture."
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Postponed Discussion on "Recent Researches on the Potato Fungus." 2. Mr. Francis Darwin, "The Hygroscopic Mechanism by which certain Seeds are enabled to Bury themselves in the Ground." 3. Mr. George J. Romanes, "Account of some New Species of Medusæ."
Chemical, Burlington House, W., 8 p.m. 1. Dr. Roos, "Experiments with Crystallized Glycerin." 2. Mr. W. H. Hatcher, "Notes on the Fatty Acids, and on a Suggested Application of Photography." 3. Mr. F. Jones, "Stibine." 4. Mr. Ferdinand Kopfer, "The Use of Platinum in the Ultimate Analysis of Carbon Compounds." 5. Dr. Stenhouse and Mr. Groves, "The Action of Sulphuric Acid on Napthaline." 6. Mr. Beckett and Dr. Wright, "The Action of the Organic Acids and their Anhydrides on their Natural Alkaloids." Part V.
Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Spottiswoode, "Polarised Light." (Lecture I.)
National Indian Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. H. Beveridge, "Eastern Bengal."
Zoological, 11, Hanover-square, W., 4 p.m.
Numismatic, 13, Gate-street, W.C., 7 p.m.
Royal Society's Club, Willis's Rooms, St. James's, S.W., 6 p.m.
Civil and Mechanical Engineers Society, 7, Westminster-chambers, S.W. Mr. W. C. Whitaker, "Hoarwithy-bridge over the River Wye."

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Mr. W. Valentin, "The Preparation of Dextrine-Maltose (malt-sugar), and its Use for Brewing and other Purposes."
Royal United Service Insitution, Whitehall-yard, 3 p.m. Major-General J. L. Vaughan, "Roman Military Occupation of Britain."
Royal Institution, Albemarle-street, W. 8 p.m., Weekly Meeting. 9 p.m., Sir Henry Sumner Maine, "The State of Feudal Property in England and France on the Eve of the First Revolution."
Philological, University College, W.C., 8 p.m.

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Prof. G. C. Robertson, "Human Senses." (Lecture II.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,217. Vol. XXIV.

FRIDAY, MARCH 17, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1876, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (now Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., in "recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, Foreign Member of the Royal Society, Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food-economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to M. Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. Henry Bessemer, "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to M. Michel Eugène Chevreul, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Mons. Michel Chevalier, the distinguished French statesman, "who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

The Council invite members of the Society to forward to the Secretary, on or before the 16th of April, the names of such men of high distinction as they may think worthy of this honour.

NATIONAL TRAINING SCHOOL FOR MUSIC.

As announced in previous numbers of the *Journal*, a fund is being subscribed among the members of the Society of Arts, for the purpose of establishing scholarships at the School. Members willing to make donations or give subscriptions in aid, are requested to communicate with the Secretary.

Yearly Subscriptions for Five Years.	
G. C. T. Bartley	£1
Mrs. Bartley	1
Edward Brooke	5
Andrew Cassels	2
Lord Alfred Churchill (Chairman of Council)	5
Sir Henry Cole, K.C.B.	5
Mrs. Freake	8
Peter Graham	2
Edwin Lawrence	2
R. Rawlinson, C.B.	2
E. J. Reed, C.B.	5
E.C. Tufnell	2
Donations.	
F. A. Abel, F.R.S	5
Hyde Clarke	5
Seymour Teulon	5
Thomas Twining	10
Major-General F. Eardley-Wilmot, R.A., F.R.S.	5

The scholarship (of £40) provided by the above subscriptions has been awarded to W. G. Alcock, the first on the list of qualified candidates. As other scholarships are subscribed for, they will be given, in order, to the seven candidates remaining who have been recommended.

INDIAN SECTION.

The adjourned meeting for the discussion of Mr. Seyd's paper was held on Monday evening, the 7th inst., Mr. Hyde Clarke occupying the chair.

Mr. Maitland opened the discussion. He commenced by referring to the passage in Mr. Seyd's paper, in which he stated that those receiving fixed incomes from India now only received £83 6s. 8d. per cent. of what they had been accustomed to, and this appeared to be the pith of

the matter. He would not enter on the scientific side of the question, with which he was hardly qualified to deal, but would refer simply to some practical points. First of all he would say, as a merchant, that while he felt the importance of the influence exercised by the fall in the rates of silver and of exchange, which, though no doubt some had benefitted by it, must on the whole be considered to be very injurious generally; some of the evil effects now being felt were due to the general state of trade in the East for some time past. He remembered most vividly the events in India at the time of the cotton famine, being at that time at the head of a mercantile firm in India, and when tens of thousands of pounds were drawn for by them at the rate of 2s. 2d. and 2s. 3d. per rupee. At that time large quantities of silver came from Europe, in payment for cotton, and a flood of wealth poured into the country which had a marvellous effect, enabling many of the ryots and others to clear off debts which had been hanging over them nearly all their lives. God forbid that any such event as the American war should again occur; but if the quantity and value of Indian produce were to so increase as to turn the balance of trade, including the 15 millions annually drawn for by the Indian Council in favour of India, it would go far to remedy the evil. The fall in value now arose from the demonetisation of silver by the German Government, and the expectation of the same measure being adopted by other States, such as Holland; and also from the increased production from the American mines. The great difficulty, however, was that not only were they in ignorance what was the entire amount of silver now being produced there, but still more what is likely to be produced in future. He was glad to see that at the same time Mr. Seyd was reading his paper a committee was being moved for in Parliament to consider this question, and could only regret that this measure had not been taken earlier. The *Calcutta Englishman* had concluded a recent article on this subject by saying it would be a good thing if the Government would send two or three competent men to America, to ascertain what was going on there; and he was glad to see that the French financial minister, M. Léon Say, had taken the matter in hand, and had sent Colonel Berton to make inquiries. The *Mining Journal* alluded to his mission in very gratifying terms, stating what the scope of it would be, including the whole facts as to the production, domestic consumption, and export of the precious metals from the United States. Some interesting letters had been published in the *Times* under the signature of "L," and in the *Daily News* by "M. N. H.," giving figures which, if they could be relied on, were very astonishing. The former gave an extract from a San Francisco paper, showing that from one mine, the Virginia Consolidated, the production in 1875 had been 169,000 tons of ore, to the value of 16,700,000 dollars, of which more than 12 millions were distributed in dividends on a capital of 411,000 dollars. With reference to these figures, the *Economist* also stated that some of the Californian mines were producing silver at an expense of 1s. 6d. per oz., a most remarkably low price. If this state of things were to go on it would throw a great difficulty in the way of any change of currency, because they could not tell what would happen, and the price might not only remain as low as at present but go still lower. On the other hand, however, there were some favourable features to be considered. Thus, the United States, it was well known, were contemplating a return to specie payments; and it had recently been stated that the Director of the Mint had recommended that 30 millions of dollars should be coined, in order to withdraw from circulation greenbacks of small denomination, and stated that he had already 12 millions in small coins of from 10 to 50 cents. To whatever extent this might be done, it would *pro tanto* aid in withdrawing silver from the market and preventing it coming to Europe. It had also occurred to him that, as the exports to India had been reduced for some time past, and as a good deal of the silver went through India to Burmah and other countries, and some was converted into ornaments, that perhaps the stock of silver in the country was somewhat less than was imagined. Mr. Seyd appeared to think the only remedy was the adoption of a mixed currency, not only for India, but for the whole of Europe. Now, many persons learned in the subject said there were great difficulties in the way of such a change; but there were difficulties any way, and probably they could not avoid doing something. In 1863 or 1864 he remembered taking the chair, in Calcutta, at a meeting of the Chamber of Commerce, when they were very anxious to introduce a gold currency into India, and perhaps it would have been possible to do so then; but circumstances had so changed sincethen, with regard to the production of both gold and silver, that he could not say whether such a measure was now feasible. In December, 1869, the same question had been discussed at great length by the Society of Arts, and the general opinion then also expressed was that such a plan was both very feasible and desirable.

Major-General Marriott, C.S.I., said he would avoid the merely incidental propositions put forward by Mr. Seyd, and keep to the essential subject, viz., the depreciation of silver, the consequences of the depreciation, and what measures should be taken to modify those consequences. The lecturer's main statements were that the principal cause was the demonetisation of silver; that that demonetisation would produce a disastrous fall of prices in Europe; that it would produce a still more disastrous rise of prices in India; that these consequences would endure indefinitely; and that the only remedy was that Europe and India should adopt a double standard, and use both silver and gold. Always conceding that every transition was attended with some inconvenience, he should argue that there would be no such fall of prices in Europe, and consequently none of the consequences predicted therefrom; and that as respects India, although the immediate consequences, are severe, the further consequences were not in any way to be called calamitous, and he thought the lecturer had mistaken the real economic probabilities. The doctrine which underlay the whole thing was the theory of prices. Prices measured in gold depend upon the quantity of gold in the intertrading world, *i.e.*, upon its relative abundance as compared with other commodities, and the quantity of currency in circulation depends upon the prices and upon the number of transactions which required to be performed by exchange of money. He would first notice the effect upon gold using countries. Mr. Seyd had assumed that America, Russia, Austria, and Italy must return to cash payments, and that in order to do so they must adopt gold, requiring 150 millions for that purpose, and he calculated that the existing stock might be about 750 millions, and argued that the redistribution in order to get the 150 millions out of the 750 millions would cause a great fall in prices. But, to say nothing of objections to the premises, they must remember the nature of the process and the time required. The process was to substitute gold for silver of the same value—of course always supplying a sufficient amount of subsidiary silver coinage—and that process could not directly alter the amount of currency. It may be admitted that additional need for gold is equivalent to a less relative abundance of it, which would tend to a fall of prices; but this tendency would be more than met by additional production and other causes, on any likely estimate of the time required to complete the process. Mr. Seyd had exhibited the presumed diminution of currency in another way, by calculating that the entire currency at the present time might be taken at some 200,000 millions, and that when the demonetisation was complete, it would be reduced to one half; but this argument involved a very great fallacy. It would be absurd to assume, as he believed Mr. Seyd admitted in a later part of his paper, that the whole 250

millions of silver in India would be thrown out of currency. If Mr. Seyd's premises were true, the inference was not that there would be a great reduction of prices, but that the demonetisation was impossible. Mr. Seyd had referred to the returns of trade as exhibiting what he termed a shadow of the evil, the evil being the disastrous consequences of the supposed general reduction of prices; but it seemed to him that the slight check which trade had received was fully accounted for by the late war. The returns referred to were no more a sign of the evils predicted than the shadow cast by his hand was a sign that the light was going out. No doubt the effects upon silver using countries were serious, but the light in which Mr. Seyd had put them, that the depreciation of currency was the most disastrous thing which could happen to a country, short of conquest or slavery, was an entire mistake. They had heard nearly equally strong expressions as to the disastrous consequences of the fall of prices, so that a fall of prices and a rise of prices seemed to be alike most frightful misfortunes. Surely this afforded some presumption that it was not the change in itself, which was the evil, but the difficulties attending a transition state, which were always intensified in proportion to the rapidity with which the change took place. They were all agreed that there were two causes for the present depreciation, one, the increased supply of silver from the mines, and the other, the main cause, the demonetisation of silver. As to the first point, there was a great want of trustworthy information; but there was always a probability that the first production from new mines was more abundant than it would be afterwards; and it is certain that the new mines in America produce along with the silver a large quantity of gold, and any parallel increase of gold tends to prevent the relative decrease of value of silver. The most important point, no doubt, was the demonetisation. Up to the end of last year the total amount thrown on the market in Germany was about $6\frac{1}{2}$ millions, and of that about 30 millions will be got rid of when the Thaler coinago shall have been wholly replaced by gold and subsidiary silver. If the actual discharge of $6\frac{1}{2}$ millions and the expected discharge of 30 millions produced such alarming effects, it may be asked what will the effect be when other countries still further diminish their use of silver coin. But on the other hand it was to be observed that the reactionary influences, which were twofold, had yet to come into play. The first was the general increase in the use of any useful material like silver, when it became cheaper; and although Mr. Seyd laughed at the idea of more spoons and forks being manufactured from it, yet there is no consequence of which we are more certain than that if silver falls in prico, there will be an increased demand for it, which will have a strong reactionary influence to prevent a further fall. Another reactionary influence was its use as coin. In India the abundance of it must tend to increase prices, and the increase of prices could not take place without a corresponding increase in the quantity in circulation. Of course, to a certain extent credit might supply the equivalent of additional money in circulation without the actual coin, though he was afraid there was but little chance of a much extended use of credit in India at present, and in the main, if there was a considerable depreciation of silver as currency in India, it must be attended by a proportionate additional importation of that metal. Tho average importation from 1850 to 1866 was put down by Mr. Seyd at 7 millions, but not deducting the exports, the average was really $9\frac{1}{4}$ millions. The exports were almost entirely to Ceylon, Mauritius, and to the Straits, and were not exports back to Europe, and, therefore, should not be deducted. The returns from 1835 to 1875 showed an average of close upon six millions for silver, and Mr. Seyd stated that since the gold produce in 1850, India took its share of gold produce in silver; but so far from that being the case it appeared that, reckoning even from the year 1835, before the great increase in the production of gold, the average import of gold has been above $2\frac{1}{2}$ million, and from 1850 it had been something near 4 millions, giving for the period chosen by the lecturer, viz., from 1850 to 1866, 13 millions instead of 7 millions, including the gold. It was highly probable that if a considerable rise of price should take place. India would take all its treasure, so to speak, in silver, Since coming into the room he had learned that there had been a shipment of £400,000 in gold from Calcutta to England, and this no doubt would practically be exchanged for silver. All these inflnences would tend to keep up the price of silver. While the measure of such reaction was conjectural, it was certain that all tho evils which had been predicted need not be expected. He believod Mr. Seyd's ideas that the gradual depreciation of silver currency would interfere with commerce, lessen capital, and hinder the import of silver, were economically unfounded. What would be the consequence of a given amount of depreciation on tho people, the trade, and the financial administration of India? Of course the case of fixed annuitants was past praying for, as the amount of their loss was fixed by the depreciation, whatever it might be, and no doubt it fell heavily upon those resident in Europe deriving their income from India. All, too, who lived upon past savings would find their savings diminished in value. But as regards the great mass of the people of India, the depreciation of their property by the depreciation in the currency, was, in his opinion, in a great measure an imaginary loss. To illustrate his meaning he would suppose that a person possessed a very large quantity of silver plate, which he never had any expectation of having occasion to sell, but rather to increase; no doubt the depreciation of silver lessened the value of his property, but he would not much mind the depreciation as he had no intention of selling, but rather an expectation of buying more at a less price. He did not say that caso was perfectly analogous, but it was sufficient to explain his meaning, that the loss was partly imaginary to the people of India. If tho people of India lost by paying higher prices for what they bought, being producers, they gained by the higher prices for what they sold. With regard to external trade, no doubt the immediate effect was most severe, as it must always be when there was a sudden change in the value of any article of commerce; but in the future the loss was wholly imaginary, from the fact that India never sold silver, but from time immemorial had been a purchaser of it. The rise of price would make no difference; India exchanged her commodities for other commodities and for silver. The quantity, say of Manchester piece goods, for which a cwt. of raw cotton would exchange, would not, *cæteris paribus*, be altered by a depreciation of India's currency. Whilst, as respects exchange for silver, so far as the price paid in India for one cwt. of raw cotton was increased by the depreciation of currency, so also would a given quantity of cotton, or anything else, purchase a larger quantity of silver from England. How the financial administration would be affected was a much more serious question. It would be a severe blow in any case, when a revenue, which could not be rapidly enlarged, was received in a depreciated currency, and the expenditure went on at higher prices. If the expenditure were all calculated in rupees, the matter would not be so serious, because the riso would take place gradually, and the revenue would tend to increase nearly *pari passu* with the expenditure; but when about £15,000,000 of the whole was calculated and paid in gold, that meant, at the present price of silver, a loss of about $1\frac{1}{2}$ million per annum by the Indian Government. What could be done to remedy this? Mr. Seyd proposed a European convention, with the object of establishing a mixed currency both in India and Europe; and he had also a plan for introducing gold into India, which he (Gen. Marriott) believed was impracticable, but that was a question of detail. This opened the whole question of the standards, and he was not going to argue out

this much-vexed question. He was, however, surprised to find it stated that the main objection to a double standard was the wrong to creditors. He had heard the objection put forward, and considered it a weak one, to the introduction of a double standard where a single one had existed, but he had never heard it as an objection to the maintenance of an existing double standard, or that it was the main objection in any case. The real objections are based on the contradiction of Mr. Seyd's assumption that gold and silver could be kept at 1 to 15½, or any other constant ratio of value, an assumpton contrary both to economical principle and to experience. Mr. Seyd spoke of the ratio as being the average from time immemorial. Whether that were so or not he could not say, but it was not a question of average at all, the objection depended on the fluctuations which constantly took place, and which Mr. Seyd called unimportant. The result of them was, that at one time gold and at another time silver became the actual standard, the other metal being partially withdrawn from circulation. These fluctuations were attributed in the paper to "want of agreement and insufficient international intercourse in former times," but it was a strange idea now-a-days to find it stated that the value of anything could be maintained by agreement. International intercourse tended to prevent fluctuation in some respects, but where change of relative value arose from natural causes, such as increased production, it would rather help to increase the fluctuation. Then Mr. Seyd spoke of "intrinsic value," which could only lead to misconception, because the only thing they had to deal with was exchange value, and attributed it to "chemical nobility," which conveyed but a vague idea to his mind; and Mr. Seyd added that any supposed influence of demand and supply could be kept under control by a general understanding and by law. He would not argue further touching notions so obviously inconsistent with ordinary economic doctrines. Besides this, it was contrary to practical experience, particularly in France. Professor Jevons stated that since the introduction of the double standard into France, the exact ratio of value of gold to silver had only twice been exactly 1 to 15½. The fluctuations have been sufficient to change the real standard. In speaking against a double standard, however, he must say that he had long wanted to see it introduced in India, where he thought it would be useful, because the constant need for more currency in India would prevent the use of gold driving out the silver, excepting by such very slow process as would be harmless, and would prevent much of the inconvenience felt in Europe. It would be useless, however, to attempt its introduction when silver was depreciated in value, because the cheaper silver would most effectually keep out the gold. It can only be tried when the average value of gold and silver shall again be more constantly established. With regard to an international convention, it appeared to him that quite irrespective of opinion, as a matter of fact the question had been so decided in favour of a single standard, that it was hopeless at present to attempt to make a change. Nevertheless, he thought an international convention might be of use in helping to carry Europe through the transition with the least inconvenience to trade. Having made so many objections to Mr Seyd's propositions, he might be asked if he had anything to submit in their place. In the first place he would observe that it is a happy thing that a large portion of the Indian revenue is derived from land, although it increases the difficulty at first, because no increase of it could be obtained until the settlements fell in, nevertheless, on the whole, it was an advantage, because if it was necessary to obtain a larger revenue it could be levied upon the land with much less hindrance to trade and general prosperity than if it were raised by custom duties, or any analogous means. He had two suggestions to make. If England, recognising the enormous benefit she derived from her connection with India, which ensured her as customers 240 millions of people, and enabled her to direct their financial policy and remembering how much of India's debt had been forced upon her in the supposed interest of England, should, when the Queen took her new title, accept a share of responsibility for India's funded debt; this would be the means of reducing the debt by, perhaps, half a million. Again, if it should appear hereafter that there is such a demand for gold as to make a general diminution of prices, which he did not expect, England has a means of virtually increasing the supply of gold more effectually than by using silver, and with gain instead of inconvenience to herself. The means would be the use of one pound notes. Whatever be the minimum number of sovereigns now used in England for internal exchange transactions, and the quantity was estimated thirty years ago as at least £30 millions, and is probably now more than double that sum, that quantity of gold could be discharged from use as money by the issue of one pound notes, without any need for the State to lock up gold to secure their convertibility. The setting at liberty this large quantity of gold would tend to balance the increased supply of silver. In conclusion, he repeated that let the depreciation of silver be what it might, it was a consequence of the greater supply of both gold and silver, and when he remembered the manifold purposes to which they could both be applied, besides that of currency, it seemed to him contrary to the first principles of economic science to believe that that greater abundance, notwithstanding its incidental and temporary inconvenience, could ultimately be anything but a boon to the world at large.

Mr. Frederick Hendriks said—The existing state of things, as regards the price of silver, is certainly a grave one, but it appears to me by no means so grave as to make the adoption of the remedy suggested by Mr. Seyd, namely, the recourse to a double standard of value by the whole of Europe at all likely. Moreover, it is apparent to me that in describing the situation of the moment, the figures cited by Mr. Seyd immensely over-estimate the amount of silver to be demonetised. He speaks of £200,000,000 worth in Europe, and £250,000,000 in India. Total, £450,000,000 worth in Europe and India, which must be immediately or prospectively demonetised unless we all adopt the double standard. I am disposed to think that these figures are erroneous to the extent of about £325,000,000, or, in other words, that it would be more correct to say that if France and her monetary allies, Italy, Belgium, Switzerland, Greece, Roumania, and Spain, adopt the single gold standard, as Great Britain, Germany, Portugal, Sweden, and Norway, Denmark, Turkey, Brazil, the United States, Japan, and Australia, have already either done, or have resolved to do as soon as they can; and if India be either disposed or compelled also to adopt the single gold standard, the stock of silver to be demonetised, in consequence of these two events, would not necessarily exceed £125,000,000, instead of the £450,000,000 with which Mr. Seyd alarms us. £75,000,000 worth in Europe, and £50,000,000 worth in India, total £125,000,000, would be much nearer to the mark. I proceed to justify these conclusions. First, as regards Europe. For instance, instead of Mr. Seyd's figures of £70,000,000 to be demonetised, £32,000,000 at the outside should be substituted. The latter sum, I should add, is the estimate of a very high authority, M. Paul Leroy Beaulieu, who, in the *Journal des Débats* of the 3rd instant (3rd March, 1876), observes: "Since 1795 there have been coined, down to 1871 inclusive, 5,122 million francs (£204,880,000), of which 236 million francs (£9,440,000) have been demonetised, so as to reduce the surplus to 4,886 million francs (£195,440,000), but by far the larger part of this enormous sum has emigrated abroad, and a vast part has been melted down, silver at certain times having borne a slight premium. It is not believed that there

exist in France more than 1,200 million francs worth (£48,000,000) of five-franc pieces, of which 500 millions (£20,000,000) are at the Bank of France. And, admitting that there should be kept (M. Leroy Beaulieu means, of course, for the purposes of token coinago) 300 or 400 million francs (£12,000,000 or £16,000,000 worth) of these, the demonetisation would only take effect upon 800 million francs (£32,000,000)." Next, as regards Germany, various estimates have been made of the amount of the old thaler currency of North Germany, of the old gulden currency of South Germany, and of Hamburg and other local currency, to be converted into new silver mark currency. These estimates have ranged between an amount of £60,000,000 and £30,000,000. There is good reason to believe that the lesser amount, or 30 millions sterling worth, is by far the nearer of the two to the truth. Germany was always poor in metallic circulation as compared with France. The following table succinctly proves this:—

	Million Pounds Sterling Worth.		
	Gold.	Silver. Full weighted pieces.	Gold and Silver.
Coinage of France, 78 years, 1795 to 1872	309	196	505
Coinage of North and South Germany, Hamburg, &c., 110 years, 1764 to 1873..	26	86	112
Surplus in favour of France as compared with Germany	283	110	393

Of the silver coined in Germany (North, South, and local Hamburg, &c.) in the 110 years, 1764 to 1873, £86,000,000 worth were in full-weighted coin and £3,000,000 worth in token coinage. The total was, therefore, £89,000,000 worth of silver coined. Now if from this amount be deducted (1) all the numerous meltings and re-coinages of old current coins during that long period of years, and if due allowance be made (2) for all the forced contributions on Germany levied by the French (3), for the driving out of a great part of the German metallic circulation by the long continued use of legal tender paper notes of exceedingly small denominations; and (4) for all the wear and tear and loss of coinage of so soft a metal as silver, it is not consonant with experience in other countries to suppose that more than about one-third of this 110 years coinage can still have remained in existence, say 30 million pounds sterling worth, in 1873, when the Germans began their new silver coinage. Their own official documents prove that at the present time they have already called in and got rid of 15 millions sterling worth of old silver coin. There consequently may be estimated to remain some 15 millions sterling worth still to call in. Against the 15 millions of old coinage, 8½ millions worth of new silver mark coins have been struck. The demonetisation of 15 millions thus left only 6½ millions sterling of silver to be thrown on the market in the three years, 1873–75. And the demonetisation of the remaining 15 millions will not throw more than a like sum of 6½ millions sterling of silver on the market, as there will be quite 8½ millions more of new silver mark coinage required to make up a total coinage of 17 millions sterling, which the large population of North and South Germany, so long used to silver coins, can easily find uso for. I am, of course, aware that amongst the specie payments that entered Germany in payment of the indemnity from France, it is believed that there were in silver—

Pounds sterling worth.	
9,560,000	French francs.
10,040,000	Dutch florins.
11,840,000	Belgian francs.
£31,440,000	

But it is also believed that nearly the whole of this sum has been got rid of by the German Government in its purchases of gold. Even if they have not been disposed of, two-thirds of the total, or £21,400,000 of French and Belgian silver francs, need no demonetisation, as they are legal tender in all the countries of the Union of France and her monetary allies. On the whole it will be a liberal estimate if we assume that Germany still has,

Pounds sterling worth.	
6,500,000	silver to dispose of, from the demonetisation of her own old coin.
13,500,000	silver to dispose of, from the demonetisation of foreign coin and bullion.
£20,000,000 total.	

We have thus arrived at a total of £52,000,000, in the proportions of about three-fifths of it for France, and two-fifths for Germany. The amount of silver to be demonetised in other European countries, which have before been named, could not (after allowing for token coinage required) exceed £23,000,000 sterling. Thus we arrive at a total demonetisation of silver (if all Europe take to a single gold standard) amounting to about 75 millions sterling, instead of the 200 millions sterling reckoned by Mr. Seyd. As regards Indian coinage, which Mr. Seyd reckons would be demonetised to the extent of 250 millions sterling worth if a single gold standard were introduced into that country, it seems to me that there is a mistake of something like 200 millions sterling in excess. The Society of Arts *Journal* for 1870 contains a very full report of the papers "On a Gold Currency for India," read in December, 1869, by Mr. Andrew Cassels (now a member of the Council of India), and by myself, and I would beg leave to quote the following passages from my then remarks respecting Indian gold coinage statistics, as still applicable at the present moment. "The idea of the immense amount of silver coin existing in India is a mere myth. There is no collateral testimony to prove it. On the contrary, so far as it extends, the collateral testimony rather disproves the existence of anything of the kind. It is certainly matter of statistical history, that during the British rule in India, from the year 1800, about £250,000,000 sterling worth of silver rupees have been coined at the mints of Calcutta, Madras, and Bombay. But, when we take the analogy of other countries as our guide to form an estimate of what proportion of this £250,000,000 worth has passed out of circulation, or represents meltings or repeated re-meltings of old, or worn-out coinage into new, we may question whether more than 40 per cent. of the total now exists in the shape of rupees, say 1,000,000,000 rupees, or £100,000,000 sterling worth? The wear and recoinage of silver currency (the exclusively national circulation in India until recent times, when bank notes have come in aid) must have been vastly greater than that of any gold circulation in European or American countries. Silver coin is softer, more liable to abrasion than gold coin, and is thus more rapidly deteriorated below the limit of legal tender weight, so that its duration, without need for recoinage, is very much shorter.* Then again, in India, it is notorious that vast amounts of rupee coinage are constantly melted down for conversion into objects of use, of a domestic and artistic character, and into personal ornaments, such as the bangles for arms and legs, so generally worn by an enormous native population. That 40 per cent. of the whole aggregate original amount o

* As an example of the great wear and waste of silver coin, we may appropriately take note of the results of the experiments made in 1833, at the Royal Mint, in London, when Lord Auckland was Master of the Mint, which showed that the average loss upon coin in four years in circulation was £1 8s. 7d. per £100 value for sixpenny pieces; 8s. 11d. for shillings; 7s 2d. for half-crowns; and that the average loss upon silver coin 16 years in circulation was £5 11s. 11d. for sixpences; £4 19s. for shillings; and £2 7s. 7d. for half-crowns, per £100 value.

silver coined since 1800 in India, should still remain in circulation, is a liberal, and perhaps, even an over-estimate. The history of financial operations in British India may be alluded to, as supplying a strong instance in point as to over-estimation of the quantity of coin in circulation, by the highest authorities whose opinion could be appealed to by the Government there. I refer to the example of what occurred in the period 1835-39. The Act xvii. of 1835, the Magna Charta of the existing Indian silver standard coin, was passed to give effect to a long meditated purpose of establishing one coinage of uniform character and bearing a British device. It was reckoned beforehand that the amount of Sicca rupees then current, and to be brought to the mint for recoinage, would amount to a sum of very great magnitude. But what was really the result, when certainty took the place of hypothesis, was the effectual substitution of Company's rupees for Sicca rupees by a recoinage of less than 5 crores, or under one-half of the lowest estimate that had been formed, in anticipation, on the basis of the aggregate amount of Sicca rupees issued from the mint in the preceeding 30 years." At the adjourned conference, on the 21st January 1870, I added the following to my previous remarks, "An analysis of official returns of imports and exports of silver and gold bullion, from 1845 to 1869, *i.e.*, for the last 25 years, shows that a gross value of, as nearly as possible, £200,000,000 sterling worth has remained in India, as the balance of imports over exports of the two kinds of bullion. Of this, about two-thirds, or £133,000,000 sterling worth, have been excess of silver bullion imports over exports, and the remaining one-third, or £67,000,000 sterling worth, has been excess of gold bullion imports over exports. The Indian coinage during the same period of the quarter of a century last past, has amounted for silver to about £150,000,000 sterling worth of rupees. No doubt a vast portion of the silver bullion imports of 1845 to 1869 has been absorbed in this coinage, but how much of the coinage of the period has been re-coinage of light-weight rupees, minted either before 1845, or re-minted two or more times between 1845 to 1869, it is not possible to ascertain. And, as before stated, considering all the circumstances of the quantity of rupees turned into bangles and personal ornaments, and in other ways converted into bullion, and allowing for the coinage of 25 years, including much re-coinage, there are reasons to believe that the actual circulation of rupees in British India does not exceed 1,000 millions, or say £100,000,000 sterling worth. The late Right Hon. James Wilson estimated the actual circulation in 1864 at 1,000 million rupees; but Mr. W. R. Cassels, of Bombay, in his communication to Sir Bartle Frere, dated 1st January, 1864, observed "that he could not understand by what process Mr. Wilson arrived at this high estimate, but that he believed that if Mr. Wilson had reduced it one-half (*i.e.*, to 500,000,000 rupees), he would have been much nearer the mark." "But (I went on to observe) considering the great increase of wealth in India, particularly through the development of the growth of cotton, during the ten years that have elapsed since the date of Mr. Wilson's estimate, £100,000,000 sterling worth of active silver circulation is a fair and liberal amount to assume as the grand total of metallic currency, to be immediately affected by the changes in the standard." We may reckon that at least one-half of this, or say 500,000,000 rupees, will be required for re-coinage in a token form, that is to say, reduced to the lesser weight, but increased to the greater fineness of our English two shilling, or one florin piece. These 500,000,000 of rupees will be wanted for the purposes of small change and of legal tender, to the extent of 100 rupees (according to the plan for the establishment of a single gold standard in India, which I had brought before this Society at its meetings, December, 1869, and January, 1870). I assumed that this greater extension of the limit of token coinage, say to 100 rupees in India, as against 20 rupees, or £2 sterling worth in England, and about the same value in Germany according to its new coinage law, would be found useful in India, as utilising a larger portion of the old silver to be demonetised, and thus effectually bridging over one of the greatest difficulties of the operation. Two and a-half rupees, say 5s. worth per head of silver token coinage, of the same weight and fineness as our English silver coinage, would, it seems to me, be by no means excessive to introduce amongst the 200,000,000 and upwards of population of the Indian Empire. And I still think, as I did in 1870, that out of the balance of 500 million of rupees to be demonetised, as I suggested, in five years, an outlet would be found for some portion in China and also in swelling the ever-augmenting wealth of India in ingots, personal ornaments, and objects of artistic or useful value, and that much of the gold for supplying the gold coinage of £50,000,000 sterling worth to take the place of the supplanted 500 million rupees of silver would be found already available in India. The seignorage, at the existing Calcutta and Bombay Mint rate of 2 per cent. upon all silver coin and bullion on the new token coinage of 500 million rupees would be a set-off against the price or premium at which the gold might be bought. And, as I stated in 1870, it must be recollected that quite 670 million rupees worth of gold bullion, after deducting exports, had remained as the balance of imports into India in the 25 years, 1845-69, and that partly out of this, and partly out of previously existing stocks of gold, less than 20 million rupees worth of gold mohurs had been coined at the Indian mints during these twenty-five years. This large amount of gold already existing in different shapes in India, not only in the gold imports, since 1845, but in its long previously accumulating stores, justify the conviction that at a fair premium to bring out the hoarded metal, the greater part of the gold to supply India with a metallic circulation entirely of that metal would be found in the country itself. I may also take occasion to remark that, since the date of the suggestions on a gold coinage for India which I had the honour to submit to this Society, a practical example has been shown to the world of an Eastern nation adopting a gold coinage and a decimal one with every prospect of success. I refer to Japan, whose coinage reforms I have described at length in the pages of the *Economist*. To return, however, to Mr. Seyd's paper. I submit that the estimates I have given will support the conclusion that his opinion that £250 millions sterling worth of Indian silver coinage will have to be demonetised, is inflated to the extent of £200,000,000. As to Mr. Seyd's proposed remedy of a double standard, I hold that it would be be perfectly hopeless to look to the nations of Europe generally adopting a double standard which is so opposed to their own interests, convenience, and advantage. The plan which I had the honour of explaining to the Society of Arts, in December, 1869, and January, 1870, as to the introduction of a gold standard of currency into India, at the rate of 10 rupees per one pound sterling, could, at the then price of silver, about 60½ pence per ounce standard, have been successfully carried out without entailing any very great expense upon the revenue of India. Now, however, that silver has fallen in price from 60½d. to an average of 55d. in the last few months, a similar scheme of gold coinage could not be introduced, without much loss to the revenue of India, at a higher value to the rupee than 11, instead of 10, to the sovereign. There is reason to believe that it will be safer to accomplish the great coinage reform of substituting a single standard of gold in India, for a single standard of silver, than to allow that country, and all who are pecuniarily interested in its welfare, to suffer the greater loss, which would appear to be imminent if things are allowed to go on, from bad to worse, through the maintenance of a discredited and depreciated standard like that of silver. The present is a turning point in her financial history, a period of crisis, in which her statesmen should have the boldness to show themselves equal to the occasion, and to the responsibility of

carrying out in India the plan successfully adopted in England in 1816, and now being followed by all the leading commercial countries, as fast as they are able, supplying themselves with a single gold standard of metallic circulation, with silver as a subsidiary token coinage. The following would, briefly, be the leading conditions of the plan:—1. India to stop altogether any further coinage of the silver rupee containing, as, at present, 180 grains of silver, $\frac{11}{12}$ths fine, or 165 grains of pure silver. 2. India to coin, during the next 5 years, silver rupees at an increased fineness of $\frac{37}{40}$ths, like that of the English silver coinage, but at a diminished weight of 158·67768 grains standard, or 146·77684 grains of pure silver to each rupee, so as to give the same weight to 11 new silver rupees as are contained in 20 shillings of English silver coinage. The 11 new silver rupees would thus contain 1745·4545 grains, ·925 fine, or 1614·54552 grains of pure silver, precisely as 20 shillings, or one pound sterling's worth English coinage have done since 1816. 3. India to coin 10-rupee gold pieces of the same fineness as, but of one-eleventh less weight and value than the English sovereign, and gold 5-rupee pieces, of the same fineness as, but of one eleventh less weight and value than the English half sovereign. The Indian 10-rupee piece to contain 112·0677 grains standard gold, $\frac{11}{12}$ths fine, or 102·7287 grains pure gold, and the Indian 5-rupee piece to contain 56·03385 grains standard gold $\frac{11}{12}$ths pure, or 51·3644 grains pure gold. 4. The English and Australian sovereign to have legal tender currency in India at the rate of 11 rupees, and the English and Australian half-sovereign at the rate of $5\frac{1}{2}$ rupees, and, *vice versâ*, 11 of the 10-rupee pieces of India to have currency in England or Australia as of the value of £10, and 11 of the 5-rupee pieces as of the value of £5. 5. India to resolve, by legislative enactment, that, at the end of five years, gold alone shall be the standard and legal tender to an unlimited amount, and that silver coin shall then become legal tender to the value of 100 rupees in any one payment, just as, in England, in 1774–1783 and in 1798–1816, silver was made legal tender for sums under £25 by tale, and above £25 by weight, gold being the sole leading standard of value. 6. India to call in, at the end of five years, the silver coins, both rupees and of lower denominations, minted before the commencement of the period of five years, and to deal with them as was done with the Sicca rupees in 1835-38, when it was ordered that from the 1st January, 1838, they should cease to be a legal tender, though receivable by the collectors of inland revenue, and at the public treasuries, by weight, and subject to a charge of 1 per cent. for recoinage. 7. India to establish a temporary transitional double standard of gold and silver, for the purpose of carrying out the above changes and for the discharge of debts (according to the debtor's option) in either of the two metals, this double standard to be discontinued absolutely at the end of five years unless it were then found that the operation of introducing a single gold standard required some extension of the time. The above plan will make the permanent mint ratio of India between gold and coined silver the same as it is in England, namely, 1 to 14·287, if the seignorage charged in India be disregarded, and this would indicate a permanent mint par of exchange between India and England of 9·0969 rupees per £1, or between 1s. $9\frac{7}{8}$d. and 1s. 10d. per rupee. The following table may be found useful for comparison of the old and proposed new coinage:—

A.

Present Standard Weight of English and of Indian Silver Coins compared.

	Grains troy.	Fineness.
Florin	174·54545	·925
Rupee	180·00000	·916
Shilling	87·27272	·925
Half Rupee	90·00000	·916

B.

Present Pure Silver Contents of English and Indian Silver Coins compared.

	Grains troy.	Fineness.
Florin	161·4545	1·000
Rupee	165·0000	1·000
Shilling	80·7272	1·000
Half-Rupee	82·5000	1·000

C.

Proposed Standard Weight of Indian Silver Coins compared with English Silver Coins.

	Grains troy.	Fineness.
New Rupee ($\frac{10}{11}$ths of one Florin)	158·67768	·925
Florin	174·54545	·925
New Half-Rupee ($\frac{10}{11}$ths of one Shilling)	79·33884	·925
Shilling	87·27272	·925

D.

Proposed Pure Silver Contents of Indian Silver Coins compared with English Coins.

	Grains troy.	Fineness.
New rupee ($\frac{10}{11}$ths of one florin	146·77684	1·000
Florin	161·45453	1·000
New half-rupee, or $\frac{10}{11}$ths of one shilling	73·38842	1·000
Shilling	80·72727	1·000

E.

Proposed Standard Weight of Indian Gold Coins compared with English Coins.

New 10 rupees, or $\frac{10}{11}$ths of £1 sterling	112·06770	·916
Sovereign, or 11 rupees	123·27447	·916
New 5 rupees, or $\frac{10}{11}$ths of half a sovereign	56·03385	·916
Half a sovereign, or $5\frac{1}{2}$ rupees	61·63723	·916

F.

Proposed Pure Gold Contents of Indian Gold Coins compared with English Coins.

	Grains troy.	Fineness.
New 10 rupees, or $\frac{10}{11}$ths of £1 sterling	102·7287	1·000
Sovereign, or 11 rupees	113·0016	1·000
New 5 rupees, or $\frac{10}{11}$ths of £1 sterling	51·3644	1·000
Half a sovereign, or $5\frac{1}{2}$ rupees	56·5008	1·000

The controversy about a double standard again raised by Mr. Seyd in his paper has been worn almost threadbare, to the last tatter of any new argument, practical or theoretical, and the very list of the controversial literature of the subject would be sufficient to occupy some hours' attention. After all the practical experience of two hundred years, since Sir William Petty touched upon the subject incidentally, nothing has really shaken the truth of what that writer said about the use of a single standard; and I may quote his words, as they are few, but weighty. "So there can be but one of the two metals of gold and silver to be a fit matter for money. Wherefore if silver be that one metal fit for money, then gold is but a commodity very like money. And as things now stand, silver only is the matter of money." The greater convenience of gold over silver led England to prefer gold as the "matter of money" in the whole of the century after the days of Petty, so that Lord Liverpool, in 1805, in his well-known letter to the King, on which was based the change to a single gold standard, *de jure*, in 1817, contended (at page 173 of his letter), "That in this kingdom the gold coins only have been

for many years past, and are now, in the practice and opinion of the people, the principal measure of property and instrument of commerce." "Thus *de facto* the gold valuation prevailed in all large affairs, and the double standard, so far from enabling the country to retain any silver, positively drove it out whenever it became the dearer metal." This induced Lord Liverpool to a conclusion which has never been successfully controverted down to the present time, but has, on the contrary, been confirmed by the experience of all the countries in the world which have had a double standard in the present century and down to the present time. His conclusion was, that "it appears, not only by the clearest deduction of reason, and by the concurrent opinion of the most eminent writers, but by the evidence which long experience in this kingdom has afforded, to be a certain and incontrovertible principle, that coins, which are to be the principal measure of property, can be made but of one metal only." I have, myself, in other publications, given abundance of practical examples to show that the experience of other countries has been identical with that of our own country, and brought down the experience to the latest date. The student of the question may be referred to the very recent works of M. Malou, late Minister of Finance in Belgium, of M. Victor Bonnet, of M. Leroy Beaulieu, and other economists, and of M. de Parieu, late Minister President of the French Council of State, and recently elected to the Senate. I must also ask permission, briefly, but emphatically, to protest against some remarks introduced into his paper by by Mr. Seyd on the subject of seignorage. I refer to the passage where he speaks of it as a "hocus-pocus." Well, if by a hocus-pocus be meant, as is usually supposed, some jugglery or deception, it is strange that such great names as those of Sir Dudley North, Sir James Steuart, Adam Smith, Ricardo, Thomas Tooke, and John Stuart Mill can all be cited as advocates for charging a seignorage within fair and proper limits. I may be allowed to mention that having been the first amongst the witnesses examined by the Royal Commission on International Coinage, in 1868, who spoke in favour of a moderate seignorage, and a report on seignorage having, in March, 1869, been made to the Chancellor of the Exchequer on this subject under the signatures of myself and Colonel Smith (which will be found translated into French in the report of the Commission of 1870), I am not at all prepared to admit that there is any deception either intended or involved in the plan. And the late Chancellor of the Exchequer, Mr. Lowe, and the chairman of the Royal Commission, Viscount Halifax—as well as other statesmen with whom I have discussed the question—would never, I am sure, have entertained the matter, any more than I would have done had there been in it such *charlatanerie* as, I assume, Mr. Seyd thinks there is. Then, again, I must take leave to express my regret at the terms in which Mr. Seyd has referred to the enquiry by the French Imperial Commission, in 1870, which, he says, "had a political design in view in forging another weapon against Germany" in deciding, as he alleges, "on conflicting evidence," in favour of a gold standard. All that I can say is that when I was in Paris to give evidence to this Commission, in 1870, I never heard one word to lead me to suppose that there was any weapon of offence to be forged against any country. On the contrary, it was stated that the Commission of 1870 was to examine, by a larger number of witnesses, and by a more important Commission, the conclusions in favour of a gold standard arrived at two years previously, of course without reference to Germany or any other country, those previous conclusions, of the Commission of 1868, having been as follows:—"That a single standard of gold, particularly with the addition of a 25-franc piece, would be of greater service than the double standard to the system of unification of money of various countries, and would even be preferable from the point of view of external commerce and of interior circulation. That, besides, every legal and permanent equation between the value of two metals, subjected, each from its own side, to the variations of supply and demand, is in flagrant contradiction with the principles of political economy, and even with the very nature of things." Thus, then, it will be seen that the single gold standard was recommended by a French Imperial Commission two years at least before the political events, or the Imperial Commission, of 1870! And in July, 1869, exactly one year before the war between France and Germany, the British Government, or at least the Lords of the Treasury, in a letter to Lord Clarendon (transmitted to Lord Lyons, at Paris, as an answer to the Prince de la Tour d'Auvergne's request to know the views of her Majesty's Government on the subject of the conclusions of the French Commission upon the monetary question), positively recommended the French Government to adopt a single gold standard as a means of greatly facilitating international coinage. Here, then, we have our own Government, in 1869, with no design against Germany, giving the very same recommendation which Mr. Disraeli (in his Glasgow banquet speech of 1873) blames the French Commission of 1867 for doing, and which Mr. Seyd (in his paper just read to this Society) blames the French Commission of 1870 for also doing. The continental press generally failed to see any justice in Mr. Disraeli's conclusion on this occasion, and, as I pointed out at the time, in articles in the *Economist*, the French were in no way open to the charge of precipitancy in the matter of the gold standard. They have indeed crippled their double standard by the measures they have so wisely taken in the past three years to strengthen their gold reserve, and to draw a gradually narrowing limit upon the amount of full weighted coin in 5-franc pieces now allowed to be coined at the mints of France, and of her monetary allies, from year to year. Instead of ranking these countries in the list of double standard valuation, they will all soon have to be ranked with those which have a single standard of gold. In fact, that standard is now *de facto* what prevails in France. It is only thinly disguised by the law, whilst the actual gold circulation amounts to 225 millions sterling worth, and this gold circulation is nearly five times as large as the silver circulation of, say, 48 millions sterling worth, to which two million sterling worth only will be allowed to be added in the current year 1876-7.

The Chairman said—It must be very evident to all how important is this subject, and what were the responsibilities of the committee in allowing it to be brought forward. They felt at the outset that it would be neccessary to have an adjournment in order to allow of its being thoroughly discussed, and I think you will agree that much yet remains to be said upon it. We propose, therefore, that the discussion should be again adjourned to the first convenient day, which will be Monday, the 13th inst., and I will, therefore, put that motion to you after the very few remarks which I have myself to make on the subject of the paper. The silver bullion in India cannot of itself be the cause of the crisis, which is dependent on conditions of extent, and impost, and even if a gold currency were introduced, £200,000,000 or £100,000,000 of the silver coinage of India would still be required for all the population of 200 millions. A change which is to take place in the currency relations of India will not be effected by the abolition of the silver currency, but by acting on the international relations. There are two questions to be considered, a temporary solution, or temporary relief in the present crisis, and the ultimate solution. With regard to the ultimate solution, it must be taken into account that India is undergoing a rise in prices, which must ultimately reach the European standard. Thus, within twenty years, prices have in many parts of India risen fourfold. The same operation will take place in China. Therefore, we have ultimately to take into consideration the cure

rency requirements on a European scale of 200 millions in India and more in China. Japan will early require a large supply of currency. So also Australia under the increased development consequent on Chinese immigration. One point not yet ascertained is what is the unit of currency now existing in India per head for the small quotations. Then there is the influence of hoarding. At present a few rupees are a small treasure, but with a more convenient currency hoarding will equally take place, but it will be with gold instead of rupees. It is only in a later, and what may be considered a remote stage, that we can look forward to a diminution of hoarding in India, China, and Japan, and the full action of economical expedients of currency. To my mind it appears scarcely eorrect to attribute the modern expansion of trade to an increase of gold currency, but we ought rather to attribute it to that expansion of enterprise in the Pacific, consequent on the discovery of gold, which has created such vast markets in those regions, and led to such great efforts in the Atlantic countries for their supply. This trade must go on expanding, as well by the effect of new gold discoveries in India, Africa, Australia, and New Zealand, as by the movement of immigration given to the large population of China, at one time almost sedentary, notwithstanding its overflow to the Malay countries. Now it is invited to America and Australia, and its influence must be vast. Thus we have to look forward to, and to embrace in our consideration, two great and simultaneous operations, which will at one and the same time increase the supply of gold and silver, and increase the capacity of those employing these metals. Who is at this moment to decide what the relative effect of the two metals will be, and what the effect on the total bulk is, and on the universal forces of commodities? What has not been taken into account by Mr. Seyd is, the employment of silver for jewellery, apart from what is coined. Some of the silver imported into India is immediately manufactured, and much of that which is coined is ultimately manufactured. In India, as in London, the coin speaks for itself, and is of known standard, and on that account worked up, whether to the standard, or with alloy. Although silver jewellery accumulates, there is still a great waste upon it. One circumstance to be taken into account on the other hand is, that there bas been a large displacement of silver for jewellery in Europe by fashion, and a displacement for plate, through the use of plated wares. These operations have to be estimated in the past and the future; in fact, wastage is a disturbing element, as I found when writing on the bullion statistics on the discovery of gold in California, and afterwards in Australia. Another point, difficult of calculation in reference to wastage and retention, is the quautity of metal (including coin) in what may be called paraphernalia. Although worn on the person of the women, this metal, like wedding-rings in England, is kept sacred from sale, and forms no part of a temporary market quantity, nor is it available for coinage. There is also to be estimated, that so far as gold and silver are commodities, and are commodities for adornment, they have to compete with others, as diamonds or ostrich feathers, and are subject to uncertain vicissitudes of custom and fashion. Diamonds, like feathers, have been more largely produced of late, and have been subject to great fluctuations in price. The laws of demand and supply in such cases (and this is to be considered with regard to any increased production of silver) are not regulated solely by cost of production. That uncertain influence, fashion, brings gold, silver, or diamonds more or less into use, and one displaces another. There is a part of Mr. Seyd's paper which is well deserving of consideration in reference to remedial measures, and that is, where he expounds the value of public debts for national purposes and works. I do not understand that he puts these debts as absolute values, but that he treats them as values for international exchange. A public debt of a State must always be for certain purposes a burden, but it is true that it may be made a means of raising money abroad, either by the State itself, or by the individual citizens who have become possessed of shares of it. The explanation I take it is, that a mortgage of national property is put in a representative and negotiable form by stocks and bonds and trdaing bills, more convenient than by attempting to place a large mortgage at a loan in block. The amount to which India has hitherto invested in stocks or railway shares, or debentures, has been very slight. Without going into the matter at length, and into the alleged facts, it seems to me useful to take measures for increasing the native investments. In Turkey, since the institution of the exchange of Constantinople, a largo amount of local investment has taken place, the shares being at the utmost £20, and some as small as £8. A £5 share may be found available for India. Among other measures for the relief of the situation, a loan, as proposed, is justifiable, in the view that the crisis is temporary. It is well worthy of consideration whether in view of giving temporary assistance, the duty on silver plate should not be suspended in this country, the Hall-marking being left optional. This would give a large premium in combination with the reduced price of silver for the employment of silver plate. With regard to the phrase of bleeding India, used by Mr. Seyd, it is unfortunate the United States and many other countries are bled, and have to make exports to England for moneys supplied for loans and public work. So is India bled, and to its great benefit; and, besides this, India has to contribute justly for the expenses of a Congress and administration, which have severed it from anarchy and bloodshed, and bestowed on it peace and progress. One small point Mr. Seyd may correct in his tables, and that is where he attributes to Turkey an inconvertible paper, the fact being that the notes have long since been redeemed, and that the Ottoman Bank has not yet been able to place much of its convertible notes. There is in Turkey, however, a large quantity of debased money and of copper. In reference to Mr. Seyd's attacks on gold fanatics, there is this to be said for them that they have been supported by an enormous production of gold, and it is only lately that there has been a large supply of silver. In the real and ultimate condition of the subjects before us, no convention such as Mr. Seyd proposes can constitute the equilibrium he desires. No equilibrium can indeed be obtained between the two metals, and between them and the commodities. All history is against this. The utmost that can be obtained is a temporary adjustment. One part of the problem is to determine what we have not been able to foretell for the last ten years or twenty years, what will be the yearly production of gold and of silver, and what the relation of these to the total amount first of currency, and secondly of precious bullion.

The motion for adjournment was then put and carried, and the discussion was therefore adjourned to the succeeding Monday.

The discussion was resumed on Monday evening, the 13th inst., when Lord Alfred Churchill occupied the chair.

Colonel Smith said he would endeavour not to lay down any views dogmatically, but to give a fair consideration to the views which Mr. Seyd had put forward. His arguments were founded mainly on statistics and estimates, some of which had been impugned by Mr. Hendriks, but not being in a position to question them himself he would deal with them as they were given. At page 311 of the *Journal*, Mr. Seyd stated that there were 136 millions sterling of pure paper currency in the United States, and that to bring this to even the verge of convertibility a minimum of 50 millions in gold would be required. It appeared to him, however, that the author

had not sufficiently distinguished between currency on a par with gold, and gold currency. Besides, the esti mate of 50 millions seemed an error in arithmetic. Gold was now at a premium of 13 per cent., so that 136 millions of paper would be repaid by 120 millions at par, and from this it would appear that gold, to the amount of 16 millions instead of 50, would be sufficient to bring the currency to par. He believed, however, that no gold at all was necessary. On page 308 there was a table showing the premium on gold at various times in the United States, from which it appeared that at one period in 1865 the premium was 100 per cent. It was now reduced to 13; but, it appeared, from page 312, that all the gold and silver produced in America from 1848 to 1875 had been exported, showing that the reduction in the premium had not been effected by the addition of gold to the currency, and the same process which had reduced the premium from 100 to 13 might go farther, and reduce it from 13 to nothing. It would be effected by simply reducing the bulk of the currency by withdrawing the excessive issues. Another statement to be found at page 320 was this, that the main objection to a double standard was that creditors might be paid in whichever metal was lower in value; and that this was untrue both in practice and theory; because large payments were made in bills or cheques, and took place on a higher stratum than that of the metallic currency. He (Colonel Smith) contended that if a man owed him a million sterling, and could pay him in either gold or silver, and if the latter were depreciated 12 per cent., there would be no possibility of preventing him being exposed to a loss of £120,000. The debtor could take the depreciated silver to the mint and demand currency for it, and deliver it to him at the depreciated value. Another statement at page 312 was, that unless the currency were rapidly reduced in America, exports would be stopped. He did not profess to be a political economist, but this seemed to him a mistake, and that inflation of the currency had nothing to do with barring export or encouraging imports. If prices rose from any other cause than inflation of the currency in one country more than another, that would, no doubt, be a bar to export; but any rise in prices arising from over currency would be set right in foreign commerce by the ratio of exchange. It was true the exports must be increased to pay off the debt to foreign nations, but he should infer that it would not be necessary for prices to be reduced. He could not go through every point which had been raised, but he must take exception to the chief basis of the argument which was to be found at page 319, where he made the calculation that all the gold and silver money in the world was 2,015 millions, and that the demonetisation of silver would reduce it to 1,080 millions, or little more than one-half. From this he showed that there would be a great reduction in the circulating medium, and that very great evils would necessary and rapidly follow. He stated that the great fall in silver during the last few months foreshadowed a great fall in price, and that when once the decision for the gold valuation was taken by a State, no transition period could take place without seriously hampering the acquisition or retention of gold; the law of limited tender for silver must come into force at once, and thus throw the masses of legal tender silver out of use immediately. From that it appeared a very serious misfortune was rapidly approaching. All this was based on the great reduction of currency, one effect of which would be that subsidiary coins to the extent of 45 millions would be thrown out of circulation immediately. On page 318 he said that if the price of silver fell much it would not only cease as legal tender money, but could not be maintained as a material for subsidiary coinage; but he seemed to have forgotten that in the 145 millions were included about 70 millions in France, and the idea of the silver coinage of that country leaving it was contradicted by facts. He also struck out bank notes to the amount of 285 millions, because they were based on gold, and when the gold was diminished they could not issue so many notes. But this did not at all follow. There might be a gold standard without a gold currency, and as Gen. Marriott had said, we might reduce the amount of gold currency required in England by 40 millions by issuing £1 notes. He (Colonel Smith) should put the amount much higher. You might, indeed, do without gold at all, except so much as was necessary for the export of bullion. He should also contend that even if a gold currency were established in India it need not part with its silver. You might either have inconvertible currency, though he did not recommend that plan, or you might purchase gold and give notes for it. Either of these methods would prevent the rupees leaving the country. And if it were not necessary that countries introducing a gold currency should send away their silver the whole argument failed. Mr. Seyd said it was impossible to introduce a gold standard into India, but he took leave to doubt that. You could introduce it immediately if you liked, but you could not bring it into circulation. There were only two ways of carrying out Mr. Seyd's proposal, either a double set of prices, or a double set of coins; the last would be the easiest, but it would require an entire re-coinage. His only other remark was that the evil could be cured by the simple method of stopping the coinage of rupees. Mr. Seyd said that prices varied according to the abundance of money, and, therefore, if prices were falling it would be only necessary to restrict the coinage, when prices would rise to such an extent that gold might be introduced.

Sir Hector Hay said—Agreeing as I do to a great extent in the scope and purpose of Mr. Seyd's able paper, I shall not occupy much of the time of the meeting, but there are three points in which I presume to differ in some degree from Mr. Seyd, and it appears to me that a true apprehension of these is essential to a practical conclusion. The first is, the amount of metallic money (coin and bullion) now existing, and (which has not been referred to by Mr. Seyd) the annual production required to maintain that amount. Second, the category in which England should be placed as to metallic currency; and third, the necessity of any alteration in the denomination of the Indian currency in the event of an international agreement as to the relative value of gold and silver. I hope also to be able to show some ground for the belief, that even in the failure of any agreement among the nations as to a universal ratio of silver and gold, the former is not likely to be, in the future, to any considerable extent depreciated, unless those countries which still retain the silver, or the gold and silver valuation, should allow themselves to be carried away by an unworthy panic, and follow the example of Germany, without even the specious pretext which she had for her arrogant contempt for the metal which forms 4-10ths of the monetary wealth of the world. With respect to the first point, I have here a statement showing at a glance the estimated production of gold and silver since 1492. The source from which the figures are taken is "McCulloch's Commercial Dictionary," so far as the production up to 1848 is concerned; after that date, up to 1875, the official returns of Australia and the United States supply the information as to those countries forming two-thirds of the whole, while the amounts credited to Russia, Mexico, South America, &c., are gathered partly from the report of the director of the United States Mint for 1874, and partly from a consideration of the known exports from those countries. In the article on "Precious Metals" in McCulloch's Dictionary, the celebrated Humboldt is given as the authority for the production of the American mines to 1803, and other authors are cited for the estimates as to the years 1804 to 1810, 1811 to 1829, 1830 to 1848, after which date more detailed information is obtainable. This total is £2,309,000,000. In the same article it is calculated that $1\frac{1}{2}$ per cent. of the whole

amount existing is annually consumed in wear and tear and loss of coin, and 2 per cent. more in arts and manufacturers, but I cannot help thinking that this proportion is greatly over-estimated. If, however, we assume, that only 1 per cent. has been thus consumed, it follows that in 1875 an amount equal to the total production up to 1775 must be taken off; this is 956,000,000, and then the proportionate loss on the production since 1775 is also to be deducted, say, £263,000,000, leaving 1,090,000,000 as the total now existing:—

		Gold		Silver.	
1492 to 1775	£956,000,000	say £320		£636	
1776 to 1803	182,000,000	,, 60		122	
1804 to 1810	77,000,000	,, 26		51	
1811 to 1829	76,000,000	,, 26		50	
1830 to 1848 say	90,000,000	,, 30		60	
			£462		£919
1849 to 1851	65,000,000	,, 41		24	
1852 to 1875	814,000,000	,, 573		241	
	£2,260,000,000				
Russia 1810 to 1851	49,000,000	,, 43		6	
			£651		£371
	£2,309,000,000	£1,119		£1,190	
In 1875, total product before 1775	956,000,000	,, 320		636	
	£1,353,000,000	,, £799		£544	
Proportionate since 1875	263,000,000	,, 155		108	
	£1,090,000,000	£644		£446	

The difference between this total and Mr. Seyd's estimate, £1,350,000,000, is very considerable, but being, in all probability, arrived at in a totally different manner, the agreement is sufficiently close to permit an argument to be founded on both without deciding which is nearer exactitude. I think it will probably be admitted that, in the present day when wealth and luxury have advanced with gigantic strides, the quantity of the precious metals consumed in arts and manufacturers, and the loss by wear, &c., may safely be taken at not less than 2 per cent. There would be thus necessary an annual production of 22 millions, simply to maintain the amount now in existence, while the average production of the last 5 years has been only 33½ millions, leaving 11½ millions to supply the annual increase necessitated by increase of population and wealth, and for the resumption of specie payments on the United States. This, it will be observed, is the quantity of both metals, but if it were possible to demonetise silver throughout the world (which it is not) the annual yield of gold alone has only averaged 19½ millions for the last 5 years, and is more likely to diminish than to augment. I think, therefore, I am justified in saying, that even if Germany is able to maintain a gold currency with only a subsidiary coinage of silver, the total production of gold and silver is not in excess of the requirements of the world, and if this be so, it is only necessary that the fact should be known and recognised to restore silver to its normal value in relation to gold. I think it quite fair to speak of 15½ to 1 as the nominal ratio, because for centuries the proportion has remained between 15 and 16 to 1, and since the beginning of the present century 15½ has been accepted as the basis among all nations possessing the gold and silver valuation, and may therefore be justly styled "the average," as it is by Mr. Seyd, although General Marriott asked the other evening what we have to do with an average in the matter; but I confess I cannot see any other means of arriving at a just proportion except universal consent and the experience of ages. I admit, however, that I share General Marriott's inability to deduce an "intrinsic value" of either metal from its chemical "nobility." The fact is that the "value" of both gold and silver is purely conventional, and the only reason why it is desirable that 15½ to 1 should be universally adopted is that this proportion is already established by custom all over Europe. It will not be denied by any one acquainted with the subject that the extreme depression which silver has suffered during the last three years has been caused almost entirely by the German demonetisation. Making every allowance for the increased production (of silver) in America, and languishing trade in India, I venture to assert that it is the unknown amonnt which, it has been supposed, Germany might at any moment put in the market, that has caused all the mischief, and that had it been known four years ago that the quantity she could spare was as small as it probably is silver would never have gone down to 53d. as it recently has. With respect to the actual amount of silver which Germany had in 1870, I am inclined to think that Mr. Seyd has very greatly over-estimated it at 76 millions. as indeed he himself shows where he states at page 23, that she "has £30 millions yet to dispose of;" now as the sum authorised to be coined in marcs is 20 millions, and she has already sold 6 millions, these sums would make together only 57 millions; but even this is almost certainly too high, though I cannot imagine that the total could have been so low as Mr. Hendrik puts it, about 33 millions if I am not mistaken. According to a German official statement, the whole amount of silver coined by the States of the confederation between 1764 and 1870 was—Thalers 597,717,759, say £89,654,000

of which allow for re-coinage		25,000,000
		64,654,000
and for loss of coin wear, &c.		25,000,000
leaving		39,654,000
of which required for new coin	£20,500,000	
sold as bars	6,000,000	
		27,000,000
	probably	£12,654,000

still to be disposed of, if the German Government can carry out in full its project of demonetisation. I am in a position to state that the German Government was warned, when the demonetisation was first mooted, that the result would be what it has proved, and was told that by waiting quietly until in the ordinray course of trade a demand arose, they might dispose of their surplus with little or no loss. They were too high and mighty, after getting the 200 millions, to act in this prudent manner, and what has been the consequence? They have succeeded in selling about 6 millions sterling, a sum which in a good season India would have absorbed in six months, and in doing so have temporarily depreciated by 10 per cent. 450 millions of silver! I say temporarily, for it is absurd to talk of a gold currency with only a subsidiary debased silver coinage for all the world, but a gold standard is quite a different thing, and is not only practicable but desirable, if supported by a legal tender silver currency at an established ratio. Taken thus together, gold and silver form one measure of value for all other commodities, and are as essential to each other as the mile, the yard, the foot, and the inch are in the measurement of space. The effects of the reduction of the monetary circulation by the demonetisation of silver, supposing it were possible to accomplish it, are so well drawn by the writer of the article in "McCulloch's Dictionary," to which I have before referred, that I am sure you will excuse my quoting a passage from it. After showing that a fall in the value of money—that is, in its purchasing power—is advantageous to the vast majority of the people, he goes on:—"The opposite effects follow when, instead of falling, the currency becomes more valuable, taxes and fixed charges being then augmented in an equal degree, the profits of those by whom they are principally borne are proportionately lessened, industry is depressed, and the situation of the working classes changed for the worse. Money being the standard or measure of value, to interfere with it, whether in the way of increase or diminution, would be an act of extreme injustice. Government is bound to protect, in as far as possible, the rights and interests of all classes of its subjects, and it cannot, without

trampling on its most sacred duty, adopt, to benefit one part of them, any measure which might to be injurious to another part. But a fall in the value of the precious metals, caused by the greater facility of their production, or by the discovery of new sources of supply, is a wholly different matter. It depends in no degree on the theories of philosophers or the decisions of statesmen, but is the result of circumstances that are beyond human control." Secondly, the category on which England should be placed in relation to metallic currency. I approach this consideration with some diffidence, because I know beforehand the scorn which will be poured upon my theory by the partisans of a single standard, whether of gold or of silver. Nevertheless it seems to me that the British Empire is in fact the most prominent example of a gold and silver valuation, for it must not be ignored that India forms a part of the Empire, which, as a whole, employs not only as large a gold currency as any other nation, bnt one of silver nearly equal to all the rest of the world put together. True, she uses the gold in some portions of her territories, viz., in England and Australia, and the silver in others, India and Canada, but to object that this distribntion of her wealth removes her from the group of "gold and silver valuation" is as reasonable as to insist that the bi-metallic theory requires every man to carry gold and silver in his pocket, and to ignore the fact that the rich man carries gold because he has much money, and it is more convenient in that form, and the poor man silver because he has little. I do not see then that thero would be any justice in the reproach which, Mr. Seyd says, Germany and France might throw at England were she to propose the one restoring and the other retaining the double valuation. If England and India are not, to use a French phrase *solidaire* in this matter, will any one tell me what authority would represent India, if an international conference on the standard of value were to be held. To prove what I have asserted as to the use by England of both gold and silver, allow me to give the figures of the production and coinage of both for the ten years 1861 to 1870:—

Total gold production ..		£223,925,000
Coined at the Royal mint	£51,449,301	
,, at the branch mint at Sydney	21,173,000	
		72,622,301

or nearly one-third of the whole production, turned into coin for the use of the British possessions.

The production of silver was		£99,000,000
Of which England purchased and exported to India ..	£45,700,000	
And coined at the mint	2,957,000	
		48,757,000

or nearly half of the production. It is worthy of remark, as illustrating the quantity of German silver before referred to, that of the three millions coined at the mint in ten years, one million nearly (975·789) consisted of worn silver coin. Thirdly, though, as I have endeavoured to show, I believe it will be found impossible in the long run to demonetise silver, and that ultimately it must in any case recover its position as an integral part of the money of the world, I am not blind to the enormous injury which the attempt has already inflicted, and must continue to inflict on all nations, but more especially on England and India. There will, no doubt, be an almost insuperable difficulty in convincing the British public of the necessity for the adoption of a silver legal tender, but if no other means can be found to prevent the spread of the demonetisation mania to France, Belgium, Russia, &c., I agree with Mr. Seyd, that it will be the duty of thoughtful and influential men to consider whether such a measure has not become unavoidable in the interest of India, with whose welfare England is inseparably bound up. In reality it would matter very little that four or five millions of notes were in circulation in England which had been issued against silver lying in the vaults of the Bank of England, instead of against bar gold. In the course of time it might be possible to introduce the proposed 4s. piece or English dollar into India, but I think it is open to very grave doubts whether it would be wise to make any alteration in the weight, appearance, or denomination of the rupee, as it is more than probable that any such change would breed suspicion and discontent among the ignorant masses of the natives. Mr. Seyd says very truly (page 34) "changes in the arithmetical reforms of a coinage system can never succeed if they are radical both as regards the standard pieces and the subdivision, either the one or the other must be maintained as the connecting link," but it appears to me that his "proposal" goes so far as to alter every constituent of the standard piece, the rupee, and of the sub-divisions, the anna and the pice. If the sovereign were proclaimed legal tender in India as equivalent to (10·10) which practically is in the proportion 15½ of silver to 1 of gold, there need be no change in the currency to which the native is accustomed, and that is really of much more importance than that the rupee should be contained an exact number of times in the sovereign. I do not venture to suggest any plan of my own to remedy the evils of the depreciation of silver, my only object being to bring before this meeting certain considerations, which an enforced attention to the subject has convinced me are important.

Mr. Conybeare, while entirely agreeing with Mr. Seyd that the demonetisation of silver would become absolutely prevalent throughout Europe, thought he was incorrect in many of his conclusions. As Adam Smith had taught England practical economy, so England had taught the world, and one of the greatest applications of political economy was to see that a double standard of gold and silver was more or less conventional—much more so in the case of silver than gold. It would be impossible to produce any great effect by attempting to demonetise gold, for gold was the best medium of exchange yet known for mercantile purposes, and if any country in the world were to demonetise it, the commerce of the world would soon remonetise it. That was not the case with silver, for when silver was demonetised it tended to reduce it in value to an extent many times greater than could be done by attempting by legal measures to demonetise gold. He thought the axe was laid at the root of the tree when it was stated that England had hit upon the great truth that an artificial double standard could not be maintained, and that a single standard was the one rule to observe. The doom of silver, as far as Europe was concerned, was then fixed. How long it would take to complete that process was not the question they had to consider, but they could not lose sight of this fact that the greatest nation in the world had adopted the single gold standard. He thought that Germany would not be moved from her resolve, and the attempts proposed by the author were just about as useful as trying to make the Thames run uphill; until that were done there would be no chance of getting the various Governments to do anything so retrogade as that proposed. There were few in that room who advocated protection, and the notion of artificially and by law fixing a double standard by an international convention was really a measure for the protection of silver. The lecturer had wonderfully exaggerated the evils of what would take place; he thought what would happen would be that silver would be demonetised throughout Europe; Germany sticking to its proposal, and Italy, Belgium, and France following suit. He did not think the demonetisation of silver would be half so fatal as was imagined. Granting that 200 million of silver in Europe (leaving out of consideration token currency), are now monetised, which would then be demonetised, one of the results would be that there would be a larger subsidiary currency of silver which would be very much

altered, because even with the present depreciation of silver the result pointed out of gaining 3s. on every sovereign might lead to coinage abroad, and to avoid the silver coinage of silver would have to be brought much nearer the market value. Of all the precious metals in the world, no doubt from the first period of civilisation, gold and silver had been universally known. Mr. Seyd had given a Cassandra view, but he would give a true one. No doubt they would have 200 millions thrown out of circulation, but it would not be forced out, for it would go in the way of commerce, and, doubtless, part of the effect which had been produced was owing to the clumsy way in which Germany managed her mercantile affairs. He had stated various reasons, which were not correct, why the silver could not be absorbed, but he had evidently not calculated the enormous absorbing power of the East, and, probably, when the East became more civilised, following the example of the great mercantile and trading nations, they would have a single gold standard, though it was a thing English statesmen would try to prevent. He thought one to two hundred millions would be absorbed by the demand from the East and the demand for manufacturing purposes, and every depreciation in its value would call for a very much larger use in the way of silver plate and articles of luxury of that kind. He thought America had been rather unfairly treated by Mr. Seyd. America, in order to get control of the trade to the East, had facilitated the traffic with China in a manner no other country had done. For a long time past she had been trying to bring the traffic of China and India through the Golden Gate to supply American demands from the Pacific coast, and in so doing she paid for articles in silver dollars, which was the principal medium of Oriental traffic. One hundred years ago America was a very poor country, but now it had acquired far greater wealth than England: its land was enormous, its minerals more numerous, its coal-fields were greater, its mines were superabundant; and with such wealth there was no doubt she would be able to found a gold currency when she chose to do so.

Mr. J. T. **Wood** wished to draw attention to the relation existing between England and her creditors. The debts of England payable in India was 70 millions, the debt of India payable in England was about 34 millions, and the railway debt was about 100 millions; 60 millions annually was received from railways in India, and she had to remit to this country sufficient in silver or other valuable commodities to meet the interest on 130 millions. He did not think there was a more striking practical example of the double or treble valuation than the transactions in connection with Indian railways. They were double valuations in this way, that subscriptions were receivable either in England or India at a fixed rate of exchange of 32 pence; provisions were made in the contracts that those railway securities might be registered in India or England, or *vice versa*, but in order to prevent their being used simply for the purpose of exchange, Government strictly adhered to the stipulation that the 5 per cent. was to be paid in England only, so that persons holding the security in India had to get their interest over in the best way they could. At that time the exchange was against the Home Government, for a rupee was worth 2s. instead of 1s. 10d.; then occurred a time when it was in their favour, and now the third period had arrived when the Government were losing through the rate of exchange being below 1s. 10d. The variations backwards and forward had been very continuous, and the losses consequent upon that serious; and where the Government had lost materially was in changing the silver received in India for the gold which she had to pay in England, though the loss at present did not exceed more than one million. That was the difference between the range of money in India at 5 per cent. and 6 per cent., and a great deal of the difficulty would have been avoided if the Secretary of State could or would have raised all the money required for India in India itself. Seventy millions had been raised in India, and he had never been able to get an answer that was perfectly satisfactory to himself as to what was the real difficulty which prevented much larger sums being raised there. That struck him as an example of what had been called the double valuation. The subject had excited the greatest interest amongst people connected with India and the members of the Society as to what would be the consequence of the depreciation of silver upon persons with fixed incomes. It had been said by one speaker that if the depreciation went on the case of those persons was past praying for; and he could not help thinking that there was more than a word to be said in their favour, and that it was a case which ought to be fully gone into by the committee lately appointed by the House of Commons. The real ground on which it was alleged that these persons should abide by their bargain was that they had entered into a contract to be paid in so many ounces of silver, but to that statement he begged to take exception. He might refer to three instances where the Government had raised money in this way: the first was the 5½ Rupee paper, payable at the Bank of England at a fixed rate of exchange, and one price of that was £77; the next security was the Indian 5 per Cents, payable in like manner, and the price of that was £106; whilst in the case of the Great Indian Peninsular Railway the price was £116. In each of those cases the Government received £100 sterling, and in consequence of the double valuation the public lost £40 in the valuation; and the argument he wished to press was, that to a certain extent it was a moral fallacy to say that the creditors of the Indian Government contracted in the abstract to be paid in ounces of silver. They paid full value, either in commodity or labour, and the Government contracted to pay full value in return, not to pay ounces of silver, for there was not sufficient silver in the world for them to do it with. He thought Parliament should inquire into the matter, and do something for those persons having fixed incomes.

Mr. Seyd said:—The two speeches most antagonistic to what I have laid before you are those of Major-General Marriott and Mr. Hendriks. The former gentleman seems to differ from me on points of considerations of economy and facts. As regards economy, this is not the place or time for its discussion, but I cannot refrain from pointing out to you one characteristic doctrine illustrated by the Major-General. Speaking of the fall of silver, he appeared to think this a benefit and no loss, for, as I understood him to say, "if the price of silver falls, all that people have to do to make up the loss is to buy more silver." I can understand a bull and bear transaction on the Stock Exchange, but, with all respect to Major-General Marriott, must refuse to subscribe to the applicability of such a suggestion in this case. Then, as regards facts, Major-General Marriott disputes my rather wide estimate of a probable absorption in future by India of only about £7 millions per annum, as too little, and somehow made out that India would take £12 millions in future. Now, if a gentleman talks so freely of rules of supply and demand, and so forth, he should also bear in mind great facts, and you may remember that in the treatise I asked you not to admit mere words without facts. Major-General Marriott, in speaking of the balance of trade of India, has entirely ignored that within the last 14 years the drawings of our home Government on India have increased from £1 million to £16 millions, and I am of opinion that, as every one familiar with the state of matters may be able to admit, that this important item should not be overlooked, even in a hasty glance at the question of the balance of trade of India. Mr. Hendriks is a formidable antagonist, not only on the ground of facts, but also on that of the economical consideration. The charges are, firstly, with having inflated the amount of silver subject to the danger of demonetisation by 300 millions out of the £505 millions set down by me, saying that in all Europe

and India but £175 millions are under this liability. I venture to ask you then to permit me to reply to him at some length. When you have heard what I may have to say, you may find justification for the request, for I shall lay before you not only some facts which might be considered as a contribution to the controversy, but over and above tbis I shall show you that certain assumptions upon which the majority of by-gone and present economists have built estimates are thoroughly false, and the proofs that this is so I shall lay at once before you. From a careful study of all the authors on this subject, Humboldt, Jacob, Chevalier, Augsburg, &c., as well as the researches made by the French and Belgian commissioners, the following statement is submitted in round figures. We have no reliable data of either the production or the status of precious metals previous to the the end of the 15th century. The totals are variously estimated at from £400 millions to £1,800 millions. The ancients, as far as history is traceable, possessed immense treasures, so did Rome. For several thousand years preceding the year 1500 of the present era, many more millions may have been produced than we are aware of, and there is no reason to suppose that in remote times the immense territories of Asia did not yield the same proportions as the modern continents have done. Between the fall of the Roman power and the European middle ages, when the Eastern States, Persia, India, and others flourished, the great bulk of the then existing current stocks of gold and silver found their way eastward, and when we first went to India that country abounded in treasure. Few writers take sufficient note of this feature of the case. Again, China has always yielded silver and gold; the so-called Sycee silver is evidently a native production. We are now only on the fringe of its interior, or know little of its present state, what can be known of its statistics of the thousands of years which have passed? There is every reason to believe that the quantities involved were, and are still large, but for the purpose of this statement the actual sums of ancient and eastern silver existing before the year 1500 had best be stated as gold, £ ?— millions, silver £ ? — millions. At the end of the 15th century the total stock ascertained can be stated as:—

Gold.	Silver.
£200 millions.	£340 millions.

In the period from 1500 to 1800, authorities agree upon the following production:—

Gold.	Silver.
£420 millions.	£990 millions.

In the period from 1800 to 1848 there appears to have been produced:—

Gold.	Silver.
£155 millions	£460 millions.

Since 1849 to 1868 the production is stated at, by the *Economist*, as:—

Gold.	Silver.
669 millions.	£343 millions.

and, although we should attach greater faith to that, I take here, for moderation's sake, the estimate of other authorities as:—

Gold.	Silver.
£550 millions.	£267 millions.

From 1868 to 1875 the total production is stated at:—

Gold.	Silver.
£146 millions.	£93 millions.

The totals involved therefore are:—

	Gold.	Silver.
Ancient gold and silver productions for, say a period of 3,000 years before the year 1500 ..	£?— millions.	£?— millions.
Estimated stock in 1500	200 „	340 „
Production of gold and silver from 1500 to 1875; or 375 years ..	1,273 „	1,810 „
Total..........	£1,473	£2,150

As far as the annual production of gold and silver at this time are concerned, the *Economist* estimates the average production from 1864 to 1868 at, for:—

Gold.	Silver.
£29½ millions.	£19¼ millions.

Other authorities state that of 1867 at:—

Gold.	Silver.
£28½ millions.	£14 millions.

Since then, however, the actual production of gold has very much decreased, and according to the best authorities it had lessened in 1875 to £20⅗ millions. But that of silver has much increased. In 1868 the new American mines yielded but £2,400,000; in 1875 their produce was about £8 millions. Now, if the *Economist* states the production of silver in 1868 at £19½ millions, and others at £14 millions; and if one single district now produces £6½ to 7 millions more, was I wrong in assuming as I have done in the treatise before that the production of silver stood now at between £16 millions to £20 millions, and taking the minimum at £16 millions per annum? It is neccessary that you should bear this in mind, for Mr. Hendriks hinted that he might prove this statement to be excessive. So far as the future supply of silver is concerned, it appears that the American mines alone will probably yield upwards of £10 millions in 1876. In gold-bearing countries silver has invariably been discovered, and there is every reason to believe that Australia will soon yield silver. It has been said also that the silver mines may soon be exhausted; experience, however, shows that silver mining districts take a much longer time to exhaust than goldfields. But setting aside now the question of the future supplies of gold or silver, that which concerns the ultimate correctness of the figures submitted to you as regards the quality of £505 millions of silver subject to demonetisation, and reduced by Mr. Hendriks to £175 millions, now involves this consideration: "What has become of the £1,400 millions of gold and £2,100 millions of silver with which the world has had to deal during the last 375 years? How much has been used up by abrasion of coinage, how much is left, how much been lost and absorbed by manufacture"? It has been stated by Major-General Marriott that as the American silver contains much gold, and that this is included in the estimate, the returns separate such gold from silver on the quantities of gold, and silver are stamped upon each bar. The hint has been thrown out to you that the loss by abrasion of coinage is enormous, and accounts for the disappearance of coinage. Indeed, some of the writers have made statements, alleging that the wear of silver coin is 1½ per cent. per annum, so that the coinage would be lost in 66 years. I will show you the absurdity of these at random assumptions. The British sovereign, according to the researches of Professor Jevons, looses its legal weight by a reduction of ¾th of a grain in 18 years. The full weight is 123¼ grains. It would consequently take 2,880 years to consume the sovereign by usage. But mark, this loss of ¾ grains occurs in the first year by the wearing away of the so called "pickling" (now abandoned by the mint), and the fine edges of the impression. Further, our sovereign is the softest of the European coinage, the coins of 900 fine are much more resisting. One sovereign out of 3,000 a year would thus be absorbed. Our British silver coinage appear now to require an annual sum of about £15,000 for the reinstatement of light pieces. As the sum in circulation is about £15 millions, it would consequently take 1,000 years to consume it. But mark this, this payment has only come to an average of £15,000 during the latter period of the existence of our coinage, and when strenuous efforts were made to improve its condition, and it has been so improved. Further, our silver coinage is always in use, being unfit for bankers' reserves. It is the softest of all the silver coinages made, and in its subdivisions it offers about three times as much surface wear as the legal tender silver coins of

the thaler or dollar type. Of the latter, pieces are still in circulation abroad of the coinage of centuries ago, showing but insignificant loss in weight. It can be asserted that a period of from 2,000 to 2,500 years would be required to wear away such coin, or its equivalent per annum. If, consequently, the entire half of the gold and silver produce since 1500, say £700 millions of gold and £1,000 millions of silver, had been in use for the 375 years, the loss by abrasion of coin would only have been on gold £88 millions, on silver £140 millions. But this assumption is extravagant; the actual loss by abrasion of coin and for re-coinage for the whole period is probably under £50 millions for gold and much under £100 millions for silver during the 375 years. You may be able to face the extraordinary statements made by Mr. Hendriks and others with this real truth of the case. McCulloch also makes the preposterous statement that the annual wear on coin is $1\frac{1}{2}$ per cent. per annum, without any practical proof whatever, on the mere strength of assertion. The positive facts as to the actual wear of about $\frac{1}{30}$th per cent. can be easily verified by everybody. The next question is how much has been used in the arts and for domestic consumption in silver utensils. Here, in the first place, the idea must be dispelled that jewellers and silversmiths use up the current actual coinage. Small jewellers may occasionally use a gold coin, but the large manufacturing interest purchases its gold and silver from refineries, and obviously, if even the coin were not worn, but new, those who know what the "Mint remedy" means are aware that bullion gives more pure metal; and although the difference is small, yet the large manufacturers know how to keep accounts in £ s. d. Government officials and others make bold assumptions as to the melting down, in ignorance of the real facts of the case. On the consumption in England of gold and silver plate there appears in McCulloch's dictionary (quoted from Porter) the following table and remarks:—

Account of the number of ounces of Gold and Silver Plate upon which duty was paid, and for which drawback was allowed, showing the quantity retained for home use in each year in the undermentioned years, from 1800 *to* 1850.

Year ending 5th January.	Duty paid on		Drawback allowed on		Retained for Home Use.	
	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
	ozs.	ozs.	ozs.	ozs.	ozs.	ozs.
1801 ..	5,251	902,966	77	142,705	5,174	760,261
1805..	4,854	902,788	21	114,829	4,833	787,959
1810..	6,382	1,242,208	53	71,116	6,329	1,171,092
1815	6,779	974,245	29	55,948	6,750	918,297
1820...	6,037	1,230,104	1,607	116,507	4,430	1,113,597
1821...	6,651	1,081,310	3,735	114,224	2,916	967,086
1822 .	5,434	1,022,761	1,436	120,600	3,998	902,161
1823 .	6,997	1,027,722	1,370	64,783	5,627	962,939
1824 .	6,516	1,073,244	20	97,016	6,496	976,228
1825	7,662	1,258,658	38	70,482	7,624	1,188,176
1826 .	8,486	1,585,254	81	112,017	8,405	1,473,237
1827	7,108	1,247,880	...	71,493	7,108	1,176,387
1828...	7,266	1,207,887	10	60,910	7,256	1,146,977
1829 .	7,106	1,361,332	2	86,157	7,104	1,275,175
1830 .	6,441	1,271,322	12	109,907	6,429	1,161.415
1831..	5,716	1,076,976	6	84,444	5,710	992,532
1832..	4,574	826,052	9	100,127	4,565	725,925
1833 .	5,189	914,096	15	79,659	5,174	834,437
1834...	5,434	879,117	2	72,005	5,432	807,112
1835 ..	6,116	1,050,232	..	102,251	6,116	947,981
1836 .	6,678	1,071,026	16	110,247	6,662	960,779
1837..	7,966	1,272,920	...	164,064	7,966	1,108,856
1838..	6,811	1,178,568	4	177,539	6,807	1,001,029
1839...	6,784	1,195,483	21	161,458	6,763	1,034,025
1840...	6,875	1,270,390	7	155,923	6,868	1,114,467
1841	6,992	1,209,266	7	179,904	6,985	1,029,362
1842 ..	6,580	1,149,070	5	160,495	6,575	988,575
1843 ..	6,305	1,026,046	4	171,574	6,301	854,472
1844...	6,415	911,220	2	122,689	6,413	788,531
1845...	7,242	1,025,412	8	170,987	7,234	854,425
1846..	8,036	1,158,050	16	181,759	8,020	976,291
1847 .	8,335	1,188,736	18	167,513	8,317	1,021,223
1848 ..	7,629	1,049,268	5	161,483	7,624	887,785
1849...	6,810	756,388	...	109,136	6,810	647,252
1850 ..	7,373	735,865	3	76,759	7,370	659,106

It is not easy to account for the nearly stationary demand for plate as exhibited in this return. Most probably it has been mainly occasioned by the greater use of plated articles, which have, to a great extent, been substituted for those made of silver. Perhaps, also, it may be in part accounted for by the fact of the cost of gold and silver having increased from 1809 down to 1849 or 1850. But a large increase in the consumption of the precious metals may now be expected to result from their increasing supply and diminishing value.

Through the courtesy of Sir William H. Stephenson, Chairman of the Board of Inland Revenue, I am enabled to lay before you now the complete returns from 1851 to 1875 inclusive:—

	Duty paid on		Drawback allowed on		Retained for Home Use	
Year ended Jan. 5	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.	Ounces.
1852	8,915	876,787	...	151,840	8,915	724,947
1853	9,110	806,187	...	125,426	9,110	680,761
1854	11,038	980,280	...	142,733	11,038	837,447
Year ended Mar. 1						
1855	9,920	994,360	7	156,440	9,913	837,920
1856	10,912	863,450	53	129,466	10,859	733,987
1857	10,522	930,707	53	141,840	10,469	788,867
1858	10,288	863,440	6	166,147	10,282	697,293
1859	10.502	801,680	71	116,146	10,431	685,534
1860	12,325	863,293	69	113,400	12,256	749,893
1861	12,075	893,493	45	144,840	12,034	748,653
1862	10,348	751,067	171	100,267	10,177	650,800
1863	10,295	793,253	80	104,667	10,215	688,586
1864	11,115	803,666	12	120,973	11,103	682,693
1865	10,373	858,173	...	133,160	10,373	725,013
1866	12,888	843,560	67	97,093	12,821	746,467
1867	14,188	788,626	79	96,813	14,109	681,813
1868	13,552	764,387	25	107,253	13,527	657,134
1869	13,432	716,960	...	99,080	13,432	617,880
1870	139,66	707,053	321	97,293	13,645	609,760
1871	14,844	672,547	17	74,320	14,827	598,227
1872	17,926	714,253	232	86,267	17,694	627,986
1873	20,448	817,733	42	114,480	20,406	703,253
1874	23,273	847,293	...	117,573	23,273	729,720
1875	23,922	886,493	66	120,280	23,856	766,213

It must now be remarked that these returns, so far as gold is concerned, furnish no guide. The gold plate on which duty is paid is of the testimonial or utensil kind generally; and, with the exception of wedding-rings and keepers, the by far greater part of gold in watch cases, chains, and miscellaneous jewellery, pays no duty. It is, consequently, impossible to tell how much gold is actually consumed in the arts. A great deal of gold is also used in gilt jewellery in Birmingham as well as Paris. It has been stated that before the invention of electro-plating, in the former fire-gilding process, about 400 oz. per week, or £80,000 a year, were used in Birmingham; since then, although in electro-gilding much thinner films are applied, yet the number of articles has much increased. In gold-leaf beating, picture frames, outside and inside decorations, tradesmen's signs, &c., there is a large consumption. Chloride of gold is also used now in photography, and some gold is lost annually by shipwrecks, and accidents, and buried with the dead. The friction on gold in jewellery is, of course, much less in quantity than silver but greater in value, and the pecuniary loss in gilding not recoverable much larger. It is not unlikely that during the last 350 years there may have been thus lost between £100 millions to £120 millions; and, taking the loss by abrasion of coin at £50 millions, there is reason to suppose that of the total of £1,471 millions there are now in existence, say, £1,300 millions to £1,320 millions. Of this, £750 millions are now in use as money, in bar gold and coin, and £570 millions may be in the shape of plate and jewellery. It is possible, then, that during the whole period from 1500 the annual absorption by abrasion of gold plate is about $£\frac{1}{3}$ million, and that of abrasion in

the use in jewellery, &c., from £1½ millions to £2 millions. The by far heavier portion of this falls upon the recent years. We know that out of the total of £700 millions found since (of which California and Australia furnished about £550 millions), a sum of £350 millions has gone into money and bank-bars; the other half seems to have been used for the other purposes. This fact affords much support to the question of the value of gold as resting upon appreciation and demand for both purposes; and upon this theory it has been assumed that the demonetisation of either gold or silver would bring down the value of the one or the other to one-fourth of the present. It appears, also, that the quantities here involved agree with other statements as to the localities in which gold may be now. In 1868 the total stock of gold present in the civilised western portion of the world was estimated at £1,085 millions, of which £510 millions were in money in 1870 in Europe; of the balance of £310 millions, £170 millions were in money elsewhere, and from £130 millions to £140 millions in other forms, India's share being probably between £50 millions to £60 millions. But, as the correctness of the statements as regards gold made before is not impeached, I need not give further details. The only point worthy of remembrance as in the controversy is this. McCulloch states the amount of gold and silver used per annum for arts and ornaments at £12 millions. Although his estimate for silver is too high, as presently to be shown, yet it is too low for gold. It is very likely that the consumption in the arts and the accumulation of the stock of gold plate and jewellery proceeds at the rate of from £10 to £13 millions per annum. But the production of gold from its highest average of £30 millions between 1849 to 1867 has now fallen to about £21 millions per annum. The advocates of the gold valuation who talk so glibly of the continuous supply of gold may bear this in mind, independently of the increasing population and of the diminished percentage addition to the increased stock. As far as silver now is concerned, the returns of silver plate on which duty was paid are full reliable. With the exception of small articles of less than five pennyweights, or about 1s. to 1s. 3d. in value, of which a very insignificant quantity is used in small mountings (prayer-books chiefly), all the silver manufactured is hall marked, not only because people will have it so, but because there is a heavy penalty on the avoidance of duty. McCulloch, puzzled at the moderate quantity of silver used, tries to explain the matter by alleging that the duty is much avoided, and that inferior qualities are used. This is the case in gold jewellery, and is a grievance to the trade and the public, but there is no foundation for the statement as regards silver, and silver below standard is rejected at Goldsmiths'-hall. It appears then that England, during the period of its greatest increase in population and enormous increase in wealth, used but about one million ounces of silver for plate, or £250,000 per annum. But it is less than that. A great deal of old plate is continually being melted down, and at least-one sixth of the total must be deducted on that account. For the same reason also this annual amount of duty-paying silver plate includes the annual wear and tear to which plate is subject. The positive loss on plate by such abrasion falls on spoons, forks, and dishes—formerly these amounted to about 60 per cent.; less are now made. From careful inquiries instituted in proper quarters, I have ascertained that spoons and forks subject to daily use and cleaning get old in 50 years, when they may have lost between 15 to 20 per cent. of their weight. The annual absolute loss on silver plate in England may therefore be between £7,000 to £10,000; many people think this too high an estimate. The present stock of silver plate, watches, &c., in England may amount to about £52,000,000. From 1800 to 1875, including the small imports and deducting one-fourth for the remelting of old plate, there may have accumulated from £15 to £16 millions. Previous to this, according to the last researches, the stock was estimated at about £37 to £38 millions, and that would seem to be in accord with the estimates to be formed on lesser population and wealth during the last century, the remelting of utensils required, and the probable remains of ancient silver plate. But it will here be seen, the greater part of the consumption in silver is in silver-plated or electro-plated goods. Be it remembred that the electro-silvering process is of recent origin only (of which more hereafter); that what concerns us here is the total consumption of silver in plating, say previous to 1845. Before that time silver was soldered to iron spoons, and the process was troublesome and expensive; or it was rolled out into very thin plates, mostly on a copper backing, from which candlesticks, candelabra, and other goods were made by stamping and filling out with baser metals. The manufacture was a very pretty one, almost entirely confined to Sheffield. I have been told that the largest maker in Sheffield, who moreover realised £100,000 per annum when this trade in silver-plated spoons and silverware was at its best, used less than 120,000 oz. of silver, the manufacturing value being about five times as high as that of the silver used; and altogether, from careful inquiries made, I have been told that if the consumption of silver from this manufacture up to 1845 be estimated at 60,000,000 oz. in silver, or £15,000,000, it would fully cover that actually used during the whole period. The electro-plating process, applicable now not only to forks, dishes, and all kinds of ornaments, cups, and centrepieces, has probably hundredfolded the production of this class of goods formerly made of silver; and my researches in the best-informed quarters show that the amount of silver used now is about 100,000,000 ounces per annum, of which Birmingham, Sheffield, and London are the chief consumers. This would give, taking the development of silver-plating for this rate at twenty-five years, a consumption of £6,250,000, so far, in England. A great deal of worn plated goods are stripped of their silver. Photography may be said to have become flourishing during the same period. A sheet of photographic paper absorbs after washing (the surplus of nitrate of silver being saved by all working establishments) about 1½ grains of metallic silver, say one-tenth of a grain per *carte de visite* copy. An ounce of metallic silver will therefore give 4,800 of such portraits, 10,000 ounces 48 millions; so that if 4 millions of persons are photographed in England every year each might have a dozen. The silver used in negatives is all recoverable. Making allowance for all that is used for larger photography, waste by amateurs, including, also, the use of nitrate of silver for medicinal purposes, hair-dyes, &c., an allowance of £30,000 per annum, or £600,000 of silver used in England during the last twenty-five years, seems more than ample. A certain quantity of silver is also lost by accident, or hoarded and forgotten. From all these facts it would now appear that England, since 1500, has used about £82 millions of silver for other purposes than coin, and that with the periodic remelting of old plate, the losses by wear, manufacturing, electro-plating, and from other causes, may have been about £27,000,000, without making any allowance for what is recoverable from silver-plated goods; the present stock of solid silver-plate is £55 millions. This is a large average per head of population, but is no more than would be expected for so rich a country. The bulk of this stock is held by the richest of our noblemen. In France, the use of silver-plate is more distributed then in England, the comparitively less wealthy, down to the peasantry, possess old family plate, heirlooms, in spoons and forks, in comparatively greater quantity than the English classes of the same level, and the total is said to exceed that held here. Germany has been too often invaded by war, and what there is in silver-plate is not only not heavy, but perhaps only one third of what there is in England. But a great deal of a kind of silver-plate, similar to that formerly made in Sheffield, is manufac-

tured there. In Belgium, Holland, Russia, Sweden, Denmark, and other States, the use of silver-plate is very considerable. The stock of silver-plate throughout Europe is probably less than one half per head of population than that of England and France, and including the latter, will be about £220 millions; so that of the total European plate of £275 millions; between £110 to £120 millions belong to England and France alone. The manufacture of silver-plated ware, therefore, and the electro process of the rest of Europe has been much less in comparison than that of England, but instead of this much greater quantities of small silver ornaments were used, especially in former times. On the whole also, during the wars, much of this must have been lost or put away, and forgotten; in photography about the same quantities may be used. The estimates made seem confirmed by comparison with England, when given at about £150 to £160 millions irrecoverably lost during the last 350 years on the continent of Europe. Of the total of the £850 millions of silver which, since the year 1500, have been retained in Europe, £175 millions have been lost by manufacturing and other causes, and about £15 millions by abrasion of coinage and remelting, leaving a stock of silver of £630 millions, consisting of £275 millions of plate, and £355 millions in silver coins and bars in Europe. The estimate of this quantity does not quite agree with official researches made in 1867, when the stock of silver in Europe was stated at £760 millions, since when also additions have been made, but the figures given will enable you to pass a judgment on Mr. Hendrik's statement; "that only 75 millions of silver require demonetisation in Europe." If Europe goes over to the gold valuation, the utmost amount of silver change that can be issued will be £100 millions, which, on the present stock of gold, would be double the proportion of what we use in England. But let it be supposed that even with the reduction of this stock which is in prospect, there should be used £120 millions, or double as much in proportion as the maximum assumed possible in Germany, there would still remain £235 millions of legal tender money. As I have stated this amount at only £205 millions, I must ask you to decide whether in so doing I have not been reasonable and moderate, and whether Mr. Hendriks, in charging me with having inflated this sum, does not err himself far more grievously in the other direction. And, as in this important matter the utmost unity should prevail, I now refer to the European coinages in further support of my statements, before going over to India and the East. In the table on page 316 (of No. 1,216 of the *Journal*) I give the stock of full valued silver in France at £70 millions. France has coined in silver during the last eighty years £207 millions (Mr. Hendriks having omitted to state to you the coinage during the last five years). Of this, taking the demonetisation of the silver change before 1867 as high as £12 millions—and that substituted at £11 millions—there would remain £192 millions of 5-franc pieces to be accounted for. With the exception of small amounts absorbed by South America, the coinage up to 1850 remained in Europe, partly in Belgium, Italy, Switzerland, and Germany, but the bulk in France itself. Now you have been told that in consequence of the Indian demands France has changed her silver for gold, the total coinage of gold since 1850 being no less than £270 millions. The simple truth of the matter is that the total of the exports of French silver to the East amounts to £32 millions only. Our bullion brokers, too, who know everything that is done, and for whose account, will confirm this. They will also tell you that the exportation of bar silver or 5-franc pieces from France to the East cannot commence until the price of silver in London stands at 61¾ to 61⅞ pure, and the French Stock Exchange at 25·20. How often this has been the case, the quotations show; about 45 of the 164 monthly quotations, between the years 1853 and 1866 inclusive, only exceed 61¾ pence. France has accumulated this stock of gold chiefly because during the period from 1850 it has made immense strides in international wealth, for besides the large profits made on her foreign trade, it may be mentioned that she derived an income from the visits to the city of Paris and the provinces by foreigners, which, taken at 250,000 millions of persons, and but £1 expenditure per day of each as averages, brought £90 millions of money per annum into the country. The French people retain a larger amount of metallic currency, because they are less dependent on concentrated capital, and prefer individual action and possession of means of contract; they have but one Bank of Issue, and what all this means as regards financial strength and rapid recovery, the history of France of the last five years has demonstrated. Allowing then that of the stock of £191 millions something like £32 milliions has gone to the East, that with export to other parts beyond Europe including the French colonies, with loss of abrasion and otherwise lost, there were abstracted £60 millions—there would remain £131 millions in five-franc pieces in Europe, distributed in France, Italy, Switzerland, previous to 1872, in Germany and other parts of Europe. Now, after the war, France paid Germany about £9 millions in silver. The finance minister then estimated that besides gold there remained in the country 1½ milliards—or £60 millions of such silver. Since then the 9 millions of silver have been returned to France. In Germany a further sum of £10 millions hitherto current has also been driven back, and £12 millions have been coined afresh since. But to the £91 millions must now be added, or accounted for as part of it, the stock of silver in the note issue of the Bank of France. Of the total of £76 millions of bullion held against the £97 millions of notes issued, it has lately been stated that £26 millions are in silver. How much of this is in bars, I cannot state, but it may be remarked, as our bullion brokers will confirm, that the price of silver in London would have fallen much lower than it has done, but for certain purchases still made by France. The Bank of France may have bought silver bars at the lower prices for reasons of policy, and founded on opinions as to tho ultimate result of the general controversy, which on the one division may give less, but on the other be a much greater benefit to the whole case. That French economists of Victor Bonnet type should endeavour to make out that there are but £30 to £36 milions of five-franc pieces to demonetise, that they should omit to refer to the stock of silver in the Bank of France, is only in accord with their *penchant*, but from the figures submitted to you, you may think that out of the total I assign £70 millions of silver as subject to demonetisation in France, I state only what can be below the minimum. In Germany £98 millions have been coined in silver since 1764. But, as is well known, Germany used large quantities of five-franc pieces, Dutch and Austrian florins. The German Government asserts that a considerable portion of its silver coinage has been used up by silversmiths. Nobody will pretend to say that during the wars of last century and the Napoleonic invasion up to 1815, a country like Germany absorbed much silver for plate; on the contrary, in these times of distress, silver was melted down and paid away to France, and elsewhere. Now if for argument sake we, nevertheless, assume that in Germany, during the last 75 years, there were consumed one half of that of England, viz., £500,000 or £100,000 per annum, that would be but £7,500,000; and the large German silversmiths, as those of other countries, use bar silver instead of coin. Yet the gold fanatics in Germany assert that a much larger proportion of the coinage itself has disappeared in silversmiths' work; it is a mere wild at random statement. The coin taken away by Napoleon I, has long since returned. It is also said that much of the thalers have been melted at Hamburg. This is true, but the German Government much over estimates the sum; the amount is under £10 millions. Much of the export of silver from

Hamburg is accounted for by the fact that Germany itself is a large silver producer, the production being now about £500,000 per annum. In my statement, I estimate the amount of legal tender silver in Germany in 1870 at £60 millions, and say further on that at this time £30 millions are left. Mr. Hendriks would have you believe that there are but £15 millions, and says Germany will yet require £8½ millions for subsidiary coinage, leaving but £6½ millions to sell. Now the German Government, driven to justify itself by making out as little as it can of the amount of the silver remaining, has already provided for subsidiary coin, and Mr. Hendriks assertion can only be explained by his penchant for reducing figures. Dr. Sœtberr disputes the returns made by his Government, and says that £23 millions of silver must yet be sold. Now, if having regard to the comparatively small amount of silver which Germany has actually sold of its own coin since 1871, I assume in 1875 there are 30 millions left I should only differ by £8 millions, but Dr. Sœtberr is the principal gold fanatic of Germany, and accepts the at random statements of the Government as to the amount melted for silver-plate. From personal observation and correspondence I can assert, that although French, Dutch, and Austrian silver has almost disappeared in Germany, and although the new gold prices now appear in appreciable measure, yet their seems no diminution in the quantity of thalers current in commerce, as compared to previous times. This can be confirmed by inquiry. Of the stores of silver bullion present in the banks of Berlin, Hamburg, Frankfort, or in 1870, I need say nothing, you may be able to come to the conclusion that the sums set down by me are but the minimum figures. As regards the rest of Europe, I have stated in the table that £45 millions would be demonetised in Belgium, Holland, Portugal, Denmark, Sweden, &c., and £30 millions among the rest and internationally prohibited States. The following exhibit of the coinages made in recent times may enable you to judge of the moderation of this statement:—

Countries.	Years.	Coinage of Silver.
Belgium....	1832 to 1873 ..	£18 millions
Holland....	1840 to 1872 ..	37½ ,,
Italy	1862 to 1873 ..	8 ,,
Austria	1857 to 1867 ..	20½ ,,
Russia .... Sweden and Norway .. Portugal .. Spain ...... Greece, &c.	Statistics not obtained .	

Now, although some of the Belgian pices have been sent to the East, as well as a portion of the Dutch coins to the Dutch colonies, there was left in Italy previous to 1862 a large quantity of the coinage of the previous political divisions. But the greater part of the legal tender silver in Italy consists of French 5-francs, and. this, as shown before, accounts partly for the absorption of these pieces from France. And throughout the note-issuing States large quantities of five francs and a mass of older coinage are partly current and partly hoarded. I must, then, leave it to you to decide whether my estimate of £200 millions of silver subject to demonetisation in Europe is not a moderate one, and whether Mr. Hendriks is justified in accusing me of having inflated it by £125 millions. Altogether, let me here remind you of a general feature in the matter. It is not so long ago but that a few persons may yet live remembering that the term sterling silver money was one practically honoured in England, where alone the gold valuation came into force in 1816. And until 1850 the great mass of Continental and other currencies consisted of silver. The legerdemain with which the advocates of the gold valuation made light of this fact, I trust I have exposed to you in what I have said. I now come to the question of silver in India and the East. I have stated the amount of silver liable to demonetisation at £250 millions. Now here I must first complain of Mr. Hendriks' method of charging me with inflation. Mr. Hendriks says that I have overstated the case by £200 millions, because, according to his own view, but £50 millions worth of rupees required demonetisation in India. My statement, as you see, refers to India, China, and the East, and among the latter I include Persia and other States, as usually understood. Moreover, my figures do not refer only to coined rupees but to coins of all sorts, and to bullion (excepting bangles and bars of silver hoarded by the natives) serving for monetary purposes. First, then, as far as Asia at large is concerned, it has already been stated that the bulk of the precious metals from the Roman times, to 1500, seems to have gone to the East, and principally India. Whether that which was there at the time was 100 millions, more or less, it would be a most moderate one for the immense populations. But it is also certain that China has always produced silver, and that this was distributed over Asia, for in the years between 1840 and 1870 large parcels of Sycee silver were obtained in the Indian bazaars for export to Europe. Further all evidence agrees on the point that between the years 1500 to 1800 a sum of between £100 and £500 millions went to the East. Humboldt says that out of the total of the £870 millions of the produce of American mines alone, more than one-half went that way. From 1800 to 1835 we have no reliable statistics, but there is every reason to believe that a higher rate of treasure-shipment prevailed than before and immediately after; and together, with what came from North America, Mexico, and South America, to the islands and India, the amount is likely to have been between £120 to £130 millions. In the early part of the period, from 1835 to 1851, the import seems to have fallen off, especially in India, yet the balance on the whole for the sixteen years, for India alone, was about 50 millions, as shipped from Europe; and this is more than confirmed by the coinage of the period. With that which went to China during the same time, the total seems to amount to about £90 millions. From 1851 to 1875, there was shipped to the East:—

From Great Britain, per Peninsular steamers	£143,221,000
From Mediterranean ports	59,192,000
Total	202,413,300

—But, besides this, silver has gone from Mexico and California during the last ten years (bars and trade dollars from San Francisco). It appears then, that the East has absorbed at from £1,000 to £1,100 millions sterling during the last 375 years; that during the present century, between £450 to £500 millions; in the last 25 years alone, about £210 millions have been sent there. Now, if according to what has been shown before, the mere abrasion of coinage would be overstated at £60 millions, and if allowance is made for losses by arrivants and otherwise, and the total stock remaining may be £900 millions. It may be stated that the greater part of this total has gone to India. India does not only do business with the islands and China, but the balance of trade from the latter country alone has been often in its favour, to a very large amount. Allowing that between £40 and £50 millions of silver may be current in Japan, the Dutch, French, and other possessions in the East, and that China, irrespective of her own Sycee mines, holds about £200 millions in dollars, bars, and bullion, it may fairly be assumed that the major part of this is used for monetary purposes. The passion for bangles does not exist among the populations there in the same degree as in India, and of the total it may be stated that from £150 to £160 millions are in service as money. There are several authorities who assert that in India there are in bangles and hoarded in silver bars, between £300 and £400 millions of silver. It is also stated that the silver

coinage is melted down for the purpose of increasing this store. Permit me to show you to what extent only this can bo done. The imports into India of silver, exceed the coinage of rupecs by a very large per centage. The bars or dollars so imported are free of charge; tbe coinage of the rupee costs 2 per eent. Now, apart from the use of the mint remedy, which takes off value from the rupee, is it at all likely that the bazaar peoplo would incur this loss, as long as silver bars are available, and would pay 2 per cent. for the coinage, and then remelt it? It is true tbat a portion of total coinage of about £300 millions during this century has been melted or hoarded, when bars were not to be had. To these causes must also be attributed the fact, that when the old silver rupee was called in, much less eame forward than was oxported. In 1835 the balance of trade was against India, and silver was exported. The Sicca rupees were melted down both for home use and export. Further, the Sicca rupees, especially those of before 1818, were of much finer silver, and contained traces of gold, and without waiting to reflect upon the mint authorities in 1835, it ean yet be stated, as assays proved, that they made a larger use of the Mint remedies than had been thougbt proper before. The Indian bazaar people knew this well, and preferred the melting of the Sicca rupee to its surrender against new pieces. But since 1851 the greater part of the silver shipments to India consisted of so-called refined or fine bars (bullion brokers know what I mean), and these are most coveted by the markets. It can be said that the £125 millions of rupees coined since 1851 have been preserved, and even if of the coinages mado before that time, thc greater portion had disappcared, it is not too mucb, if we take the amount of current rupees at this time at £150 millions. In the report of 1872-73 on India's progress, it is stated that the amount current amounts to £158 millions. Wilson, it is true, stated that but £100 millions were current in 1870, believing in the excessive abrasion. And there are other reasons why this amount of £150 millions must be nearer the mark. Including tbe limited amount of gold and bank notes, the proportion of currency per hoad of the 250 millions of people under British sway, would be 16s., whcreas in France the rate is about £8. Now inasmuch as commodities are on about the same level of price, if we compare tbe rates of soldiers' pay or labour generally, there would here be a correspondence, which, if anything, should show a larger currency in India. Besides the amount of actual money now current, I refer again to what I have said before as regards Mr. Hendriks' treatment of the matter. He speaks only of rupees; I speak both of bullion and iron. Hc states that a large portion of the coinage is melted into bars, and dug into the ground; a still larger portion so hcld is in fine original bars, and this is, so to speak, a guaranteed capital for the native traders and wealthier classes, out of, or partly besides the £300 to £400 millions of bangles. This may amount to between £120 to £140 millions. If then, out of the total of £900 or £950 millions sterling left in the East in solid metal, I assign for the States not under British rule, £160 millions, and for India in currency, £150 millions, for bar silver held as money £130 millions, or £440 millions in actual money, am I justified in stating that the enforced introduction of the gold valuation, and after making due allowance for what can possibly be maintained in debased silver cbange, there must be at least £250 millions of silver in jeopardy in the East. I eontend, however, that even this does not complete the case. We have yet to deal witb the other half of tbe £900 millions, supposed to be in bangles, ehiefly in India. I have already stated that of the bars buried in India £140 to £150 millions may be partly included, or partly outside the £300 or £400 millions of bangles in India. Nevertheless, that which remains under the expression of bangles is only partially in personal ornaments and utensils. It is admitted that it also greatly held in lumps and various forms dug away for safekeeping by way of savings. With all the confidence which we may have in our own rule in India, this feature of hoarding money is one of tbe most telling signs of the suspicions of the natives, and we should not make light of it. If the natives under our eharge become confident, if their civilisation advances as we may hope these millions of hoarded treasures would come forward to be invested in savings banks and otherwise. But if tbe people then found that the Government had demonetised silver and ruined their savings, what would be the result? For the same reason we ought also to respect the bangles, in which the poor of India invest partly for ornament, but mostly for personal safekeeping. Unless the funny doctrine spoken of before, namely, "that if the value of the silver falls, all that pcople have to do to make up the loss is to buy more silver," becomes one by wbich the Indian Government is to be guided, thc gravity of the whole matter must surely appeal to the plainest understanding without the necessity for making the experiment itself. I must, however, take further notice of one of the economical ideas stated by Mr. Hendriks. He not only says that only £50 millions of rupees require demonetisation, but that there is now sufficient gold in India for the exchange. With the exception of some eight or ten millions of sovereigns and bars supposed to be in India, thc balance of from forty-five to fifty-five millions of gold is all in the sbape of ornaments and bangles, the rich wearing gold, the less wealthy silver. Does Mr. Hendriks wish to assert that these bangles would be surrendered by the Indian people to be made up into coin? As stated before, patriotism, in the event of the life of a nation being in question by war, has occasionally given up gold ornaments to tho king—by way of present—but the sums have been small. What will the Indian Government give in exchange to tbe holders of gold? Silver? at a depreciated price at the expense of the taxpayer? or debentures—in other words, drafts by the Government on the people themselves? Finally, Mr. Hendriks told you tbat this subject of the controversy as to the supremacy of the gold valuation is a threadbare one, and that long ago it has been derided. It has been so derided only by the brotherhood to which Mr. Hendriks belongs in England, and its scbool of disciples formed abroad by Anglo mania. In my treatise I have already sbown you why this course has been taken abroad, and what are the views of those who do not belong to that school. Mr. Hendriks names De Parien, Victor Bonnet, and others as men of his opinions. I can name the governors of the Banks of France, of Germany, of Holland, Baron Alphonse de Rothschild, of Paris (one of the most cultivated and higb-minded intellects), Mr. Wolowski, Mons. Cernuschi, and a host of others as holding my views. But, bear in mind this: the whole question before us is that of the single gold *versus* the gold and silver valuation—all turns upon that; and I trust that, both as men of judgment and philosophers, you will not say that Mr. Hendriks' allegation as to the subject having been worn threadbare must deter you from looking for tbreads. The whole of this matter is one in which both the head and heart of thinking men must become engaged, in which higher views as to providential arrangements, together with the strict truth as to facts, must be considered before a mere narrow-minded dogma, apart from the proof of its theoretical and practical nonentity already given. Whether the existence or use of gold and silver, and their evident powerful factorship in human society be ascribed to a direct divine plan, or to some other metaphysical origin, it ean at least be said that nature furnishes gold and silver as materials for money. And as far back as human history can be traced, and in spite of all quarrels of poets with gold and silver, in spite of all attempts to supplant them by something else—they have hitberto calmly maintained their

superiority. Again, through the history of development of human society, nature has, so to speak, issued these materials to mankind, partly in a moderate regular way, partly by more or less periodic copious supply. Because that is so, because nature is not strictly mathematical in all it does, the advocates of the single gold valuation say we must only use the one material, unable to see that nature itself is not a system of pure mathematics, but that of a combination between the utmost variations and mathematics—that this combination is its very life and *raison d'être*. And so it can be proven, not only upon general grounds, but also upon distinct detailed points as, to special chemical, mechanical, and other qualifications which together constitute the utmost reachable perfection of fitness for the purpose, that gold and silver are products of nature, which, either by providence or by the undeniable practice, have been designed and used for the purpose of serving as money and guarantee for value. It may be conceded that as gold and silver are of different "nobility" as metals, their difference in value rests, in the first place, upon a natural law, which other beings higher than men, would recognise as a definite one. But, besides this, the practice itself, as it has been from time immemorial, is the second natural law, which affirms the first law. If, under this combination or affirmation, doubts as the firmness of the proportionate value within limited variations are still possible, the third affirmation, that of the legislative law, entirely removes them. Such a legislative law may also be called a product of the nature of human society. What its force must be I have already hinted at; if so slight a disagreement in the equilibrium as that caused by the German law has so great an effect in lowering the value of silver, it is evident that the legislative law, or universal agreement to uphold such equilibrium, must be most powerful for removing even the slightest protence to variations. I venture to say all this not because I want to plead that in accordance with what goes on now we must come to what is called a mere practically convenient conclusion, and override the honest views expressed in favour of the gold standard, but because these reflections may seem really superior to the honourable but otherwise more algebraical or actuarial views, which threaten to annihilate the benefit of the present and future issues by nature of silver, and that the case, and with it the welfare of mankind, must be rescued from the hands which now seem to sway its fate. That this is a difficult task in England I admit, for we live in the midst of the prejudices and habits which our own gold valuation has engendered. And even if the facts and arguments contained in this treatise could become matters of popular consideration, if the common sense of the people (or *vox populi*) of this country were in favour of the use of both gold and and silver, on the true natural and only just basis, there would be plenty of so-called "authorities," educated in a special line of practice, and hard-hearted enough (to use the milder term) to battle against it with all the sophistry that has hitherto been current. Fortunately, whilst this sophistry has hitherto been successful, because, in spite of the prognostications made by others (including myself), there were no strongly visible signs of the coming mischief, we in England now find ourselves suddenly face to face with the rapid decline of silver, with the problem of the Indian valuation, and there is a better chance now of inducing people to look into the prospects of the future. What this prospect involves on all sides, in lessening the means of conveyance of contract, in suppressing industry, in lowering prices, in ruin to both debtors and creditors in fixed contracts, in diminished taxing power, and in stoppage of civilisation, must be weighed either by the full measure as has been here indicated in the figures laid before you, or by such per centage as we may deem proper to select. It may then appear that the actuarial doctrine of the gold valuation, even were it not false in theory and practice, is not worth the slightest tittle of sacrifice t be made on its behalf. And the recognition of this truth may altogether lead to a sounder and more comprehensive policy, and action in reference to monetary matters. During the last twenty years a bitter strife of economists has raged, not only on this point, but on monetary matters generally. People have been at cross purposes with each other, and from the money article read at breakfast-time to the discussion at night in a scientific society, the minds of many persons have been unsettled between the one view and the other. Amidst this turmoil we only know, here in England, that our commerce continued to flourish in spite of the conflict, so long as nothing was actually done to upset the balance. But since that balance has been overthrown by Germany, the case comes home to us, because we see an actual falling off, instead of an encrease in out commerce, and the nicety or delicacy of the matter claims our attention, because we observe the great effect which an apparently slight cause has upon it in the very rapid fall of silver. Hence it is possible that the elucidation of the whole subject at this moment may result in a general peace on monetary matters. If this peace is not established by the full restoration of the valuation as has here been suggested, if the gold valuation is enforced, one of the most outrageous crimes upon humanity will be committed. Not only will the benefit derived from the golden gifts of nature, through California and Australia, the forty per cent. increase, with its produce of four hundred per cent. of enhanced commerce be lost and counteracted, but the deduction will be far beyond the mere "negative" indicated thereby. The future gifts of nature in silver will cease to benefit mankind, and become a curse instead of a blessing. The progress of commerce and civilisation has before it an almost boundless field, where it may step, accompanied by solid equivalents, faster at one time than at another, and it will so step in spite of preachers on financial morality. But when by a wanton social crime of this kind, one of two factors is actually deducted from the advancement made, and prevented from assisting it in the future, it involves a defiance of the order or nature of things, which is equal only to the wanton destruction of one or two lives and all its progeny. How far this is immediately applicable will appear from the reflection, that if the gold which has been added to the worlds store since 1848 has so much advanced commerce, the new supplies of silver would also have similar effect, but for the policy of its demonetisation recently adopted. Hence we already find that business is bad, that commerce in England and elsewhere has fallen off seriously, and if that is but the shadow of the coming event, if in only two months after the balance being upset by Germany, we find so rapid a decline, what must be the effect when the spread of the gold valuation receives further, or its final development? But were this matter met with truo intelligence, were this new gift of nature in the shape of silver freely received as additional agents of commerce and civilization, there is not the slightest doubt, that in lieu of the dark present and dangerous-looking future of commerce, we should have the same progress which distinguished the years from 1848 to 1872; that under a more orderly system the joint supplies of gold and silver would become all the more available for, and develop more rapidly the well-being, wealth, and civilisation of mankind. This, at all events, is a consideration in which the interest of every individual member of the present generation is immediately concerned, independently of the blessing or the curse which future generations may heap upon those who have now to decide this case for good or evil.

The Chairman moved a cordial vote of thanks to Mr. Seyd for his paper. He had brought forwarded most valuable facts and statistics, and whether or not they had agreed with all his deductions, all must feel that he had done good service in collecting so much valuable material on a question of such great importance.

The vote of thanks was passed unanimously, and the proceedings terminated.

The following are the extracts referred to in Mr. Maitland's remarks above:—

From the "Daily News" of February 29th, 1876.

We receive the following interesting communication from our correspondent "H. M. H.," with reference to the production of gold and silver since 1852. We do not think his statistics quite bear out his assertions, and on several points, it will be observed, our criticism of the figures he formerly sent us is fully justified by the more careful statistics he has now put together; but the communication is itself so valuable that we have great pleasure in inserting it without comment in this place, reserving for a future occasion, if necessary, any criticism of the details:—

Sir,—Thanking you for the insertion of my last letter in your paper of the 21st inst., I regret that other engagements have till now prevented my sending you the statistics of the supplies of gold and silver with which you express a wish to be furnished. The production of gold in 1868, as stated in my letter of the 16th inst., was taken from McCulloch's Dictionary, article "Precious Metals," and appears to have been over-estimated, but the correction which I have found it necessary to make rather strengthens my argument. A glance at the totals of gold and silver clearly shows that "while the production of silver is increasing, that of gold is is falling off in a greater proportion." That it may not be supposed that I overlooked China and Japan, I may here state that though large sums in Japanese gold coin have been received here in the last two or three years, the gold from which they were coined was chiefly Californian, and is therefore already taken into account in the yield of the United States. The only native gold received from Japan and China has consisted of some comparatively insignificant amounts of the old coinage of Japan (niboos). I am not concerned to discuss the policy of Germany in adopting a gold standard, but I submit that the figures of the enclosed table prove that the demonetisation of silver was "ill-timed," for not only was the production of gold falling off, and that of silver increasing, but there had been for some years a diminished demand for the latter. I maintain that had Germany simply decided to replace her silver with gold, as opportunity offered, she might within a very few years have accomplished her object without incurring the serious loss caused by the plan she adopted, and without disturbing the Eastern exchanges. This is what France did during the Empire, and the operation was, as is well known, very successful.—Yours obediently,

London, Feb. 24. H. M. H.

PRODUCTION OF GOLD AND SILVER THROUGHOUT THE WORLD IN THE YEARS 1852—1875, INCLUSIVE.

I.—Production of Gold.

[Note.—The amounts are given in millions and tenths of millions sterling.]

	Australia.	United States.	Mexico and South America	Russia.	Other Countries.	Total.
1852	20·6	12·	1·	2·4	·5	36·5
1853	14·1	13·	1·	2·4	·5	31
1854	9·5	12·	1·	2·4	·5	25·4
1855	12·1	11·	1·	2·4	·5	27
1856	14·3	11·	1·	2·7	·5	29·5
1857	11·4	11·	1·	2·7	·5	26·6
1858	10·7	10·	1·	2·7	·5	24 9
1859	10·8	10·	·9	2·7	·5	24·9
1860	10·5	9·2	·9	2 7	·5	23·8
1861	9·8	8·6	·9	3·	·5	22·8
1862	9·3	7·8	·9	3·	·5	21·5
1863	8·9	8·	·9	3·1	·5	21·4
1864	9·1	9·2	·8	3·	·5	22·6
1865	8·8	10·6	·8	3 3	·5	24
1866	8·8	10·7	·8	3 4	·5	24·2
1867	8·3	10·3	·7	3·4	·5	23·2
1868	9·7	9·6	·6	3·6	·5	24
1869	9·3	9·9	·5	4·	·5	24·2
1870	7·7	10·	·5	4·5	·5	23 2
1871	8·6	8·7	·7	4·8	·5	23·3
1872	7·3	7·2	·7	4 6	·5	20·3
1873	7·8	7·2	·7	4·5	·5	20·7
1874	5·9	6·4	·8	4·5	·5	18 1
1875	5·7	8·	·8	4·5	·5	19·5

Five Years Average of Total.

1852-66	299
1857-61	246
1862-66	227
1867-71	236
1871-75	204

II.—Production of Silver.

[Note.—The amounts are given in millions and tenths of millions sterling.]

	United States.	Mexico and South America	Russia.	Other Conntries.	Total.
1852	—	6·	·1	·2	8·1
1853	—	6·	·1	·2	8·1
1854	—	6·	·1	·2	8·1
1855	—	6·	·1	·2	8·1
1856	—	6·	·1	·2	8·1
1857	—	6·	·1	·2	8·1
1858	—	6·	·1	·2	8·1
1859	—	6·	·1	·2	8·1
1860	—	6·	·1	·2	8·1
1861	·4	6·	·1	·2	8·5
1862	·9	6·	·1	·2	9·
1863	1·7	6·	·1	·2	9·8
1864	2 2	6·	·1	·2	10·3
1865	2·3	6·	·1	·2	10·4
1866	2·	6·	·1	·2	10·1
1867	2·7	5·	·1	·2	10·8
1868	2·4	5·	·1	·2	10·
1869	2·4	5·	·1	·2	9·5
1870	3·2	5·5	·1	·2	10·3
1871	4·6	5·2	·1	·2	12·2
1872	5·7	5·2	·1	·2	13·
1873	7·1	4·8	·1	·2	14·
1874	7·2	5·	·1	·2	14·3
1875	9.	5·	·1	·2	16·1

Five Years Average of Total.

1852-56	8·1
1857-61	8·2
1862-66	9·9
1867-71	10·6
1871-75	13·9

III.—Total Production of Gold and Silver Together.

[Note.—The amounts are given in millions and tenths of millions sterling.]

1852	44·6	1864	32·9
1853	39·1	1865	34·4
1854	35·5	1866	34·3
1855	35 1	1867	34·
1856	37·6	1868	34·
1857	34·7	1869	33·7
1858	33·	1870	33·5
1859	33·	1871	35·5
1860	31·9	1872	33·3
1861	31·3	1873	34·7
1862	30·5	1874	32·4
1863	31·2	1875	35·6

Note.—The authorities for the above figures are (1) for Australia—the Register of Statistics of Victoria and New South Wales, published by the Colonial Governments; (2) for United States, Mexico, and South America, and Russia—Reports of the Directors of the United States Mint, 1874, 1875; and (3), for "other countries"—the same as No. 2, production of 1871 taken as an average, no details being obtainable. For 1875, the figures for the United States are taken from a summary published in San Francisco, and for Australia and Mexico, &c., from the imports of the year.

Colonel Berton's Mission to the United States—The Monetary Question—The Metallic Wealth of California and Nevada.

The serious pre-occupation that exists in Europe with regard to the rapid depreciation of silver, and, on the other hand, the unprecedented and ever-increasing production of the great silver mines of Nevada, gives an unexceptional importance to the mission which has been entrusted to Col. Berton, President of the Pacific Coast Mining Bureau, by M. Léon Say, Minister of Finance, and Mr. L. Ruan, Director-General of the French Mint. It is to be noted that both the English and French leading press have commended M. Léon Say for the enlightened appreciation he has shown of a public want in setting the inquiry on foot at present, and also on his judgment of the Commissioner. It has been rightly acknowledged that Colonel Berton's qualification for reporting on the monetary question in the United States, and on the metallic wealth of California and Nevada, and the prospects of production are unique, while his association with the English and French leading newspapers may be taken as a guarantee that no empirical views on finance will bias his statements.

We learn that Col. Berton is by this time on his way to the Pacific Coast, and will arrive in a few days in Washington, where he is to collect all materials for his reports upon the monetary question in the United States. The high credentials of which he is the bearer will give him access to to the high officials of the American Government, who will heartily co-operate with him in the accomplishment of his important duties.

The points, as summarised in the official instructions are—

1. The Monetary Question in the United States, and the means

proposed to prepare for a resumption of specie payment at the period fixed by Act of Congress.

2. Statistics of the National Banks, and average issue of greenbacks and other paper moneys.

3. Administration of the United States Mint, and statistics of the coinage, and circulation of gold and silver.

4. The production of gold, silver, and quicksilver in the Pacific States, particularly in California and Nevada, and the present condition of the leading silver mines worked on the Great Comstock lode

5. The Extent of the Californian Auriferous Land and Gravels.

6. Production, Domestic Consumption, and Export of the Precious Metals so far as the Union is concerned.

Col. Berton's official reports will form a valuable history of all facts connected with the causes of prosperity in the United States, together with the extraordinary mining resources of the Pacific Coast. Considered as such they will be of great service to European capitalists, and being widely circulated after their publication—in the *Journal Officiel* and the *Journal des Debats*, for France; and the *Mining Journal*, for England—they will enlighten the scientific as well as the financial world upon the great questions which now so justly pre-occupy the English and French Governments.

From the "Hour" of 29th February, 1876.

Dr. Linderman, the Director of the Mint, therefore proposes that the present "fractional" paper money should be redeemed by silver pieces as a step towards a return to specie payments. This "fractional" paper currency was issued to the extent of 46,000,000 dollars, and it is supposed that 16,000,000 dols. thereof has been worn out, leaving but 30,000,000 dols. in circulation. Dr. Linderman thinks that double that amount—60,000,000 dols.—if silver token currency can be absorbed, as, unlike "fractional" notes, much of it would be hoarded, and certainly more of it would be carried; it would, too, in great degree, take the place of the "dollar greenbacks," leaving the five-dollar notes and larger denominations in circulation. The Mint has ready for issue 12,000,000 dols. in 10-cent, 20-cent, 25-cent, and 50-cent silver pieces. So, if Dr. Linderman's calculation be correct, 48,000,000 dols. additional silver will be required in the United States for its token currency. This demand, in itself, would check the downward tendency in the price of the article.

From the "Times," 16th February, 1876.

The writer of the following letter predicts a further fall in the price of silver, and a renewed decline, in consequence, in the Indian exchanges:—

Sir,—At the present time, when the very low range of Eastern exchanges is attracting attention, not only by its important bearing upon our vast commerce in India and China, but also by the serious loss it entails upon the Indian Government and those who derive their income from the Indian Rupee Loans, it is interesting to consider the facts relating to the production and cost of silver, the price of this metal being, practically, the basis upon which rates of exchange in India and China mainly depend.

The production of silver on the Pacific coast, according to estimates published in the San Francisco *Journal of Commerce* of January 12, rose from 90,900 dollars in 1860 to 27,548,000 dollars in 1872, 44,600,000 dollars in 1873, 46,600,000 dollars in 1874, and 58,000,000 in 1875. It will thus be seen that the production has been more than doubled since 1872, and although the ratio of increase for the past three years has been but moderate, the increase in 1875 alone was 25 per cent., and is the more significant as being but the first fruits of fresh discoveries of ore of enormous extent and great richness. The journal above referred to alludes to these discoveries as making the year 1875 "one of the most notable known on the coast;" and adds, "The discovery of this vast deposit will not improbably be followed by others of greater or less extent; and, in fact, it seems that we are but at the beginning of the realisation of the vast mineral wealth hidden in the bowels of our mountains."

A glance at the reports of some of these mining companies tends to confirm the opinion that even far lower prices for silver than have yet been reached would yield a very handsome profit to the miners, and would not, therefore, tend materially to check the production.

Thus the Consolidated Virginia Mining Company is shown by the report for 1875 to have raised during the year 169,307 tons of ore, producing 16,739,600 dollars, and of this large sum more than 12,000,000 dollars appears to have been distributed in dividends to shareholders on a capital of 411,000 dollars. There are two or three other mines the accounts of which exhibit scarcely less startling results, although, of course, they are exceptions to the rule, and stand out in strong contrast with hundreds of less successful ventures. But it is quite evident that the fresh discoveries to which allusion has been made are expected in San Francisco to lead to further very astonishing results. In the face of such an actual and prospective increase of production, it would seem that the demand for the East, so far from increasing, has fallen off. The direct export of bullion (chiefly silver) from San Francisco to China in 1875 was 7,168,649 dollars, against 8,324,675 dollars in 1874, while the export of silver from Great Britain to the East was only about £4,000,000 in 1875, against £6,840,000 in 1874.

We have thus an indefinitely increasing production of silver from the mines, added to an enormous amount thrown upon the hands of the German Government by the operation of their new currency laws; and in face of such supplies, with no sign of any corresponding increase of demand, it seems unreasonable to expect the value of silver to be maintained, and equally so to suppose that the lowest point of Eastern exchanges has yet been reached.

I am, Sir, your obedient servant, L.

London, Feb. 15, 1876.

CHEMICAL SECTION.

A meeting of this Section was held on Friday, March 10th, David Howard in the chair.

The Chairman said, I have great pleasure in calling upon Mr. Warington to read his paper upon the "Chemistry of Citric and Tartaric Acids." It is a subject well worthy of study, being both interesting in itself, and a very good example of the application of scientific knowledge to a branch of manufacture of far more importance than many would suppose, whose only knowledge of it is derived from a seidlitz powder. There is very great need for the practical application of science in manufactures, not in manufacturing chemistry only, but in all directions. To those who love science for its own sake, it may seem a shame to put Pegasus to plough, but unless we are content to do this, we shall certainly be left behind in the ever-increasing competition with our Continental rivals, who never miss an opportunity of bringing the newest discoveries of science to bear upon their work.

The paper read was—

ON THE MANUFACTURE OF CITRIC AND TARTARIC ACID.

By Robert Warington.

We have to-night to speak of two manufactures which are frequently pursued together; they are however on many points essentially distinct, and we shall have to treat the whole subject with considerable brevity in order to include the principal facts in the compass of a single paper. Some months ago I laid before the Chemical Society a series of laboratory notes on the chemistry of citric and tartaric acid. These notes were chiefly occupied with a description of analytical processes suitable for the examination of the various materials and products of the two manufactures. This paper will be found in the Journal of the Society for October, 1875. I propose on the present occasion to omit this part of the subject as far as possible, and to treat rather of the general chemistry of the manufacture.

Citric acid has been known to us as a distinct acid since 1784, when it was separated from lemon juice by Scheele. Citric acid occurs in many vegetable juices; it is obtained for the purpose of the arts from the fruit of three species of the genus *citrus*, namely, the lemon, bergamot, and lime. Lemon juice (from which about three-fourths of English citric acid is made) is exported as concentrated juice from Sicily. Concentrated bergamot juice is prepared on the Calabrian coast of South Italy, and is exported thence or from Messina. Concentrated lime juice is exported in small quantities from Montserrat and Dominica in the West Indies. The total quantity of lemon and bergamot juice shipped to England during 1875 was certainly not under 1,800 pipes, and perhaps reached 2,000; of this about 500 pipes were bergamot. Besides the juice used for the citric acid manufacture, a rather considerable quantity is exported to Liverpool and Glasgow for the use of the calico printers. The quantity of concentrated lime juice used in the citric acid manufacture in 1875 was about 100 pipes.

The concentrated lemon juice of Sicily is obtained from windfalls, and from more or less damaged fruits, which could not be shipped as lemons; from

such fruit essence and juice are prepared. The lemons, after peeling, are packed in flag baskets, having a very small mouth; these baskets are placed one on the other, so that the mouth of each is closed by the basket above it; the whole is then pressed in a screw press. On an average 13,000 lemons are required to yield one pipe (108 gallons) of raw juice. The concentration is effected in a copper vessel over an open fire; the juice is boiled down till it marks, when cold, 60 degs. on the citrometer. On the citrometer 1 deg. is equal to ·004 specific gravity, 60 degs. therefore equal 1·24 specific gravity. The hot concentrated juice is strained through canvas into pipes, and is then ready for exportation.

We turn next to the composition of juice. The mode of testing raw juice in Sicily is rough in the extreme. Solid carbonate of ammonium is placed in a tall glass, and a certain measure of juice is poured on it; the character of the juice is then judged by the height which the effervescence reaches in the glass. In England juice is also purchased on the basis of its acidity. The free acid in juice is expressed in ounces of citric acid per gallon; but it must be recollected that in commercial analyses this citric acid is reckoned as containing only half a molecule of water (atomic weight 201), while ordinary crystallised citric acid really contains a whole molecule (atomic weight 210). In the present paper the citric acid in juice will be expressed in terms of ordinary crystallised acid.

There are two well marked kinds of lemon juice; the first is of high acidity, and contains a very small proportion of combined organic acids; the second is of low acidity, and contains a much larger proportion of combined acid. The raw juice which is pressed in England from fine lemons belongs to the first class; it contains about 12 ozs. of free acid per gallon, and the combined organic acids are only about $2\frac{1}{2}$ per cent. of the total organic acids present. The juice pressed in Sicily from inferior fruit has a much lower acidity. The pressings in November will contain about 9 ozs. of free acid, and this will diminish to about 6 ozs. by the end of April; the combined organic acids are however as much as 7 to 9 per cent. of the total acids. The concentrated juice from Sicily is similar in character to the juice last mentioned, concentration increasing indeed to a small extent the proportion of combined acid. Now and then, however, concentrated juice, similar to that obtained from English pressed juice, is to be met with.*

Concentrated lemon juice is considered to be of standard quality when it contains 64 ozs. of nominal citric acid, that is 66·87 ozs. of crystallised acid per gallon. In bygone years the acidity was usually as high as 71 or 72 ozs. but is now often below 62 ozs. of the crystallised acid. The present average is about 63 ozs. Concentrated juice generally contains 7—8 ozs. of combined organic acid (calculated as citric) per gallon, amounting to about 10 per cent. of the total organic acids. When concentrated juice is kept, a deposit of citrate of calcium generally takes place, which is often considerable.

Concentrated bergamot juice has a higher gravity, but a lower acidity than lemon juice; it will average about 51 ozs. of crystallised acid per gallon. The acidity being low, the proportion of combined acid is high. The quantity of combined acid per gallon is about 7-8 ozs., and its proportion to the total acids 12-13 per cent. Bergamot is very commonly mixed with lemon juice, or sold under that name, manufacturers of citric acid having a prejudice against it.

With lime juice I am less acquainted; it appears to vary in the same manner as lemon juice. Raw Montserrat juice has an average acidity of about 12 ozs. per gallon, and contains combined acid equal to about 5 per cent of the total acids. Concentrated lime juice is very different from concentrated lemon or bergamot juice; it is a very thick viscid fluid. The average gravity of concentrated Montserrat juice is 1·32, and its acidity equals 93 ozs.; occasionally the acidity of lime juice will reach 112 ozs., and I am told that crystals of citric acid have been observed in it. Two samples of Montserrat juice gave me an average of 8·6 ozs. of combined acid per gallon, equal to 7·36 per cent. of the total acids. A very acid Dominica juice contained 4·6 ozs. per gallon, or 3·93 per cent.

We have hitherto spoken of the total organic acid in juice, whether free or combined; it is clearly, however, of great importance to ascertain to what extent this acid is citric acid. There is no difficulty in determining the quantity of the acids in juice which yield insoluble calcium salts, and as citric acid is, we believe, the only acid in juice which has this property, the method practically amounts to a direct determination of citric acid. Examining lemon juice in this manner we again find that it falls into two classes. In English pressed juice—the kind which shows a high acidity and low proportion of combined acid—apparently about 1 per cent. of the total organic acids forms a soluble calcium salt, and is therefore not citric. In a single analysis of Sicilian raw juice there was, on the other hand, 8·3 per cent. of the organic acids unprecipitable. With this agrees Sicilian concentrated juice, which gave as a mean of several analyses of 8·5 per cent. of unprecipitable acid. There is, however, great variation in the proportion, and I have met with concentrated juice containing as little as 5·4, and as much as 11·2 of unprecipitable acid per 100 of total acids. The juice of different seasons is well known by the manufacturer to differ frequently in quality. Two analyses of concentrated bergamot juice gave a mean of 11·9 per cent. of unprecipitable acid; three analyses of raw lime juice 8·8; and four analyses of concentrated lime juice 11·3 per cent. of acids having soluble calcium salts. It has naturally been supposed that the rough mode of concentrating the juice, employed in Sicily and the West Indies, must destroy a portion of the citric acid, and introduce simpler acids in its place; the figures here given do not, however, point to any large increase in the proportion of unprecipitable acid during concentration, and show that unprecipitable acids may occur in notable quantity in raw juice. Of the acids other than citric occurring in juice, a small proportion is made up of formic, acetic, and homologous acids, but by far the larger proportion consists of non-volatile acids. Malic acid is mentioned in most books as a constituent of lemon juice; no distinct

* Some English pressed juice, concentrated in the laboratory, gave a product marking, only 49 degs. on the citrometer, and containing 68·9 ozs. of free acid, and 2·26 ozs. of combined acid, equal to 3·2 per cent. of the total.

proof of its existence is however given. Mr. D. Howard has, however, told me that he once obtained a large quantity of malic acid from a parcel of bergamot juice. I believe that other acids besides malic are generally present.

Having ascertained in many instances the amount of precipitable acid in juice, it is important to inquire—How does this direct mode of determination agree with the usual valuation of juice based upon its acidity? In the case of lemon juice, it appears that the result arrived at by precipitation is 2—3 per cent. more or less than that calculated from the acidity. In two analyses of bergamot juice the two methods gave nearly agreeing results. With lime juice, on the other hand, whether raw or concentrated, the precipitable acid is always below that calculated from acidity, and indeed 3—7 per cent. less. I am told by a maker using concentrated lime juice, that this juice never yields so good a return of citric acid as lemon juice; an experience which quite agrees with the above statement. Of the two methods of valuing juice, that by precipitation as calcium salt is of course the more accurate.

The process of preparing citric acid from juice is exactly the same as that employed by Scheele in his original investigation; the improvements since his time have been chiefly mechanical. The concentrated juice, diluted with water, is first neutralised by whiting, the operation being aided by heat. The resulting citrate of calcium has a different mechanical character, whether the juice is added to the whiting, or the whiting to the juice; in the former case precipitation is immediate, and the precipitate is finely divided; in the second case precipitation is more gradual, and the citrate heavy and more crystalline.

Concentrated lemon juice is never perfectly neutralised by chalk, however long the boiling may be continued; litmus is thus of no use in determining the point of saturation; this is, however, readily ascertained by testing a portion of the mixture for acid by a further addition of whiting, and for excess of whiting by a few drops of acid, effervescence in either case being the indication sought. The amount of unneutralised acid on the large scale is 1—2½ per cent. of the acidity of the juice. It has been proposed to complete the neutralisation with slaked lime. This would no doubt precipitate a further quantity of citric acid; but it is found that perfect neutralisation occasions the precipitation of much colouring matter and impurity; the manufacturer prefers, therefore, to leave the liquor in its natural feeble acidity. Pure citric acid is readily and completely neutralised by chalk, malic and aconitic acid are not. Citric acid if mixed with phosphoric acid, and especially with phosphate of iron, is also not neutralised by boiling with chalk. As phosphoric acid and iron are certainly present, and probably also malic and aconitic acid, the explanation of the partial neutralisation of juice is not difficult.

A considerable improvement in the manufacture both of citric and tartaric acid is the introduction of vacuum filters; by their means precipitates can be washed with a far smaller quantity of water than formerly; this is specially important in the case of citrate of calcium, owing to its partial solubility in water. Crystalline citrate of calcium prepared in the laboratory, I find to have a mean solubility of 1 in 1,180 at 14 degs. C., and of 1 in 1,730 at 90-100 degs. C. The citrate being, as is well known, less soluble in hot than in cold water. A specimen of amorphous citrate, prepared by adding juice to whiting, had a higher solubility, namely 1 in 707 at 18 degs. C., and 1 in 1,123 at 100 degs. C. There is no doubt that a rather considerable loss occurs in washing citrate, and in warm weather there is also risk of decomposition if this operation is not quickly conducted.

The citrate of calcium after washing is mixed with water, and is then ready for decomposition with sulphuric acid, by which sulphate of calcium (gypsum), and free citric acid are produced. There is a very clever practical test for ascertaining when the sulphuric acid has been added in excess. The weak liquor being saturated with gypsum, chloride of barium would indicate sulphuric acid long before the sulphuric acid was actually in excess, and would therefore be of little use. The manufacturer employs as his test chloride of calcium; this in a liquor saturated with gypsum yields a precipitate only when free sulphuric acid is present: the precipitate takes a little time to form.

The gypsum resulting from the decomposition of the citrate is washed on a vacuum filter, and the citric acid liquors are evaporated, generally in leaden baths about 9 inches deep, heated by steam. Vacuum pans may be used both in concentrating citric and tartaric liquors, but are more convenient for weak liquors than for stronger solutions evaporated for crystallisation. During the evaporation much gypsum is deposited; this adheres to the bath, the clear liquor is run off, and concentration resumed. The first crystallisations are by granulation. The hot concentrated liquor is run into a tub provided with a revolving agitator; this is kept in motion for about 24 hours, and the acid is deposited as a granular salt. The mother liquor is then again concentrated, and a second granulation takes place. From the second mother liquor a third crystallisation can be obtained. The residual liquor is then generally too dark and impure to yield further crops of crystal, and is then known as "old liquor." Granulation may be looked on as a great practical improvement on the former method of crystallising by standing, the citric acid being separated from the solution in about 1-5th the time required for ordinary crystallisation. Granulation seems to have been introduced about 1856.

The white saleable crystals of citric acid are obtained by redissolving the granulated salt, heating it with animal charcoal, filtering, and then crystallising the concentrated bright liquor in leaden trays about three inches deep. The difference in the solubility of citric acid in hot and cold water is such that a hot saturate solution almost solidifies on cooling; it is necessary therefore to employ shallow vessels for crystallisation. The animal charcoal used is free from phosphate of calcium, which is removed by a previous treatment with hydrochloric acid, without this precaution the phosphate would pass into the citric acid.

Commercial citric acid always contains a trace of lead, most of the operations being performed in leaden vessels; if acid is required free from lead stoneware apparatus must be used.

The "old liquor," which will no longer yield crystals of citric acid, is diluted with water, and

precipitated by whiting with the aid of heat, precisely as in the case of the original juice. The citrate of calcium thus obtained is pure and clean; it is decomposed with sulphuric acid in the ordinary way, and the citric acid thus recovered is added to the general liquors. Old liquor is never perfectly neutralised by chalk. The acidity may possibly be partly due to aconitic acid, formed during the long heating of the citric acid liquors; it may also, as already mentioned, be occasioned by the presence of phosphate of iron or aluminium in the liquor; the latter reaction we shall refer to more fully presently.

The proportion of citric acid, which can be obtained from juice in the form of crystal, varies in different seasons, according to the quality of the juice employed. It has been ascertained at the experimental stations in Germany that the proportion of malic acid to tartaric acid varies in the grape in different years; that in good years the proportion of tartaric acid is high, and of malic acid low, while in bad years the reverse is the case. Probably similar variations may be observed in the juice of all fruit, though the fruits of tropical and subtropical countries will naturally be less liable to such variations. Most books, at the present day, continue to quote the statement of Samuel Parkes in his essay published 1815, that 20 gallons of (raw) lemon juice will yield 10 lbs. of citric acid. Supposing the juice to contain 12 ozs. to the gallon, this is a yield of only 66 per cent., one third of the acid being lost. In the trade it is usual to speak of 20 per cent. as being the loss in making citric acid. This however may be taken as the extreme loss, occurring only in years of inferior juice. If the citric acid in the juice is reckoned from its acidity, we may assume the loss in manufacture to vary from 12—20 per cent. as its extreme ranges, and depending chiefly upon the season.

The quantity of citric acid made in this country, in 1875, was about 300 tons. The manufacture has lately been in a depressed state, due to the high price of juice, owing, it is said, to disease in the lemon orchards; the make is nevertheless much higher than formerly, being estimated in Muspratt's Dictionary (rather more than 20 years ago) at 60 to 80 tons per annum. With the exception of Messrs. Sturge's factory, at Birmingham, the manufacture is confined to the neighbourhood of London, where there are four factories. Citric acid is made in various foreign countries, but none is imported.

We turn in the next place to the manufacture of tartaric acid.

Tartaric acid was first obtained in a separate form by Scheele in 1769. It occurs, like citric acid, in many vegetable juices. The source from which it has always been prepared on the large scale is the grape. Grapes contain a considerable, but variable amount of acid tartrate of potassium, with probably a little tartrate of calcium, and some free tartaric acid. When grape juice is fermented, and alcohol produced, the acid tartrate of potassium is gradually thrown out of solution, being insoluble in spirit. A crystalline deposit of the acid tartrate of potassium, with some tartrate of calcium, is formed on the sides of the casks, and is known as "argol." At the same time, a more bulky precipitate is separated, consisting of yeast, and the various suspended matters of the must; this precipitate, which is known as "lees," also contains a considerable amount of tartrates, thrown out of solution by the formation of alcohol. From these two products, argol and lees, a purer form of bitartrate of potassium is prepared by a rough process of solution in hot water and crystallisation; the substance thus obtained is known as "tartar." This tartar is always more or less highly coloured. By a subsequent process of refinement, it is obtained without colour, and is known as "cream of tartar." Nearly the whole of the tartaric acid manufactured in this country is made from coloured tartars. Argols and lees are also used, but to a much smaller extent.

Every country producing wine does not manufacture tartar. If the wine is plastered, the quantity of bitartrate of potassium deposited during fermentation is greatly diminished, tartrate of calcium being formed instead; in such cases the lees contain too little bitartrate to pay for its extraction. Plastering is effected by treading plaster (a baked native sulphate of calcium) with the grapes. This process is almost universal in Spain, is common in the south of France, and is adopted in some of the Greek islands, and in the Marsala district of Sicily; in other districts of Sicily, in Italy, Germany, and a great part of France, plastering is not practised.

Italy exports nearly the whole of the coloured tartars used in England; a small amount of coloured tartar, and a good deal of cream, come to us from Bordeaux and Marseilles. The total imports of tartar recorded in the Customs' bills of entry for 1875 amounted to 6,765 casks, of which 2,295 casks were from Bordeaux and Marseilles, and consisted in greatest part of cream. The weight of coloured tartar imported might be from these data, 2,000 to 2,500 tons. The amount of tartar used, calculated from the tartaric acid made, would be 1,650 tons. It must be recollected, however, that tartar is used for other purposes besides the manufacture of tartaric acid. The records in the bills of entry are also liable to serious errors, both of excess and deficiency. Besides tartar and argol, wine lees are imported from Spain, Italy, France, and Greece. About 1,400 tons of wine lees were employed last year in this country for the manufacture of tartaric acid.

The best class of coloured tartars consist of nearly pure bitartrate of potassium; such tartars, as those of Messina, contain about 76 per cent. of tartaric acid, of which $1\frac{1}{2}$ to $3\frac{1}{2}$ exists as tartrate of calcium. Good ordinary tartar, as that of Naples (St. Antimo), will contain 74 to 75 per cent. of tartaric acid, of which 3 to $4\frac{1}{2}$ is present as tartrate of calcium. Vinaccia tartar is of lower quality; it is prepared in a variety of districts from the skins and solid matter of the grape, which remain after pressing; it will contain about 70 to 73 per per cent. of tartaric acid, 5 to 7 per cent. being in the state of calcium tartrate. The table on the following page shows the detailed composition of two samples of good tartar of different quality. The potash in these analyses is calculated from the acidity of the tartar.

Argol being a natural, and not a manufactured product, has a much wider range of composition than tartar. Superior qualities are equal to tartar, while very inferior kinds are scarcely better than

good lees. The tartaric acid varies from 40 to 70 per cent., and is always chiefly in the form of bitartrate of potassium. Sulphur is a frequent ingredient, derived from the practice of sulphuring the casks.

Detailed Composition of Tartar.

	Messina Tartar.	St. Antimo Tartar.
Tartaric acid as acid tartrate	74·05	69·34
Tartaric acid as neutral tartrates	2·60	4·66
Total tartaric acid	76·65	74·00
Sand	·140	·425
Silica	·055	·130
Ferric oxide	·053	·086
Alumina	·021	·092
Phosphoric acid	·041	·068
Lime	1·081	1·778
Magnesia	·025	·041
Potash	[23·236]	[21·773]
Tartaric anhydride	67·408	65·120
Combined water	5·688	6·396
Water, vegetable, and undetermined matter	2·252	4·091
	100·000	100·000

Lees, compared with tartar or argol, furnish a very inferior source of tartaric acid. They contain a great bulk of vegetable matter, and all the dirt that has accumulated in processes not remarkable for cleanliness. Lees have been largely used as manure; their general employment as a source of tartaric acid seems comparatively recent. The composition of lees varies very much according as the wine has been plastered or not. The following table shows the average composition of the lees of various countries, so far as the quantity of tartaric acid, and its form of combination, are concerned:—

General Composition of Lees.

	Tartaric acid as		Total tartaric acid.
	Bitartrate of potassium.	Tartrate of calcium.	
Italian lees (33 samples)	24·1	6 1	30·2
Greek lees (14 samples)	19·9	11·8	31·7
French lees (9 samples)	17·3	6·0	23·3
Ditto (30 samples)	5·3	20·5	25·8
Yellow Spanish lees (59 samples)	8·7	18·2	26·9
Red Spanish lees (17 samples)	8·8	17·4	26·2

In the unplastered lees the tartaric acid exists chiefly as bitartrate of potassium; in the plastered lees the tartaric acid is in combination with calcium. The French lees have been divided into two classes, some being plastered and some not. Plastered lees contain gypsum, the residue of the plaster employed. Carbonate of calcium is now and then found in Spanish lees in considerable quantity. Resin frequently occurs in lees from the Greek islands. The lees from Spain are sometimes largely adulterated with Spanish earth; this is a native silicate of aluminium and magnesium, commonly employed for fining the wine.

The detailed composition of three lees is shown in the following table. Lees I. and II. are undoubtedly plastered; Lees III. is unplastered.

Detailed Composition of Lees.

	I. French Lees.	II. Spanish Lees.	III. Spanish Lees.
Tartaric acid as acid tartrate	4·48	5·27	22·66
Tartaric acid as neutral tartrates	21·34	19·13	11·67
Total tartaric acid	25·82	24·40	34·33
Water at 100°	11·305	10·694	9·750
Sand	4·600	4·900	4·730
Silica	2·130	1·960	
Ferric oxide	·394	·351	·214
Alumina	·844	·832	·578
Phosphoric acid	·527	·486	·569
Lime	10·567	10·600	4·514
Magnesia	·327	·363	·209
Potash	1·868	2·123	[7·115]*
Soda	·100	·060	—
Sulphuric acid	4·566	5·729	—
Chlorine	·040	·042	—
Carbonic acid	·435	·388	—
Tartaric anhydride	22·721	21·472	30·210
Combined water	5·904	5·552	4·159
Vegetable matter	33·672	34·448	[37·952]
	100·000	100·000	100·000

The vegetable matter of lees contains a considerable amount of nitrogen.

Before leaving the consideration of lees, we would compare the proportion of impurity present with that found in tartar. Alumina, ferric oxide, and phosphoric acid, are three impurities most injurious to the tartaric acid manufacturer. The proportion of these impurities in lees and tartar for 1,000 of tartaric acid present, is shown in the following table:—

Impurities Present for 1,000 of Tartaric Acid.

	Tartar.		Lees.		
	Messina	St. Antimo	Spanish	Spanish	French
Ferric oxide	·69	1·16	6·23	14·38	15·26
Alumina	·27	1·24	16·84	34·10	32·69
Phosphoric acid	·53	·92	16·57	19·91	20·41
Total	1·49	3·32	39·64	68·39	68·36

A glance at these figures shows at once the inferiority of lees as a source of tartaric acid. In extracting the acid the impurities we have mentioned are in great part dissolved, and are the occasion of much hindrance and loss, as we shall presently describe.

The commercial analysis of tartar and argols is usually performed by various indirect methods; these will be found described in the paper in the Chemical Society's journal already referred to. By these indirect methods the tartaric acid in good

* This figure is calculated from the acidity.

tartar may be correctly found, but it is impossible to determine with any exactness the tartarie acid in lees and low argols. I have recommended for the analysis of these latter a direct method, based on the conversion of all the tartaric acid into neutral tartrate of potassium, and its subsequent separation in the form of bitartrate of potassium. Until a trustworthy direct method for the analysis of lees is employed, their use will be restricted and unsatisfactory, the common methods of analysis on which lees have to be purchased giving results 10 to 15 per cent. above the tartaric acid actually present.

We may now pass from the materials used to the process of manufacture. This has been somewhat altered from that originally employed by Scheele. He was satisfied with merely neutralising the tartar with chalk, by which only half the tartaric acid was precipitated; the tartrate of calcium thus obtained was then decomposed with sulphurie acid precisely as in the case of citric acid. The first improvement seems to have been the substitution of lime for chalk; by this means a far larger amount of tartrate of calcium was obtained from the tartar; but the process was not perfect, the caustic potash produced holding tartrate of calcium in solution. Lowitz (quoted in Aikin's "Dictionary," 1807) then suggested the use of chloride of calcium to decompose the neutral tartrate of potassium formed by the action of the chalk, and thus precipitate the second half of the tartaric acid. This method has been largely used, and chemically leaves little to be desired. It involves, however, the purchase of chloride of calcium, and the inconvenience of dealing with a deliquescent substance, the excess of which also contaminates the chloride of potassium produced. The proposal to use the hydrated sulphate of calcium, which, as one of the products of the tartaric acid manufacture, is always at hand, seems to have originated with M. Desfosses, and this process is the one which is, I believe, now universally adopted in this country. I was surprised, therefore, to find that Hofmann in his exhibition report of 1863 describes the use of chloride of calcium, and says:—"Some manufacturers have endeavoured to decompose the neutral potassic tartrate by calcic sulphate, but this method occasions considerable loss of tartrate of calcium, which remains dissolved in the sulphate of potassium."

The method adopted in England is to add the tartar gradually to a boiling mixture of whiting and water, till the whiting is consumed and the tartar neutralised. A sufficient quantity of wet gypsum is then added to decompose the resulting neutral tartrate of potassium, the agitation of the whole being continued for some time. The result is a dense precipitate of crystalline tartrate of calcium (mixed with all the insoluble matters of the original tartar), and a solution of sulphate of potassium, coloured, slightly alkaline, and containing some sulphate of calcium in solution.

It is quite true that this sulphate of potassium liquor contains some tartaric acid in solution. This tartaric does not exist, as books tell us, as tartrate of calcium dissolved in sulphate of potassium, but is simply a residue of neutral tartrate of potassium which the gypsum has failed to decompose. In fact, if to this sulphate of potassium liquor an acid be added, a precipitate of bitartrate of potassium is produced on standing; and this is the best and most accurate mode of determining the amount of tartarie acid that may be present, bitartrate of potassium being very insoluble in a solution of sulphate of potassium. Although the action of the gypsum is not quite perfect, it may by care be made nearly so, and the advantages of its use are believed to be greater than the disadvantages.

The sulphate of potassium liquor is boiled down and allowed to crystallise; the resulting crude sulphate of potassium is one of the valuable products of the tartarie acid manufacture. The crude salt will contain about 90 per cent. of real sulphate of potassium, the impurities being chiefly water, gypsum, a little carbonate of calcium, and organic matter. If the decomposition has been badly conducted, tartrates and carbonates may be present in notable quantity.

By no means all the potash present in the tartar is recovered by the manufacturer. Some of the washings of the tartrate of calcium are too weak to pay for concentration, and some potash remains behind with the tartrate of calcium, and passes into the tartaric acid liquors. On the whole I do not think that more than 80 per cent. of the potash present in the tartar is recovered, and this estimate is probably too high. Assuming it however to to be true, the amount of 90 per cent. sulphate of potassium produced last year in the tartaric acid factories of this country should be about 745 tons.

The tartrate of calcium having been washed on a vacuum filter is mixed with water, and decomposed with sulphuric acid. The test by which an excess of sulphuric acid is recognised, the mode of evaporation, the granulation, &c., are quite similar to the methods employed in the case of citric acid, and need not be again described. The final crystallisation of the bright liquor is, however, conducted in deep cylindrical leaden vessels, about two feet high, and not in the shallow trays used for citric acid.

The mother liquor remaining after three crystalisations have been taken is precipitated with whiting, as in the case of citric acid, but the result is in some respects very different. If a solution of tartaric acid, containing ferric oxide, or alumina, is treated with chalk, the iron and aluminium are precipitated along with the tartrate of calcium; it follows that precipitation with chalk will not purify tartaric liquors from these substances. If, however, the iron is in the ferrous state, a considerable amount will remain in solution after boiling with chalk. In a laboratory experiment, in which an old liquor of known composition was treated with chalk in the usual manner, I found that only about 1 per cent. of the aluminium, $3\frac{1}{2}$ per cent of the phosphoric acid, and 30 per cent. of the iron present were removed by this method of purification. It appears, therefore, that in a tartaric acid factory in which iron, aluminium, and phosphoric acid are continually being introduced in small quantities in the tartar, the whiting, and perhaps in the animal charcoal used, an accumulation of aluminium and phosphoric acid in the liquors will gradually take place, the accumulation being greater in proportion to the impurity of the materials used. When a factory has been newly started the mischief is perhaps not felt for a few years. Gradually more and more free sulphuric acid has to be employed to induce the

liquors to crystallise; this excess of sulphuric acid occasions a greater decomposition of tartaric acid during the evaporations, and oxalic, and probably other acids are produced, which further load the old liquor with worthless matter. At last the old liquor becomes intractable. It is very thick, and if induced to crystallise it yields potash-alum and oxalic acid, but no tartaric acid can be obtained from it. When analysed it is found to contain far less tartaric acid than had been supposed; that a quantity of organic acid not tartaric is present, with a large amount of alumina and phosphoric acid, and an enormous quantity of free sulphuric acid. This is the *caput mortuum* of the tartaric acid manufacture. The liquor is probably thrown away, and the manufacturer's books show for that year a considerable loss. All these facts point to the economy of using pure materials, and to the importance of seeing that the whiting and animal charcoal used are as free as possible from iron, aluminium, and phosphoric acid. With citric acid, as already mentioned, no such accumulation of impurities takes place, iron and aluminium not being precipitated from a citric solution by boiling with chalk. The purity of citric liquors is maintained, however, only by a loss of citric acid, and the absence of iron and aluminium is therefore as important in the citric as in the tartaric manufacture.

The proportion of tartaric acid which can be obtained from tartar on the large scale depends very much on the purity of the liquors. In a freshly started factory the loss in manufacture may be as low as 8 per cent.; in one that has been several years in work without removal of the old liquors the loss may be as high as 12 per cent., and these probably may be taken as the two extremes in cases where only tartar is used.

We must refer briefly in conclusion to C. Kestner's process for extracting tartaric acid; the process is employed in Germany, and is specially adapted for the treatment of low argols and lees. The tartaric matter is in this process heated with hydrochloric acid, which dissolves both bitartrate of potassium and tartrate of calcium; the hydrochloric solution is then decanted from the undissolved matter, and the tartaric acid it contains precipitated by neutralisation with chalk or lime. The remainder of the process is similar to that already described.

The amount of tartaric acid manufactured in England in 1875, is estimated at about 1,350 tons; there are six factories, all in the neighbourhood of London. Besides the acid made in England, large quantities of German and Hungarian acid are imported, chiefly to Liverpool and Glasgow. The principal foreign factories are at Heilbronn in Würtemberg, Pforzheim in Baden, and Pesth in Hungary. The Hungarian manufacture is rapidly developing. The total quantity of acid made in Germany, Austria, and Hungary is, I am told, about 1,000 tons per annum. The manufacture of France is very small, and is said to be under 200 tons.

We have now concluded our rapid survey of the more important features of the citric and tartaric acid manufacture. I must not sit down without expressing my obligations to many friends, who have most kindly placed their information at my service, and I must especially mention Mr. Northcott, to whom I am indebted for many of the estimates given, and Mr. W. Kemball, manager of the Atlas Chemical Works, who has kindly placed his long experience at my disposal. I must add, that if any of the results mentioned in this, or in my earlier paper, are found of service by tartaric or citric acid manufacturers, it should be recollected they are really indebted for them to Mr. Lawes, by whose liberality the results both of the laboratory and factory have been made public.

DISCUSSION.

Mr. Leschemacher asked whether, from the analyses which had been made, any light was thrown upon the organic constitution of fruits?

Mr. Cogan, in reference to the fact mentioned in the paper, that samples of tartar were frequently found adulterated with quantities of Spanish earth and other foreign matters, said that he hardly thought that this could be the case with the samples from Sicily, since he had himself watched the process of extracting the juice, and care was taken to prevent any dirt from being introduced. The lemons are peeled, and in order to squeeze the juice from them easily, the pores of the fruit must not be clogged with dirt, the peels being afterwards pressed by themselves.

Mr. Warington, in reply to Mr. Leschemacher, said that our information concerning the organic nature of fruits was very imperfect, but that in certain years one acid would predominate, in other years another acid.

The Chairman said—Mr. Warington has mentioned an instance that once came under my notice, of the presence of malic acid in a particular parcel of bergamot juice. It was present in large quantity, in fact, some hundred-weights were separated. I have never known another similar example, and I failed entirely to learn what was the cause of the unusual admixture. It may have been caused by a fraudulent admixture of other acid juice, or possibly by some abnormal condition of growth. The effect of different conditions of growth upon the acid present is well worthy of careful study. The differences shown in Mr. Warington's analyses, between the finest lemons and the inferior fruit, both in the quantity of combined acid, and of acids other than citric, clearly show the effect of such variations of growth. Perhaps those who have watched the process of collection can tell us if the presence of combined acid is likely to be caused by the accidental admixture of calcareous earth in the preparation of the juice. I cannot but think that a careful study of these questions, such as French chemists have given to the formation of the various kinds of sugar in the pressing of fruits, would be productive of most interesting results, and throw great light on the whole question of the formation of organic acids in fruits.

A vote of thanks to the reader of the paper and also to the Chairman, both of which were unanimously adopted, brought the proceedings to a close.

AFRICAN SECTION.

A meeting of this Section was held on Tuesday, March 14th, Prof. Nevil S. Maskelyne, M.A., F.R.S., in the chair.

The paper read was—

THE DIAMOND FIELDS OF GRIQUALAND, AND THEIR PROBABLE INFLUENCE ON THE NATIVE RACES OF SOUTH AFRICA.

By John B. Currey.

Late Secretary to Government, Griqualand West.

The unexpected discovery of vast diamond deposits in Griqualand will probably always be

regarded as an important event in the present century, in respect both of the material and moral effects it was destined to produce in Southern Africa.

Griqualand is one of the tracts which stretching across the continent of Africa from the Atlantic to the Indian Ocean, north of the colony of the Cape of Good Hope, indicate by their nomenclature the tribes which still inhabit them—Damaraland, Namaqualand, Griqualand, Basutoland, Zululand; and the Griquas are a race of mixed Dutch and Hottentot extraction whose presence in the Cape Colony was inconvenient, and who eventually found a home on the high table land on the northern bank of the Orange River, where they settled in the early part of the present century. They were a peaceable and orderly people, though the possession of fire-arms and a knowledge of their use made them feared by the neighbouring tribes; and the intelligence of their chiefs, who were always men of some little education, coupled with the good faith invariably observed by them, made them valuable allies to the English Government in keeping order along the northern frontier of the Cape Colony. Their territory, the boundaries of which were recognised by the English Governors of the Cape in formal treaties, lay between the 22nd and 26th meridians of east longitude and the 27th and 30th parallels of south latitude, and consisted of a tract of table-land, between 4,000 and 5,000 feet above the sea level, watered by the Vaal, Hart, Riet, and Modder rivers, with their smaller tributary streams, and having the Orange River for its southern boundary. On its eastern boundary, the influx of colonists from the Cape made it necessary, in 1848, to annex to the English Crown a considerable tract of country, under the name of the Orange River Sovereignty, which was governed by a British resident, whose authority, after being once successfully defied, was supported by a garrison at Bloemfontein; and this tract of country being abandoned by England in 1854, became the quasi-independent republic now called the Orange Free State. On the north and northwest the Griqua territory was bounded by the country of the Batlapin, a branch of the Bechuana nation, where, at Kuruman, was the home of Moffat and the scene of Livingstone's earlier labours; and on the extreme west stretched the great Kalihari desert. The country, though uninviting in appearance, with its vast wind-swept, mirage-haunted plains, which summer sun and winter frost convert into a yellow desert for eight months out of the twelve, still furnished excellent grazing ground for cattle and sheep, and had here and there well watered tracts of surpassing fertility. It abounded too in game, and irrespective of the noble streams which wound through it without being made to turn a single mill or fertilise one acre of ground, and of the vast mineral treasures which lay unsuspected almost on the surface, it offered sufficient attractions to the Griquas—those descendants of African Hagars—those sons of the bond woman who were cast out that they might not be heirs with the sons of the free, and who, it is worthy of passing remark, thus obtained a more excellent inheritance; pitching their squalid kraals on mines of priceless gems, and tending their scanty flocks on fields where untold millions of money lay beneath their feet. But the curse of ignorance and idleness was upon them. The wealth of the land was theirs, but not for them. They never knew they had possessed it till the stronger white man had seized it and claimed it for his own; and unable to hold, or even to occupy, much less to govern, the land of their adoption, they thankfully ceded it to England, in 1871, and prepared, some to follow their brethren, the Eastern Griquas, who had already migrated to pastures new to the eastward of the Cape Colony, and the remainder to follow their old course of life in such spots of their country as might be reserved for them.

The existence of diamonds in South Africa was first made known in 1867, when one which had come into the possession of a travelling trader was sent to Dr. Atherstone, of Graham's Town, who at once forwarded it to Sir Philip Wodehouse, then Governor of the Cape Colony. The discovery came at a most opportune moment; for South Africa, with a climate which is almost perfection, and a soil in many parts of wonderful fertility, has hitherto, from an absence of means of storing water for irrigation, and an imperfect knowledge of the best way of treating stock and crops under the peculiar conditions of the country, been subject to visitations of drought and other calamities, which have impoverished the landowners and retarded the progress of the different Colonies and States. In 1867, a long continued series of misfortunes had reduced the farmers—the only producing class—to almost universal bankruptcy. Drought had so parched the ground that the earth brought forth no grass, and murrain had swept off the flocks and herds by thousands. Mildew had blasted the vines; fires had devastated the forests. Every industry was paralysed. The public income of the Cape Colony fell far short of the necessary expenditure, even after the most rigorous pruning. It was impossible to raise additional revenue by increased taxation, the public credit was in danger, and things seemed at the worst, when, like the little cloud no bigger than a man's hand which brought with it the sound of abundance of rain, the discovery of the first diamond raised the hope, which has since been so abundantly verified, that there were in the country vast resources hitherto undreamt of, which would attract science and capital and labour to its shores; and (whilst by establishing new industries and creating a new commerce they would raise South Africa, from the rank of a mere hunting and grazing ground) would at the same time not only materially and directly benefit the colonists, but open a means of communication between the Southern States and the vast interior, by which the march of Christianity and civilisation might proceed into new lands, and an endless supply of labour be made available for the peaceful purposes of trade and agriculture.

Sir Philip Wodehouse, upon whom naturally rested no light burden of anxiety as to the condition of the colony under his administration, seized eagerly and confidently what to many seemed a straw not worth clutching at. He purchased the diamond himself for a sum enormously in advance of its real value, and sent it to London. Models of it were displayed at the International Exhibition, and deposited in the British Museum, and in that of the School of Mines, in the hope that public attention would be widely drawn to the importance

of the new discovery, and that the streets of Cape Town would soon be thronged by newly landed crowds of sleek capitalists and horny-handed sons of toil, all bent on developing the resources of the country.

That hope was not immediately fulfilled. To tell the truth, the announcement of our wonderful good fortune, which to many in the colony seemed too good to be true, fell rather flatly on the public ear at home, and was received sometimes with polite indifference, more often with bland incredulity. Fair science coyly turned her back on us. The geologists were certain that there were no diamonds in South Africa, or that if there were there ought not to be. The mighty press, though Arizona was as yet in the womb of the future, shook its head as if it had known all about it, and by an eloquent silence seemed to grieve that the Cape should, under any pressure of circumstances, resort to such very questionable expedients in order to entice emigrants to its barren shores, and raise money by the sale of Crown lands.

So there was no rush from the countries of the Old World to make rapid fortunes in South Africa, and during 1868 and 1869, though diamonds were found and brought in by natives to such an extent as to convince the Colonial authorities that there could be no doubt about the genuiness of the discovery, there was nothing to indicate the existence of beds worth working; and the impression grew that the few stones which were picked up were the sole remains of a vast body of detritus which in former ages had been borne down to the ocean. Still some efforts were made to solve the all important problem whether diamond seeking would pay, and travellers and traders enlisted the services of the natives to pick up shining stones with offers of such dazzling rewards in the shape of oxen, waggons, guns, flocks of goats, Manchester prints, looking glasses, beads, brandy, and tobacco, that the whole population, forsaking their ordinary avocation of doing nothing, crawled on the surface of the country after the manner of the serpent, with their faces so close to the soil as to suggest to the theorist that possibly after all the whole human race had not sprung from the same origin as the monkeys, and that the flattened noses of the Africans might be the result of the peculiar mode of progression which bygone generations of semi-reptilian progenitors had been obliged to content themselves with. Some "prospecting" parties were also organised for examining the country, and two of these parties, one of young colonists from King William's Town, in the Cape Colony, the other under Major Francis, then of the 20th Regiment stationed at Natal, began digging in January, 1870, in the great beds of alluvial drift which lie parallel to the present banks of the Vaal River. Here both parties found diamonds at a place called Hebron, and the news of their good fortune being spread abroad by the press of the Colonies and States, a large number of people prepared to go and share in the fruits of their labours. I have already alluded to the depressed condition of all the South African Colonies and States at this period, and when it is borne in mind that one or more of the three qualifications for admission into the cave of Adullam, distress, debt, and discontent, was probably possessed by four-fifths of the whole population, it will be readily imagined that a vast number of persons were willing to pick up diamonds on peaceful river-banks, where the world forgetting by the world forgot, they might pass what remained to them of life in calm enjoyment, careless of mankind. So in every district and every town, and in almost every village, and at hundreds of lonely farms, were fitted out expeditions formed of those who could be best spared from the community or the family; and from every part of the Colonies, along every road to the interior, in every possible conveyance, from bullock waggons to park phaetons and donkey carts, a large and motley population was soon on its way to the new Tom Tiddler's ground by the banks of the swift flowing Vaal.

It soon became apparent that diamonds were to be found in the alluvial deposits along almost the whole of that part of the course of the Vaal River which runs through Griqua territory; and new-comers, who made in the first instance for the spot where they were at first discovered most abundantly—places called Pniel and Klip-drift, or Stony-ford—after occupying all the available ground there, spread up and down the river on either bank, from Hebron to the junction of the Hart River, a distance as the river runs of about 40 miles, congregating in camps at places which were chosen sometimes because an enormous diamond was said to have been found there; sometimes because the ground looked "likely;" sometimes because a finer growth of timber on the river bank offered a shelter from the burning heat of summer, and promised an ample supply of fuel for the cold nights of winter; and often for no reason at all. It was natural that men who had come so far to seek their fortunes should desire to pursue their new calling under the most favourable conditions. Work is work after all, and certainly digging under an African sun is hard work. Even in digging up diamonds there would be an obvious advantage in selecting the richest spots, and so not turning over an unnecessary quantity of unproductive soil; and so firm a hold did this truth obtain in the minds of many of the first diamond seekers, and so anxious were they to husband their energies in order to put them forth in the very best way and at the very best time, that some, "standing in pause where they should first commence," never began at all; whilst others led a wandering life from camp to camp, attracted alternately up stream and down stream by rumours of lucky finds, and fabulous stories of fortunes made in one day, and only made superficial scratchings at the places where they halted. This restlessness was very common, and where all was so new, and the very nature of the employment had something of the excitement of gambling in it, is quite intelligible. Rumours of all sorts came daily to the different camps, and were eagerly received and acted on. If a diamond as big as a pigeon's egg had been found at Gong-Gong, there were no doubt more of the same kind there, and it was folly to waste more time in toiling after things no bigger than pins' heads at Kiesikamma. If one man had made a fortune in a week at Hebron, why should another man work for a bare living at Pniel. Besides, it must be confessed that many of the diggers were diggers only in name. It may be the effects of climate, but, be the cause what it may, it is certain that laziness in South Africa is not confined to the black

man. It is, indeed, very difficult to find any man in that country at work without finding another man helping him by looking on with his hands in his pocket. And as Sam Slick's Nova Scotian squire liked hoeing potatoes better than any work in the world, and would rather die than do that, because it made his back ache so, even the digging up of diamonds appeared to many persons on the Vaal River at that time to be a matter involving so great an expenditure of physical energy, that it should not be lightly undertaken. But the new population on the banks of the Vaal was, on the whole, active, energetic, and laborious; and all day long the river banks rang with the sound of axe and pick as the earth was made to yield up its treasures.

The mode of working is extremely simple. The gravel is dug out and screened to get rid of large stones, after which it is washed in cradles till the earthy portions have floated off, and the residuum of clean wet sparkling pebbles is then thrown on a board or table to be examined for diamonds, which a very little practice suffices to enable even a novice to detect at a glance. This part of the work is performed by the master, or sometimes by his wife, or his children; and to sit in a chair at a table under the shade of a stately tree by the bank of a noble river, and pick out diamonds from amongst garnets and agates, and quartz, crystals, and onyx, and jasper, and chalcedony, would—if it did not make one's back ache—be probably one of the most endurable forms of bodily labour.

In order to reach the Vaal from the southward it was necessary to cross the elevated plateau lying between it and the Orange, and travellers crossing this tract soon found out that there were diamonds there as well as in the alluvial gravel by the river. They were picked up by the herd boys in the loose red sandy loam which covers the surface, and on examination they were actually found sticking in the plaster of the farmhouse walls. A great change at once took place in the new industry. The restless occupants of the river camps flocked to the new centre, where the finds were reported to be enormous, and where at least there were no huge boulders, the presence of which at the River diggings made much of the work so laborious and unprofitable. New arrivals stopped there instead of continuing their journey. It was soon found that where diamonds lay on the surface they might be safely looked for below it also, and by the middle of 1871 four large pits were opened, and thousands of diggers, principally colonists, were hard at work on the richest spot yet discovered on the face of the earth, while English gold was pouring by millions into the central spot from whence it could be most evenly distributed amongst the surrounding Colonies and States of Southern Africa.

The mines or pits in which the diamonds are found may be described as holes, all of several acres in extent, in the barren shale which covers this part of the country, and which in every case seems to form a distinct wall or reef round the diamond-bearing soil. Outside this wall or reef of shale no diamonds appear to be found. Inside it the diamonds are found in profusion. It has already been observed that they were found in the red surface soil, and for a time it was believed to be useless to look for them in the grey soil of decomposed rock which lay beneath it. Indeed, in the early days, the Boers by whose permission the diamond seekers conducted their explorations are said to have been willing enough to let the surface be examined, but to have objected strongly to the digging of holes in which their sheep might break their legs. But when the surface was exhausted, and on trial of the layer of grey decomposed rock soil diamonds were found there also, and again in the queer looking "blue stuff" beneath it, there was no more asking leave to dig holes. Huge cavities were soon made in which whole flocks might disappear, and the bewildered owners of the farms were probably glad to sell their properties for what seemed to them sufficient prices, and to migrate with their families and herds to distant lands, where one of them expressed a devout hope that he would not again be troubled by the presence of diamonds on his property.

Of the four places opened, two were on a farm called Vooruitzigt, one on a farm called Dorstfontein, and the fourth on a farm called Bultfontein, all four places lying within a rayon of about two miles. Of those on the Vooruitzigt property, one was called, first, "Colesberg Kopje," in honour of its discoverers, then "New Rush," from the number of diggers who flocked there from other spots, and finally "Kimberley mine." The other has retained the name of the De Beers, who owned the farm. That on Dorstfontein has been called "Du Toit's Pan," being the name of a large sheet of water close to it, and that on Bultfontein has retained the name of the farm. The diamonds found in the three first are of every quality, size, and colour; those found at Bultfontein are all small and white.

When these places, which are called the dry-diggings, to distinguish them from the river-diggings, were first discovered, the rule which obtained at the latter that any person might mark off and keep for himself two "claims," each 30 feet square, was adhered to; and first come first served being the diggers' law, every place was occupied or "rushed" as soon as its value was ascertained, and those were lucky whose claims were found to be inside the reef. The Kimberley mine, which affords the best example, having been the most systematically worked, was found to be about nine acres in extent on the surface, and it contains at present about 300 claims divided amongst about 1,200 holders, though the reef, contracting slightly as greater depth is reached, gradually encroaches on, and eventually shuts out, some of the claims adjoining it. Each claim was originally subject to a reservation of a roadway 7 feet 6 inches in width on one side of it, so that when the claims were measured and laid off there were parallel roads 15 feet wide crossing the ground, and each claim had a frontage to one of these roads, every digger was able to cart away his "stuff" to the place where it suited him, to sift and examine it without interfering with or inconveniencing his neighbours. The roads ran from north to south and were of very great service until with the increasing depth of the mine they became so dangerous as to render it necessary to remove them.

The mode of working at the dry-diggings was even more simple than that at the river, inasmuch as the absence of water prevented the possibility of

washing the soil, which was simply screened to get rid of large stones or lumps, and sifted to remove the finer particles before it was thrown on the sorting table and examined. A necessary consequence of this was that all the smaller diamonds and all those of any size which might happen to be coated with soil were rejected, and that the vast accumulation of *debris* around the mines was found to be still of enormous value when the water necessary for washing it was obtainable from the numerous wells sunk in the neighbourhood, and from the deeper parts of the mines which have now to be kept free by means of steam pumps. Under the present system, the soil, after being raised and exposed to the action of the air until it has become friable, is passed through washing machines of simple construction, oscillating or rotatory, worked by hand, horse, or steam power, and the lighter particles are carried off in solution, whilst the heavier sink to the bottom and are reserved for examination in the same way as at the river diggings. There is one fact in connection with this system of procuring the diamonds which may be worthy of attention; it is, that the machines now in use will not work well if clean water be used in them for mixing with the soil. If this be done, the diamonds, especially the smaller ones, are apt to be carried away and lost, but if water largely mixed with clay be used, the diamonds appear to pass through it with greater ease and rapidity than is due solely to their specific gravity, and are found safely imbedded in the heavier substances which are deposited in the bottom of the machines, consisting of the harder and undissolved portions of the soil, which may hereafter yield more diamonds, mixed with quartz crystals and garnets, and fragments of calcspar, iron pyrites, ilmanite, and peridot.

The manner of obtaining claims at new diggings has been already stated. At established diggings or mines there is an officer called the registrar to whom application can be made for any claims which may be unregistered in the name of a certificated miner. The applicant must himself be a certificated miner, and he can himself obtain a miner's certificate from the resistrar on paying £1 for the year, or five shillings for the quarter, and, if necessary, producing witnesses to character. An application for a vacant claim is posted in the registrar's office for three days, and if no other certificated miner applies for it within that time it is allotted; if other applications are received the claim is put up to public auction at the mine on the following Saturday, and sold to the highest bidder. In any case the person who obtains the claim must have it registered in his name in the registrar's office, and that done he is secure in the possession of it as long as he pays the Government a registration fee of £6 a-year, or 10s. a-month, conforms to the orders of the mining surveyor in matters affecting the safety or convenience of his neighbours, and pays the rates levied by the mining board for the general expenses of the mine, such as pumping out water, removing masses of fallen shale, making roads and approaches, or purchasing machinery. All transfers of claims are likewise registered, and all hypothecations of claims, so that the registrar's office can always supply the information that may be required regarding any claims which is a matter of great importance when it is remembered that the 300 claims are divided and subdivided into halves, quarters, eighths, and even sixteenths, and that these are being daily bought and sold to such an extent that the profession of claim broker is a recognised and profitable one. Besides the registrar, I have alluded to the mining surveyor and the mining board. The surveyor, like the registrar, is a Government officer, and his duty is to see that no digger works his claim in such a way as to endanger the lives of his own servants, or those of his neighbours, or to interfere with their convenience. He also acts as official arbitrator in disputes between claim-holders, assisted by a jury of miners in cases where damages have to be assessed. The mining board is an elected body, chosen for the year by the claim-holders, and is empowered to assess rates for the general purposes already referred to, and to make bye-laws for the management of the mine. In the Kimberley mine a valuation of the claims is made every year for rating purposes; in the other mines the rates are charged on the claims irrespective of their value, though in some cases, when special rates are levied for particular purposes, such as pumping, the claims to be benefited by the work to be done are subject to a higher rate than those which do not themselves require draining.

The claims in the Kimberley mine are valued for railway purposes at from £500 to £3,000 a piece, but this selling price is generally far in excess of the valuation. At the other mines, where there is no valuation, the prices of claims cannot be so clearly stated, but in all the latter, as at the river diggings, claims can generally be had on application to the registrar or claim inspector on payment of he registration fee only. The claims any miner can hold in his own name must not exceed ten.

Though every claim-holder must, as has been said, be a certificated miner, it is not now necessary that he should be a digger, and as a rule, it may be said that he is not. Claims are held by capitalists, merchants, professional men, retired officers, tradesmen, mechanics, and even by minors and children, and the common practice is for the claim-holder to agree with a practical digger to work the claim on shares, the holder paying the rates and taxes, and the digger finding superintendence, labour, gear, and tools, and receiving generally from 50 to 75 per cent. of the proceeds. As a rule, the digger, at the end of each week brings to his principal, or his agent, the diamonds which he has found, and they are then handed to a broker, who goes round amongst the diamond merchants and disposes of them to the best advantage. Implicit confidence has of course to be placed in the honesty of the working partner, but it is gratifying to be able to state that cases in which that confidence is abused appear to be rare, and that as a rule, the arrangement seems to be one which satisfies both parties.

There are no means of forming a correct computation of the number, weight, or value of the diamonds hitherto produced in Griqualand. The sums already paid for them are estimated at from twelve to fifteen millions sterling. I have no means of ascertaining the correctness of that estimate, but I am able to give some idea of the production in 1874, and the greatly increased production in 1875. The diamonds sent away in the former year may safely be said to have averaged not far short of 16 ounces daily, and the yield in

the latter was probably nearly half as much again, or 24 ounces daily, this enormous increase in 1875 over 1874 is attributable to the introduction of the washing machines, by which not only was the newly-raised soil more exhaustively searched, but immense quantities of the soil raised in former years, and thrown aside after what was called dry sorting, were washed with such good results that persons competent to form an opinion estimated the proceeds of this branch of the industry alone at £20,000 a-week. This débris-washing, as it is termed, is eagerly engaged in by great numbers of persons who have not the capital necessary for buying or working claims, and every person holding a miner's certificate can take out for five shillings a-month a license which enables him to search for diamonds in abandoned soil, either by setting up his apparatus in such spots near the mine as the surveyor may appoint, or by carting the soil to his own premises if he chooses to buy the right to search for diamonds in it at prices varying from three-pence to one shilling and sixpence a cart-load. This applies only to the Kimberly and De Beers mines, on the Vooruitzigt property, which has been bought by the Government, in which all rights are consequently centered. The right to the diamonds in the other mines and in the débris around them is in dispute between the Government and the owners or quit-rent tenants of the farms.

This, I think, is all that need be said as to the present position of the diamond-producing industry in Griqualand. As regards its future prospects, I believe them to be—as far as the supply of diamonds is concerned—as good as they ever were. In none of the mines has any bottom been reached, and the greatest depth does not exceed 200 feet. There are also the immense accumulations of half-examined débris already mentioned, and, finally, there are the gravel beds along the course of the Vaal River, in which the diamonds were first found, but which are now almost deserted, though the stones found in them are, as a rule, of better quality than those produced at the dry-diggings.

The social progress of the community has, considering the difficulties to be overcome, fairly kept pace with the development of the different branches of trade, and of the industries in which its members are engaged. Kimberley, Du Toit's Pan, and Barkly are towns where substantial public buildings and stores, neat cottages and trim gardens, are fast taking the place of mining camps of tents and waggons. There are churches and chapels, banks and newspapers, an excellent high school, a good hospital, regular postal and passenger conveyances, and an electric telegraph. Travelling artists give operatic and theatrical entertainments. There are balls and dinner parties. Ladies play croquet, drive pony-carriages, or ride in faultless habits and tall hats; gentlemen course antelopes and shoot partridges, and play whist and billiards at their club.

The necessaries and many of the luxuries of life are brought from every side. Imported articles are brought by trains of mule and bullock waggons from Cape Town, Port Elizabeth, East London, and Natal. The Free State sends excellent beef and mutton, the price of meat being 6d. a pound. The Trans Vaal supplies cereals and vegetables. Game is brought in abundance. Springboks are sold for 5s., blesboks for 7s. 6d., and wildebusts or gnus for about the same price. Fresh-water fish is supplied by the Vaal River.

The climate is not unhealthy. In the early days, when people lived in tents, and in many cases lay on the ground, fever was common when the heavy summer rains began to fall; but every year, as better house accommodation is provided, there is less sickness. The heat in summer is very great, 110 degrees Fahrenheit being not uncommon in an iron building, but at the dry-diggings the nights are always cool. In winter snow falls occasionally, and the nights are sharp and frosty. The most disagreeable part of the year is the spring, from September to November, when high winds prevail, with fearful dust storms; these are followed, as the season advances, by thunder storms, with torrents of rain, and the whole country is then soon covered with waving grass, and the vegetation of every kind is most luxuriant.

In domestic life the great difficulties are house accommodation and servants. Houses cannot, as a rule, be hired, and building, even with corrugated iron, is a serious matter, where all materials have to be brought 500 miles inland, and mechanics can command £1 a day as wages. Servants' wages are from £2 to £8 a month for Zulu Kaffirs and Indian coolies. Female servants are not obtainable there, and must be brought from the Cape. Firewood is brought in sufficient quantities, but at ever increasing prices. Water, on the other hand, becomes cheaper as more wells are sunk and competition grows. Shops of every kind abound, and goods are sold at reasonable prices.

The business transacted is very large. £5,000 a-day is often paid for the carriage of goods from the coast; and the town of Kimberley, with its market square and streets choked with huge waggons and teams of oxen, its hurrying crowds of sun-burnt diggers, keen-faced diamond brokers, and native labourers, the roar of many thousands of voices which now and again comes from the great mine in its centre, the life and stir and bustle which pervade it presents a scene of no ordinary interest, and one which contrasts strongly with the calm, not to say stagnant, repose which marks all the colonial towns except Port Elizabeth.

Apart from its great local business, a very large trade is springing up with the interior, and this trade may be increased to an enormous extent. Taken altogether, with its vast local wealth, its energetic population, and its connection with the interior of the continent, to which I shall presently revert, Griqualand cannot fail to exercise a most important influence on the future of South Africa, and one which under careful guidance may be as productive of moral benefit to the native races in the future as the past has been fruitful of material advantages to the colonists. How great those material advantages have been may be gathered from the briefest comparison of the present position of the different Colonies and States with their condition five years ago. In the Cape and Natal the public revenues have been more than doubled, while the value of their imports and exports have been trebled. The paper currency of the Republics from being at a depreciation which

portended insolvency, if it did not suggest repudiation, is being redeemed in full. Great railway and other public works, which five years ago the most sanguine did not dream of, are now being energetically carried out at a cost of millions. Land has risen in value, mortgages have been paid off, new farms stocked, new industries attempted, and old ones prosecuted with renewed vigour, in short a whole community has been raised from indigence to affluence, and whatever allowance may be made for the natural development of their own resources within this period, there can be no doubt that this extraordinary prosperity has been dependent on, as well as coincident with, the discoveries of diamonds in Griqualand.

Having thus briefly sketched the history, progress, and present position of those discoveries, and indicated the material results which have so far arisen from them, I desire now to draw attention to the moral effects which they may reasonably be expected to produce on the teeming population of tropical South Africa with which they are becoming rapidly and intimately connected. And as in dealing with what may be termed the European or Colonial side of the subject, I have in obedience to the rules of this Society abstained from touching on any matters involving political questions, so in treating of that aspect of it which relates to the natives I shall refrain from any direct reference to religious matters, merely premising that I regard any attempts to civilise the native African races as necessarily involving efforts to convert them to Christianity, and to make known the Gospel of peace and good will towards men in the dark places of the earth which they inhabit.

No question seemed likely to present more difficulty, if the discovery of diamonds in Griqualand should prove of any importance, than that of the supply of labour, for the established Colonies and States were so ill supplied that no great assistance could be looked for from them. The Griquas and Korannas could supply none, and but little could be expected from the Batlapins, the Barolongs, and other Bechuanas. The Basutos and the Zulu could be reckoned on, but those tribes could only reach the scene of labour by passing through the territory of the Orange Free State, whose severe laws in respect of natives were calculated to make the continual passage of large bodies of such people difficult if not impossible. But practically no difficulty was found in procuring labour. No sooner had the demand for it arisen than vast numbers of the races known as Mahawas, living between the 23° and 24° parallels of south latitude—docile, ignorant, helpless creatures, the very raw material of the slave trade—poured down from the country bordering on the Limpopo, and eagerly took service with the diggers. Very little appears to be known of these people, who are probably the descendants of tribes which have fled southwards to escape from stronger native races. They come in large bodies, often as many as 2,000 in a month, arriving in a wretched state of emaciation. They wear no clothing beyond a cincture round the loins, and bring with them no weapons or implements. They generally stay about six months, earning about ten shillings a week and their food, and at the end of that time they are sleek, well-made, and often powerful men, for as yet only adult males have arrived. Being very thrifty, they save nearly all their money, and if they are not robbed they generally have £8 or £10 by them in gold when the time of their departure arrives. This, or the great part of it, they expend in guns, powder and lead, old military uniforms, beads, brass wire, and perhaps a little food; and then having packed up their possessions, including all the old sheepskins, empty meat tins, and worn-out shoes they have been able to collect during their sojourn, they assemble in bodies, each man staggering under his burden, to which must be added, if possible, a tall hat, and white umbrella, and with loud discordant yells, and with much firing of salutes of blank powder, they set off on their long homeward journey. A noticeable and painful feature in these people is their want of feeling for each other. When they are sick it is almost impossible to get their fellow labourers to attend to them, and it is said that when, as often happens on the road, some of the party sink by the wayside, they appear to expect no assistance from their companions, who pursue their journey without halting.

For a long time it seemed probable that these Mahawas would furnish all the labour that was required; but probably, from some of them who had returned to their own country spreading still further north the wonders they had seen, in the early part of 1874 there began to arrive large parties of new tribes, whose language the Bechuana interpreters could make nothing of, but which seemed to bear some affinity to that of the Zulus. These men were of a deeper black than the Mahawas, and arrived in even a more emaciated condition. Many of them were almost living skeletons, and they spoke of hundreds having died on the journey. They were Makalakas from the great plains in latitude 20, a race said to be without chiefs, or laws, or organisation of any kind whatever. Still, degraded as is their condition, they seem to possess some remains of a more civilised state, and to show signs of an intelligence superior to that of the Mahawas. They had knives of their own manufacture, the wooden handles ornamented with neatly-plaited brass wire. They wore necklaces made, amongst other things, of chalcedony, which they had managed to round and pierce, and they carried musical instruments, composed of steel keys stretched on a wooden frame fixed in a large gourd, on which they played duets of very fair music. Parties of these people continued to arrive during 1874 and 1875, and in the middle of the latter year came the first party of the Maschonas, large, powerful, jet-black men, from latitude 18, on the southern bank of the Zambezi.

It will thus be seen that at a little spot between the 28th and 29th degrees of south latitude there is established an industry which, while giving profitable employment to a large, intelligent, and energetic population there, and circulating immense sums of money in the existing Colonies and States, draws to itself thousands of raw natives from the interior of the Continent, who are thus first brought in contact with the white men under somewhat extraordinary conditions. There meet face to face the extremes of civilisation and barbarism, knowledge and ignorance, wealth and poverty, the product of centuries of existence under the changing influences of European life and the crude humanity of heathen Africa, the same now, probably, as in the remotest ages. The

priest in his cassock is gazed at by wondering creatures, to whom his dress is a mystery, while of his creed they have never even heard. Silk and velvet-clad ladies from London and Paris move through throngs of statuesque Aborigines, who have not yet come to regard dress of any kind as a matter of importance. The European shopkeeper explains to African customers, who care for none of these things, that his motto is "Small profits and quick returns," and the unsophisticated native from the basin of the Zambesi can at the street corner purchase a—to him—unknown esculent, "all hot and floury," from the baked-potato man of Whitechapel.

And this great stream of native labour returns, after a few months, to the great ocean from which it flowed, bearing with it, as is inevitable, some traces of the strange lands through which it has passed, and some tinge of the things with which it has come in contact. We cannot prevent this, even if we would. For good or for evil these natives have tasted of the tree of knowledge, and know that they are naked. They go back with something to tell, and the strange stories that must be repeated from hut to hut and village to village, the distorted accounts which must be spread of our religion and our laws, our virtues and our vices, our manners and customs, will produce results greater than any that all the missionaries of Europe could effect in a century. Events novel and rapid, which we have had no power to control, have unexpectedly placed us in immediate communication with new tribes, and our connection with them entails results which no indifference can ignore, and from which no timidity can escape.

Nor is there any reason to fear those results if, by firmness, and prudence, and foresight, our relations with these people are made what they should be. They are not hordes of warlike savages, well armed and disciplined like the Galekas or the Zulus, against whom it is necessary for us to join in bonds of union for purposes of common defence; they are simply unsophisticated creatures, who will be very much what we make them, and whose services we urgently need. It has been said that the traders of Griqualand have distributed 200,000 stand of arms amongst them. I do not know how these figures are obtained, but even granting them to be true, I see in them nothing alarming, for I feel confident that 150,000 of them must long ago have ceased to be dangerous to anyone except their owners, and that the rest are in the hands of men who would not lightly use them against us, and who would, as enemies, in an open country, be utterly contemptible.

But what inferences are to be gathered from this trade—which is undoubtedly large—in guns and gunpowder? The 200,000 guns referred to, and the ammunition, without which they would be useless, must have cost in Griqualand at least two millions sterling. Suppose this amount had been carried away in coin by the natives—a practice which, I may state, is obtaining rapidly amongst them — what then? Would not the Griqualand and other traders have followed them, and supplied them in their own homes with the commodities they wanted, as long as they paid for them in ready money? and such trade conducted in the wilds of the interior, where the native might be tempted to plunder, even if the white man were certain not to defraud, might be more dangerous than legitimate business, under the eye of the policeman, in an English colony.

If the natives are to be allowed to earn money they must either be allowed to buy guns openly or they will be supplied with them clandestinely, for ready money attracts trade as surely as the pole does the needle. They must be allowed to earn money, for we cannot do without them. Labour must be had, and even the most consistent opponents of the black man have not as yet proposed to substitute for him anything obtainable by importation, from English peasants to Chinese coolies. We have the native, and we must make the best of him. How that may be done, what vast fields for the spreading of civilisation and the advancement of commerce must be opened up in doing it, what immensely important results may be expected to arise from it are subjects which I apprehend it is one of the functions of this Society to consider, as its privilege is to bear an important part in the formation of that intelligent public opinion which, acting on the administration of public affairs, shapes the policy of the country.

The discovery of diamonds in Griqualand has opened a great door to us, and furnished opportunities which cannot safely be neglected. It is impossible to believe that such riches were scattered there, merely to be picked up by us to add to our own wealth without regard to the country in which we find them; and we cannot, I think, avoid the conclusion that very great responsibilities rest upon us in consideration of the material benefits we derive, and that upon our discharge of those obligations depends to a very great extent the future happiness, peace, and prosperity of South Africa.

DISCUSSION.

Lieut.-General Bisset said that Mr. Currey had given such an accurate narrative of everything connected with the discovery of the diamond-fields that he could really add nothing to it, especially as these discoveries had chiefly taken place since he had left the country. However, as he had spent many years in the country, having served there from the time he was an ensign until he became a general, only leaving in 1867, he might add a word or two in regard to the native element. In 1835 the first war took place, when the natives were in the state Mr. Currey described those from the north to be—without weapons, and not at all formidable enemies, but since then they had obtained arms, which cost this country ultimately five or six millions sterling, and he feared if the system of selling arms were continued it would lead to very serious results in the future. The Kaffirs in their primitive state were easily dealt with, but when they became aware of their own powers, like all other people, difficulties immediately arose. If they could be civilised, and brought to enrich themselves from the produce of the country, instead of getting a warlike spirit instilled into them, the country would prosper, but he feared if they obtained fire-arms they would use them not only against themselves but against Europeans.

Prof. Tennant said his knowledge of the diamond-fields was only derived from what he had heard from those who had visited them, but he had taken an active part on many occasions in urging the importance of these South African diamond mines. It was now twenty-five years since a lecture was delivered in that room, speaking of the probability of diamonds being found in South Africa, in consequence of a book which

he held in his hand, by the late Mr. Mawe, which was published in 1812, wherein the gentleman, who died in 1829, stated that there was every probability of diamonds being discovered there. He had taken every opportunity of making the subject known by means of papers which were sent in letters to foreign countries, one of which he believed fell into the hands of Dr. Atherstone. On the table were some specimens of African diamonds; also some from Brazil and other countries; and some specimens of a stone which was being largely sold in London under the name of a Cape ruby, but which was really only a common garnet. He had with him also a large diamond brought from the Cape by one of his own students, who in less than four years had collected, after paying all expenses, more than £20,000, and was now gone out again. There were also some interesting photographs showing the working of tho diamond mines. He had often conversed with Dr. Livingstone on this subject, but he said he should not know a diamond if he saw one, and such no doubt was generally the case with observers, because the majority of the stones looked more like little bits of gum than like what one saw in jewellers' shops. Many people, however, went out, he believed, expecting to find the stones all ready cut and polished, and thus many were overlooked, especially the smaller ones. There was a time coming, however, when these small diamonds would be very valuable, and he hoped the Kaffirs would be taught to work the earth so as to save these small stones. It was indeed rather surprising to find that so few of these small stones came from Africa, especially as so many of this class came from the Brazils. He believed that more than 15 millions worth of diamonds had already been sent from Africa, because, although he had stated that figure at the British Association meeting, he had since received information that a much larger sum might have been stated.

Mr. Ebden thought there were one or two points in the paper which might lead to a wrong impression as to the position of South Africa. He had no wish to undervalue the importance of the diamond discoveries, but he was not prepared to admit that the country would have been in a state of bankruptcy but for these discoveries. He believed that even without them South Africa would have been in a very good position at the present moment, though not of course, so good as it now actually is. It had been gradually progressing from a number of circumstances; the seasons had been good; wool, which was the staple of the colony, was in great demand; there had been a large yield of grain, and altogether he was satisfied that South Africa would not have been in the very forlorn state which some might suppose from the paper, if the diamonds had not been discovered.

Mr. Belleville took exception to General Bisset's remarks as to arming the natives, because the races to the North of the Zambezi were a totally different class of men to the Zulus and Kaffirs. They had no cohesion amongst themselves, and if they all had arms they could only use them in little squabbles amongst themselves, having no organisation or power to unite against a great nation like the English. He had had some experience both of the Zulus and races to the north, and he was convinced that if the latter races, the Maschonas, and the Makolaka, were supplied with arms, no evil consequences would ensue. Arming the Zulus and Basutos was a different thing, and might to be open to objection.

Dr. Mann asked if all the gentler races were not allied to the Maschonas?

Mr. Belleville said they were all negroes, not Kaffirs.

Dr. Mann thought most of them had been driven northwards by the Matabele, who were an offset from the Zulus. It was quite true that they were a wholly distinct race.

Mr. Moodie, having spent a good while in the country to which Mr. Currey had referred, desired to say how entirely he agreed with everything he had said. There was no doubt that the discovery of the diamond-fields would exercise an enormous influence upon the whole of the interior of Africa, and go far to extend the knowledge of civilisation. It was to be hoped that England, which had taken so prominent a part in the country, would use her influence in extending from the centre—which was a thousand miles farther inland than civilisation had penetrated before to any extent—the blessings which such civilisation alone could promote. Further to the north again there was an immense tract of country, high and healthy, reaching up to the Limpopo, capable of accommodating any number of emigrants, and which might be utilised to great advantage. That reminded him that the port for all that part of the country would be Delagoa Bay, now lost to England by an arbitration which he regretted had ever taken place; but it made it additionally incumbent on England to make the most of her position at the diamond-fields for extending civilisation into the interior of Africa.

Mr. Campbell Johnston had had much pleasure in listening to so interesting a paper from Mr. Currey, whom he had met in South Africa. He agreed with almost everything in it, and was especially pleased with that portion which referred to the sale of arms to the natives. That involved the question of free trade, of which he had known something in his former career in China, and its advantages he knew to be very great. Without commenting on what might be the immediate result, though he had also considered that question, but merely looking at in the abstract point of view, as a measure of free trade, he had no doubt but that it would be a benefit to the whole of Africa; certainly to those portions which were affected by that centre of civilisation which was now being formed at the diamond-fields. He quite agreed with Mr. Currey that a large portion of these arms were likely to do more harm to those who used them than to any one else, but it must also be remembered that European civilisation must always keep in advance in that respect, so that if any of these native tribes were encouraged to hostility by the possession of arms, the only result would be that they would be so thoroughly beaten that they would have an immense respect for the white man, and thus a lasting peace might be secured. Some of the States followed a different policy in this respect, and no doubt they had good reasons for so doing; but he was quite sure that the vast majority of the natives were only induced to labour by the hopes of obtaining these arms. Many might think this an evil, but looking at the subject on a broad principle he did not think it was so, but that it would tend ultimately to the great benefit of all the inhabitants of South America.

Dr. Mann, having shown on the map and described the geographical position of the diamond-fields and the surrounding country, said the gun question was no doubt a difficult one, the practical difficulty being, that in Natal there was a population of about 17,000 Europeans, surrounded by 300,000 natives, and that the great tribe, the Zulus, was immediately beyond their frontier. These 300,000 natives in Natal were subject to the Queen, but they were sometimes rather unruly, and the Zulus were a warlike nation immediately to the north-west who were rapidly acquiring arms. There was no question about the policy of free trade, or of the ultimate issue, but there was an anxious intervening period, during which the advisers of the colonial authorities had very carefully to consider what was best to be done under the peculiar circumstances of the case. The recent troubles in Natal in relation to Langalibalele had arisen from this very question of the arming of the natives.

Mr. Currey, in reply, said it must be borne in mind, in dealing with the question of the sale of arms, that the native races he had alluded to, and who had been so well described by Mr. Belleville, were of a totally different character to the warlike Kaffirs in the neighbourhood of Natal. It would be readily admitted that his general

description was substantially correct—that they were a docile, ignorant, harmless race, to whom guns might very safely be entrusted. Upon the question of Natal, and its differences he had not intruded, nor would he venture to say anything; but he was quite convinced that if the natives could not get guns they would not come to work. If they took the money away with them the traders would follow them to their own country and supply them there; and he firmly believed that if there were even less than 17,000 white men in Natal a large proportion of them would be traders who would supply the natives with guns, come what might. You could not prevent the trade. All you could do was to deal with the natives so as to civilise them and render them fit to possess them. With regard to his statement that three-fourths of the guns which had been supplied to natives would be found to be useless, he must not be supposed to mean that the traders had designedly supplied them with bad guns, but that they did not know how to take care of one when they had it, and if a gun lasted a twelvemonth they considered it a wonderfully good article; so that the greater part of those supplied to them during the last five years must be already worn out. Mr. Ebden had rather misunderstood him, because he had not said that but for the diamond-fields South Africa would now be in a state of bankruptcy, but that the colonies were on the verge of that unfortunate condition at the time of their discovery, which no one could deny. And making all due allowance for the development of her internal resources, there could be no doubt that the present state of South Africa was largely owing to the diamond-fields. He had been much interested in Professor Tennant's remarks, and certainly had no idea before that the discoveries had been foretold so early as 1816. It was certainly very remarkable that so interesting a statement had attracted so little attention, and that actual discovery and the arrival of a large quantity of diamonds was needed before the public would accept it.

The Chairman, in proposing a cordial vote of thanks to Mr. Currey, said he had been much interested in these diamond discoveries, and had carefully examined the rocks in which the stones occurred. The history of the diamonds in South Africa was quite exceptional and peculiar, for as far as he knew, diamonds were found in Brazil and in India under totally different conditions. On the table were specimens of the rock or matrix, in which the South African diamonds were found at different depths, and when examined this was proved to be a rock which had entirely changed from its original character by the agency of heat. Its chief ingredient was silicate of magnesia, there being hardly a trace of lime. It was found in a large crater-like cylindrical cavity, surrounded with shales comparatively unaltered, and of a totally different composition. The rock was most probably of volcanic origin, and the best mode of explaining the existence of diamonds, as far as is known at present, was to suppose that they occurred in what were called the throats of old volcanoes, these cylindrical cavities being the bottoms of the pipes up which the volcanoes ejected the material which once covered the country, although much of it had since been swept away by the waters of the Vaal and its tributaries. The question then suggested itself, was this rock the true home of the diamond; had it come into being there, or been brought up from below? There was always a tendency in scientific men to throw back the origin of things farther and farther, and it was easy to say that the diamond was found under other conditions, and that this rock had brought it up from below. But there were other curious circumstances connected with it. This rock had passed through the shales and other beds charged with carbonaceous matter, and as the diamond was simply pure carbon, it was not impossible that it had been actually produced in this rock, under great pressure, and the influence of extreme heat. He only threw that out as a speculation, because there were not sufficient grounds for coming to a conclusion either way. Some thought the diamond was formed in the moist way, by the action of water, or the gradual change of organic matter through a long period of time, without heat; but in the present case there was no doubt it had been exposed to both heat and very violent action, because the surface of these diamonds exhibited certain lines, which had been shown by Gustave Rosa to be the constant result of the action of great heat, and they also gave evidence of having been knocked about and fractured. They were deposited in shale, which had since by hydrothermal action become quite rotten, showing the appearances to be seen on the table. Passing from this, he must say that the latter half of the paper was of even greater interest and importance. England had been described as the mother of nations, and that was emphatically true, because her children went out from her, carrying with them the inheritance of a thousand years of English law and English habits, which enabled them when they settled down, whether on a new diamond-field, or anywhere else, at once to organise themselves into a society. They did not wait for a State Commissioner, or an organisation such as might happen with Frenchmen, but settled down and made rules for themselves, because they had possessed the great inheritance of an instinct for self-government. Thus they agglutinated into new nations, and became members of that government polity of which England was the imperial head. Of this principle he believed the colonies at the Cape were about to become an eminent example, for there could be little doubt, seeing the great tendency at the present time for colonies to collect together into nations, that the same thing would go on there, and that the Cape would form a united people and government. There was an immense reach of splendid country on the western coast, rich in minerals yet to be developed. A similar deposit was found as far north as the Limpopo, comprising the same shale as that in which the diamonds were found, but absolutely unaltered, being then termed bronzite. He had only lately exhibited a specimen, which he believed was quite unknown in any other part of the world. The only things necessary to the development of the country were population and the means of locomotion. Those who had read an interesting article by Sir Geo. Campbell on the future of Egypt would, however, be inclined almost to shrink back from the brilliant prospect held out in Africa, by the reflection that England had already as much on her hands as she could manage. She had already such an enormous quantity of the temperate and productive soil of the world that it would take another two centuries probably before she had population sufficient to fill those lands and develop them properly. It was a proud hope for an Englishman that his nation should play the part of colonising all these fertile and productive countries, but it might be questioned whether her dominions were not already too large without extending her sway far into Africa. As to the question of free trade and the supply of arms, he should say let things alone to take the course which had always been followed hitherto of not imposing any restrictions, and he had no fear of the result.

The vote of thanks having been passed unanimously,

Vice-Admiral Erasmus Ommanney, C.B., F.R.S., proposed a similar compliment to the Chairman, and the proceedings terminated.

FIFTEENTH ORDINARY MEETING.

Wednesday, March 15th; H. Reader Lack, Treasurer to the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Bryan, E., Gas Works, Beverley.
Eastwood, Charles, Soothill-lane, Batley, Yorks.
Hogg, Dr. Robert, F.L.S., 99, St. George's-road, Pimlico, S.W.
Parlby, William, Aylesbury.
Whitehead, W. G., 11, Drewton-street, Bradford.

The following candidates were balloted for and duly elected members of the Society :—

Carter, Theodore, 10, Hanover-street, Rye-lane, Peckham, S.E.
Harkewitz, Herman, Lorne-terrace, South Bank, Yorkshire.
Huxham, Hortensius, 3, Rutland-street, Swansea.
Holman, Stephen, 10, Laurence Pountney-lane, E.C.
Record, John, 8, Moorgate-street, E.C.
Robertson, David Trail, The Oaks, Cambridge-park, Twickenham.
Seath, Thomas Bollen, Sunny Oaks, Langbank, and Glasgow.

The paper read was—

A NEW BRIDGE FOR PROVIDING FOR THE TRAFFIC ACROSS THE THAMES BELOW LONDON-BRIDGE.

By Frederic Barnett.

In addressing to you the following observations on a subject at this moment of general interest, I have to crave your indulgence for any technical shortcomings or errors.

I shall endeavour to submit to you my remarks in as condensed a form as possible. Though not indispensable, I beg your permission to trace succinctly the origin of bridges and the order in which they have been introduced. I think they may be divided into five series.

Firstly. The very earliest were trunks of trees thrown across narrow channels. Secondly. Suspension bridges. Thirdly. Bridges supported on arches. Fourthly. Tubular bridges; and Fifthly, girder and trellis bridges.

The first of the series was the most simple, spanning gorges, narrow channels, and brooks; trunks of trees, at first single, later, two or more, and as intelligence advanced on the subject, rude floors of rough hewn wood, placed transversely, were added. Of these primitive bridges we may assume the use in the most remote antiquity. Doubtless the first idea was derived from accidents, a tree felled by storm or lightning.

Of suspension bridges we have authentic accounts of extreme antiquity. They are known to have been in use in Japan, Thibet, and China; while these bridges are literally immemorial among the natives of South America. However, the earliest discovered in Asia were stated to be vastly superior, these being actually furnished with good substantial roads and footway, suspended by metal chains, solidly fixed on the opposite sides of chasms and river shores. The Chinese called them Thie Khiao (iron bridges), also Thie so Khiao (iron chain bridges).

According to Pauthier, one of the most ancient known was constructed between 58 and 76 of the Christian era, during the reign of the Emperor Ming-ti of the Han dynasty.

Though in Europe, during the 15th and 16th centuries, several suspension bridges were projected, the earliest of which we have a positive knowledge is comparatively modern, being established in the year 1741. It was of very modest proportion, in fact, nothing more than a foot-bridge, 65 feet long by about two feet wide, spanning a narrow part of the Tees at Sunderland.

In 1796, in the United States, a similar bridge was constructed, of much bolder proportions, accommodating carriages as well as foot passengers. Amongst the most remarkable suspension bridges now existing in Europe we may quote the one spanning the Menai Straits, uniting the Isle of Anglesey and Carnarvon, it is 550 feet long and 100 feet above the level of the sea; it was constructed by our English engineer Telford.

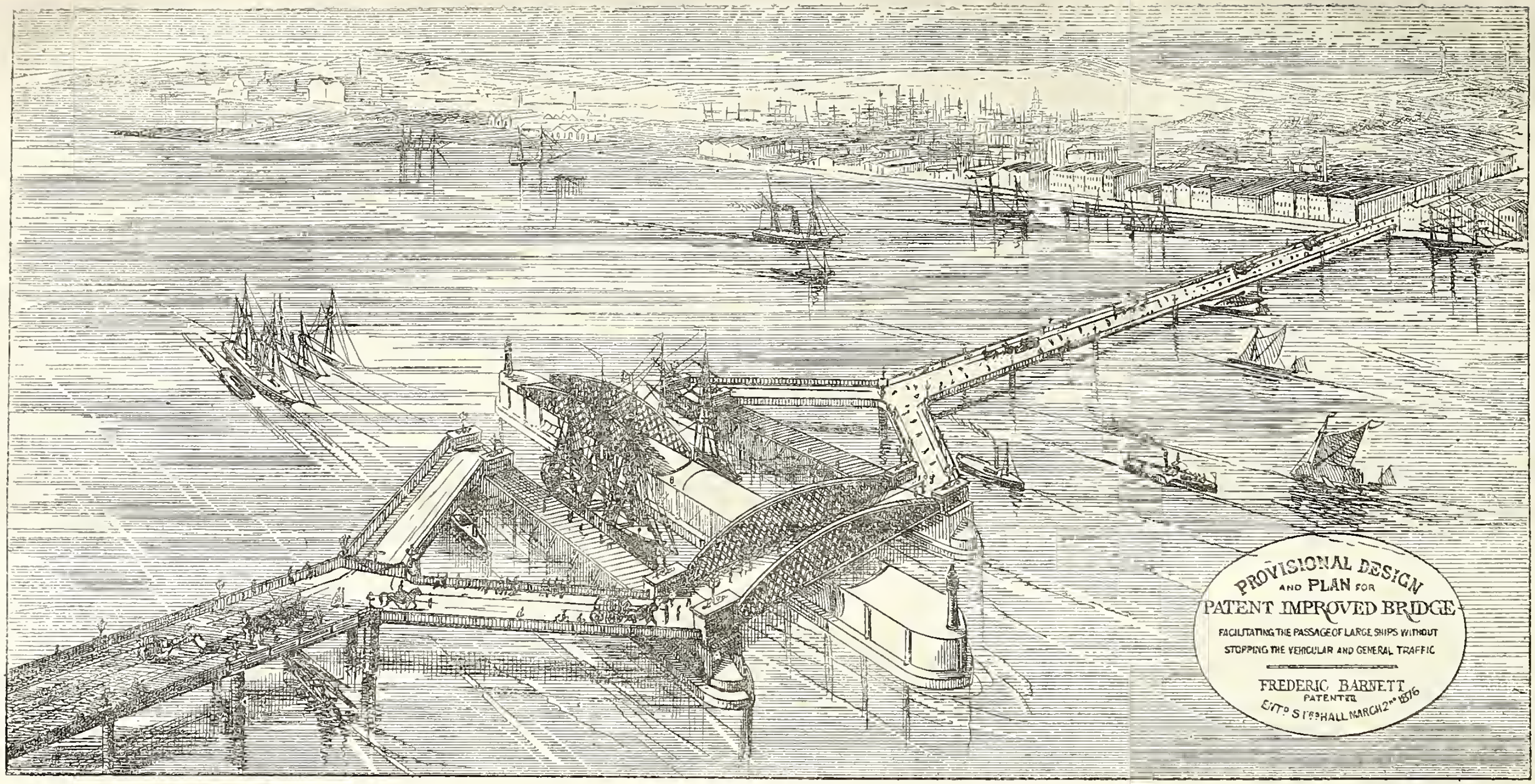
Next in importance is that in France at the Roche Bernard, over the River Vilaine, about 660 feet between the points of suspension, and 100 feet above the highest tide of the river. The author of this bridge was Mons. P. Leblanc, engineer of the Ponts et Chaussées, Paris. There is one still more remarkable at Fribourg, in Switzerland, wiih a single span, nearly 900 feet, constructed by the engineer, Mons. Chaley. There is another yet more important at Cabzue, over the river Dordogne; it exceeds 2,000 feet in length, but is sustained by five piers nearly equidistant.

Although engineers have generally opposed suspension bridges for railways, there is one nearly 800 feet long, crossing the Niagara, just above the Falls. This bridge has two roads, or floors, the upper serving for the railway, the lower vehicles and foot passengers. This unites the Canadian and United States railways.

Of fixed bridges, composed of stone piers and timber roads, Diodorus Siculus makes mention of the first, and this is well authenticated as being built by Semiramis over the Euphrates.

But for entirely arched stone bridges we are indebted to the Romans. It is true some ancient historians speak of Egyptian and Greek entirely stone bridges, which would suggest the idea that if entirely stone, they were constructed with arches. But as it is generally accepted that the arch was unknown to the Greeks, judging by the monuments they have bequeathed us, I think we may assume also that bridges, which they constructed of stone, were not known either to them or the Egyptians. There is abundant proof that the Greeks visited Egypt. It is a traditional fact, commonly known, that Cadmus, of Thebes, returned thence, bringing with him the Greek alphabet, which he copied from the Hebrew characters. You remember that Cadmus is spoken of as the father of letters. Hence, we may be assured, that had the arch been known in Egypt, and been employed in their buildings, it would have been reproduced by such people as the Greeks in their incomparable architecture. It is, however, certain that the Romans have transmitted to us such monuments, and judging from their remains, we have proof positive of the high standard of the ability of their architects, and their perfect mastery of the arch.

In the valley of Narni, Italy, there still exists a Roman bridge composed of a single arch, nearly 100 feet wide, the keystone of which is nearly 150 feet above the river. For ages architects of all countries followed slavishly the the Roman models, adopting alike their perfections and their



faults. In the bridges where the Romans had several arches, those nearest the shore were very small; while the centre one was both larger and much higher to facilitate the passage of the shipping of that period. This resulted in an abrupt rise approaching the middle.

Amongst the most remarkable bridges left us from the Middle Ages is that of the Saint Esprit on the Rhone; it was constructed between 1265 and 1309. From that period little or no improvement occurred in bridge architecture till the 16th century, and even then there was none worth recording till the construction of the Neuilly bridge crossing the Seine. This bridge was built by M. Perronet between 1768 and 1773. It narrowly escaped destruction in the Franco-German war, as I saw it mined to be blown up in the event of the Prussians approaching Paris in 1870. It, however, escaped, and looks as fresh as when first built. It is true, old Westminster-bridge was built between 1734 and 1750 by Labeleye, a few years before, but in architecture and material it was very inferior, surviving little more than a century, and even during a great portion of that period it was under repair. This might, to a certain extent, be attributed to the inexperience of employing Portland stone, a material too perishable to withstand the action of the river. Old Blackfriars was building from 1760 to 1769, and lasted also only a century, having been several

times repaired at great expense. It was built by the engineer Milne, and being also of Portland, met the same fate as that of Westminster, from the same reason.

The magnificent Waterloo-bridge was built of Cornish granite in six years by the great master of the art, Mr. John Rennie, and so scientific is the construction that the New Zealander 1,000 years hence may find it perfect.

Mr. John Rennie also built Southwark-bridge between 1814 and 1819, and then finished the plans for London-bridge. The consideration of the overcrowding, and consequent congestion of this bridge, at the present time, forms the motive and substance of this paper.

It appears that in very remote periods, even before rafts were used for ferries, in various parts of the Thames, there were irregular heaps of stones over which trunks of trees were literally thrown, and so extended as to form foot-bridges of a primitive nature crossing the river, and this was especially the case near the site of old London-bridge. Yet as early as 1008 there appears to have been a bridge, for the Iceland historian, Snorro Sturleson, gives an account of its destruction by King Anlaf of Norway, while assisting King Ethelred against the Danes. This, doubtless, was but a feeble structure of wood, as Anlaf is said to have pulled it down with his ship's cables. It must, however, have been soon rebuilt, as there was a bridge when Canute invaded this country in 1016.

London-bridge is also mentioned in a charter of the Conqueror, which he granted to the monks of Westminster Abbey in the year 1067.

Several historians speak of the almost complete destruction of this bridge on the 16th November, 1091, by a furious south-east wind, which at the same time threw down 600 houses and several churches in the City. After which it was again rebuilt.

By a charter of the 22nd of Henry I., 1122, a grant was made to the monks of Bermondsey of five shillings a year out of the lands pertaining to London-bridge. This small beginning of their endowments of landed property formed the nucleus of what are known as the Bridge-house estates, subsequently so well nursed by the intelligence, zeal, and thrift of the trustees in all succeeding generations, till they have now attained an annual revenue exceeding £50,000.

Stowe informs us that the bridge was entirely rebuilt in 1163, by one Peter of Colechurch, who lived at the south end of Coneyhoop-lane (now Grocers'-alley), on the north side of the Poultry, where stood a chapel distinguished as that in which Thomas à Becket was baptised. That bridge was wholly rebuilt, like its predecessors, of wood.

The bridge was again wholly rebuilt between 1176 and 1209 (33 years, being precisely the same period as was occupied by Sir Christopher Wren in building St. Paul's). This time Peter of Colechurch built the bridge of stone, choosing its site rather more westward. Its architect died in 1205, so that, like his great successor, Mr. John Rennie, he had not the great happiness of seeing his bridge finished. Peter, however, was buried in the chapel of Saint Thomas à Becket, which was erected on the central pier of the bridge.

The old bridge consisted of 20 arches, the roadway was 926 feet long, it was 60 feet in height from the river, and 40 feet wide.

In 1350 there were so many houses built on the new bridge on each side that, but for a few openings, it formed a continuous street, leaving a passage of little over 12 feet for traffic. At the eleventh arch from Southwark there was a drawbridge, serving the double purpose of defence and passage for ships on their way to Queenhithe and other wharves above bridge. The houses on the bridge were, fortunately, frequently burnt down, for the windows at that period were not made to open, and their limited space and interior abominations, antagonistic to health, rendered them hotbeds of fever and disease; and, curiously enough, though situated so as to have abundance of fresh air, at least exteriorwise, still, at that date the Plague, which so constantly visited London, frequently began its ravages on the bridge. This bridge withstood six centuries the attacks of time and tide, and was only removed in 1832. But for nearly 100 years previous it gave evidence of senile decay, and for the greater part of that time, like our poor Temple-bar, it was sustained on crutches.

In 1824 the present magnificent structure of London-bridge was begun, from the designs of Mr. John Rennie, and was carried to a successful completion by his son, Sir John Rennie, for which he received the honour of knighthood from King William the Fourth, who opened the bridge, assisted by Queen Adelaide. When designed by Mr. John Rennie, the proportions of the bridge were ample, with a roadway of 35 feet wide, and its footways of 9 feet. But since then the immensely increased population and commerce of London, chiefly converging on this point, demands increased accommodation, and it is a fact agreed by all, that it is now totally inadequate. However it may be effected, it is, I believe, unanimously agreed that in some manner this state of congestion must be relieved, and that the relief cannot with safety be longer delayed. The average number of vehicles that pass daily over the bridge is 20,000, and over 100,000 foot passengers, nearly the whole of which cross between 7 a.m. and 7 p.m.

The docks send forth daily from thousands of ships their cargoes, in trains of heavily laden waggons, together with the merchandise of the multitude of wharves, and the produce of the various factories, situated chiefly east of London-bridge, carrying from north to south, and south to north, swelling the already almost compact masses, crawling and stopping, and then straining and starting their horses, that have no sooner overcome the inertia of their loads than they are again stopped. I have been assured by important horse contractors that they would prefer their horses going miles further, to the constant stopping and starting occasioned by the crowded state of the bridge.

The vehicles passing during the busy time of the day average 1,700 per hour. I cannot do better than read you the letters addressed to the *Times* on this subject by Mr. William Haywood, the eminent City engineer, than whom few have such opportunities of obtaining reliable statistics, and of whom I may add, without fear of contradic-

tion, that he is a gentleman of approved talent, untiring energy, and to whose progressive ideas we are indebted for most of the great improvements east of Temple-bar.

The City, twenty years since, was one of the dirtiest and most neglected parts of the metropolis; under his influence it has risen, if not from its ashes, at least from its mud; till now it has become a model and example worthy to be copied by all the great cities of the empire. It is significant that during the agitation for the relief of London-bridge, his voice has been raised amongst the loudest, and it appears that for years he has foreseen and warned the authorities of the condition to which we have now arrived.

To the Editor of the "Times."

Sir,—My object in writing you is not to criticise the approved design for widening London-bridge. Tastes differ; and although it is not my taste, there are many engineers, and others not engineers, who think that boiler-plates well painted, and with rivets well gilt, are beautiful objects. All that I have to say on the head of design is, that whether the bridge be widened by wrought or cast iron work, by arches of a different span and different radius from those of the present bridge (the case in the approved design), or by arches of the same span and curvature, or by parapets thrown out on cast or wrought iron canti-levers; in brief, however clever the design may be, if the bridge be widened with a material altogether different in character from that with which the bridge is built, it must and will mutilate and deface the bridge more or less. But there is no necessity for this miserable defacement of a noble structure, there being no engineering difficulty in widening it with granite and stone, so as to leave it externally (excepting near the steps) as its great engineer and architect designed it; and although it may perhaps be cheaper to widen by girded and painted boiler-plates, yet widening it with granite and stone is the only fitting and proper way of dealing with this great national structure.

My object in writing is, however, to say what I stated in the *Times* in 1869, that the widening of the bridge will, for the purpose of easing the carriage traffic, be all but useless; indeed, if the bridge were as wide as Portland-place it would not materially diminish the inconvenience which now ensues from the traffic of the four crowded thoroughfares on the north being condensed into King William-street, between the statue and the bridge, and there meeting with the cross traffic from Arthur-street, East and West, and on the South by the traffic which comes from the Borough, Tooley-street, and the railway station, clashing and crossing as it enters and leaves the bridge.

The stoppages which arise on the bridge itself are trifling, and would be thought so by all, if the police returns quoted by you were not misleading in their headings; the real source of inconvenience arises almost entirely at the spots named by me.

The width of the carriage-way of London-bridge between the footways is 35 feet, that of King William-street 45 feet, is largely occupied by the vehicles stopping at the various premises, and practically, the channel for the through traffic is about the same width as it is on the bridge; and, although this channel is undoubtedly throughout its entire length too narrow for the convenience of the traffic, it cannot be relieved by widening the bridge, unless at the same time the whole of the approaches, from St. George's Church, in the Borough, through the length of Gracechurch-street and Bishopsgate-street Within, as far as to Wormwood-street, are widened at the same time and considerably. I however hold, and have treated fully of it in a report which I had the honour to submit to the Corporation (1869), that nothing but a new bridge, with proper approaches, lower down the river, will provide for the present and rapidly-growing traffic—a traffic which augments to the east of the bridge more quickly than in any other part of London. At the present time, more than one-third of the whole population is to the east of London-bridge, and it is its traffic which crowds the bridge and approaches, and needs a new highway across the river. Much of this eastern traffic comes from long distances on either side of the river for the purpose of crossing London-bridge; I should say that quite 8,000 vehicles daily would use a bridge lower down the river, and to that extent would immediately relieve London-bridge; and for want of such new bridge, there must be some millions of miles of horse journey made annually which might be saved. It is, indeed, surprising that this million of people have not before this aroused themselves to demand of the authorities a more convenient means of crossing the river. These opinions have not been formed without full consideration of the difficulties in the way of a new bridge; it will undoubtedly be costly—very costly—it will interfere with trade interests to a large extent, but not destroy them; it may threaten other interests, for which money may not be thought a compensation. But no smaller scheme will be of the slightest value so long as the population is distributed in London as it now is. All money spent in widening London-bridge, in patching up or temporising, will be money thrown away. Sooner or later a new bridge must be built, whatever be its cost, although I have but little hope of its being undertaken until that cost will be more than double what it would be if set about now.

I remain, Sir, your obedient servant,
(Signed) William Haywood.

London, September 18th, 1875.

To the Editor of the "Times," 5th October, 1875.

Sir,—I beg your permission to add a few words more t my former letter on this very important subject.

As to widening, all I desire to say is that, supposing the foundations to be as described on the 24th ult. in your columns, no one can doubt that engineering skill could widen the bridge in masonry, leaving it externally as it now looks, and making a good job in doing the work.

The utility of widening at all is, however, the important question. I said in my letter that one-fourth of the population was to the east of the bridge. From investigations since made, I believe there must be a million and a quarter, or something like one-third of the metropolitan population, to the east of it, and such is the rate of increase that if the consideration of a new bridge and approaches were now seriously entered on, that eastern population would be a million and a half before the work could be completed. In fact, the increase of population has filled up the traffic on the bridge as fast as reliefs, of which there have been several during the past 20 years, have been afforded, and it must continue to be so until permanent means of relief are given to it by a work based on considerations of the causes which generate the traffic.

But what will be the immediate effect upon the carriage traffic of widening? I have said that the impediments do not occur on the bridge itself, but at the ends of the bridge, owing to the crossing and clashing of the traffic as it seeks or leaves the adjacent streets. This is the case with four lines of traffic, and if increased to six—three going north and three going south—the effect will be a still greater clashing and greater hindrances than there are now, and it will result in policemen being stationed at the ends of the bridge, who will alternately stop and allow to go on for short periods of time separate lines of vehicles in succession; they will in fact, practically be obliged to reduce the six lines of traffic to the four which now exist.

The relief of the pedestrian traffic may be urged as a reason for widening. Now, the foot traffic is, undoubtedly, large, and for three or four hours daily is inconveniently crowded; yet it rarely jostles, it is never congested, it never actually stops, it is never endangered; it simply has at places and times to move somewhat more slowly than in less crowded thoroughfares, but, fortunately, it can be relieved. During my official life I have had to adjust the widths of the carriageways and footpaths of nearly every street in the City, and I say that, without interfering with the convenience of the carriage traffic, the footways of the bridge can be widened and more convenience be given to pedestrians, although, of course, a new highway across the river to the east will best relieve the foot as it would the carriage traffic.

And this brings me to a point which I have not yet referred to. On the south, Tooley-street and other thoroughfares, and on the north Eastcheap, Great Tower-street, and Fenchurch-street, are burdened with both foot and carriage traffic, which would be diverted by a new bridge lower down the river, and it is worthy of notice that while this million

and a quarter of people to the east have near to them but one bridge across the Thames, there are eleven bridges, counting Hungerford foot-bridge, for the remaining two and a half millions of the metropolitan population. Yet to this eastern part belongs most of the great commerce by which the metropolis thrives.

The more consideration is given to the subject, therefore, the more it becomes evident that the widening the bridge will be useless, and worse than useless—it will not relieve the present traffic, it will not provide for increase of traffic. But, unfortunately, it might for a time quiet those most interested in the question by the belief that, something being done, it would be necessary to wait to see the effect of it, and thus divert them from addressing themselves speedily to the great want of a new highway across the Tames lower down the river.

I remain, Sir, your obedient servant,

William Haywood.

London, Oct. 4.

Like comets in their perihelion, the nearer they approach their destination, so with the vexed question of the relief of London-bridge; the greater the need, the greater the agitation, and the amount of public attention directed to this end. The result has been a number of scientific suggestions.

The first has been the proposition to absorb the whole width of the bridge, including the foot-paths for the carriage traffic, providing for the foot-passengers by the projection of wrought or cast iron balconies on each side the bridge, on cantilevers or otherwise.

With a similar intention of giving the whole surface of the bridge to vehicular traffic, there is another project by which the provision for the foot-passengers is to be obtained by sinking a part of the middle of the road. A few feet above this is to be raised, supported on columns, a roadway platform, over which the light vehicles are to pass over the heads of the pedestrians. The heavy traffic to continue at the present levels, but working to the parapets. The entrance for the foot-passengers is to be from the present stairs, through galleries or short tunnels.

There is another plan to build galleries on each side of the bridge, standing clear of it. These galleries are to support rows of shops having ample footways. The system will give the bridge wholly to vehicles.

The first of these projects gave rise to enquiry, and it was found no alteration could be made in the bridge without a special power from Parliament.

It will have been observed in the letters read of Mr. Haywood, that supposing London-bridge surface to be so enlarged, it would not locally afford the relief demanded by the million and a quarter inhabitants below bridge. That provision must be made for 8,000 vehicles that come west to cross London-bridge, and which could cross a bridge lower down the river, and that, by such means only as fresh facilities for crossing the river can the present plethora be relieved. Four projects to effect this purpose are proposed.

The first is the steam ferry now in progress of execution. Secondly, a high level bridge with lifts. Thirdly, a new tunnel under the Thames. Fourthly, a low level bridge to be built in any part of the Thames, permitting a passage to the largest ships with masts 100 feet high, without interrupting for one minute the vehicular and general traffic. First, respecting the steam ferry, I can adduce what is a very general opinion, that its action will be slow and insufficient to afford any serious relief, as it can only take over twelve waggons at each crossing, including raising and lowering, or *vice versa*, to suit the rise and fall of the tide. Each operation will occupy about 15 minutes, say 50 vehicles an hour; but at the present time, according to Mr. Haywood's statistics, provision must be made for about 700 an hour during the business time, without entering into the calculation of the more than probable increase contingent on the facilities of new means of crossing would foster. To meet this emergency, it is suggested to increase the number of ferries, which to be effective, must be at least half-a-dozen. Supposing then that capital be obtained, new and other approaches would be indispensable. These ferries would require several approaches, while a bridge would only need one on each side the river. Then again, might not an increased number of these important ferries, measuring each 100 feet long by 50 beam, encumber the already overcrowded river?

In consequence of the rise and fall of the tide—a difference of sometimes 10 to 20 feet—all the waggons and horses must be raised or lowered, and then raised again by means of hydraulic lifts or other methods. Is it not just possible there may be some prejudice amongst the owners of valuable horses against such a process?

Again, I apprehend that should there continue but the one ferry, there might be much crowding by those who had overcome their prejudice against the lifts, and in such a case it is probable the overcrowding might be inconvenietly great at the approaches while awaiting their turn to embark?

The second project is a high level bridge to be built east of London-bridge about 80 feet high, that is nearly half as high as the monument, under which ships of the largest size are to pass at high tide. I am told the masts of some ships are nearly 100 feet high, if so, the bridge would have to be over 100 feet above high water. However, assuming the 80 feet would be enough for vessels; to rise that height by ordinary approaches at moderate gradients they must extend long distances from each shore, perhaps about three-quarters of a mile on each side the bridge. This would necessitate a long journey. To overcome this difficulty, it is proposed to elevate the waggons, horses, and passengers by means of hydraulic lifts. This at best must necessarily prove a slow process, and I venture to doubt its being equal to elevate more than about 700 vehicles per hour, working both sides. Nor do I think people engaged in business would like the mounting on one side and descending on the other; and I am inclined to think, from opinions I have heard from horse contractors, that they would hesitate to send their teams aloft.

The third project is a tunnel or subway to pass under the Thames, of a sufficient magnitude for the required number of vehicles and passengers.

It is patent to all Englishmen, and I might add to all the world, that such a one we have, the stupendous work of the late talented engineer, Isambard Brunel, who carried it to a successful termination. It was commenced in March, 1825, and the middle of the river was gained in January, 1828. From that period a number of irruptious of the river delayed the work, and it was only on the 13th August, 1841, that Sir Isambard Brunel passed down the shaft on the Wapping side of the river, and thence through the Tunnel for the first time to Rother-

hithe, having occupied a period of 16 years building. The boring was begun from the Rotherhithe side.

The tunnel was subsequently finished, but none but foot passengers passed through. They descended 60 feet, by a shaft of 50 feet diameter. Had the shafts for waggons been completed (though never begun) according to the original plan, they would have been much further from the river than the passenger shafts, and have consisted of immense spiral roads, winding twice round a circular excavation about 60 feet deep. The extreme diameter of the spiral roads would have been 200 feet, and the roads 40 feet wide.

This tunnel was projected and carried out for the same purpose as that now proposed; but, after the expenditure of nearly half a million sterling, the establishment of the waggon roads—which would have required the outlay of a further important sum—was hopelessly abandoned.

After the opening of the tunnel many foot passengers, from all parts of the world, passed through from curiosity, as people go to the Tower and other London sights; but few repeated the descent and ascent of 65 feet, the numbers dwindling till, at last, for years the tunnel was unused and unproductive.

If approaches other than by shafts are to be made to the new tunnel or subway at 65 feet deep—at a gradient of 1 in 50—the approaches must extend inland nearly 6 furlongs on the side of Rotherhithe, and rather more on the north side, making together a difficult mile and a half in the dark or gas-lighted tunnel, unless lifts are employed; and, if so, they will have to contend with similar difficulties and delays as I have endeavoured to explain respecting the ferries and high-level bridge.

I do not dogmatically urge these objections, but as the opinion of many persons of good understanding, and, what is more conclusive, apparently supported by experience.

Where, then, are the elements of success to be reckoned on more in a new than in Brunel's tunnel? Its situation was admirably selected, because of the general goods traffic required in that locality; there was then, as now, the great demand for transit of large portions of the cargoes from the East and West Indian Docks and others, and from the wharves from the north side of the river, such large portions of the ships' cargoes being conveyed by waggons to the south side, which now toil long miles to London-bridge, to return often the same distance on the south side.

Why was not the waggon-descent finished to the first tunnel? I suppose, because it was the opinion that the owners of horses would not use it. If such was the reason then, on what ground are we to assume the same feeling may not still prevail? Brunel's tunnel was purchased some years since by a railway company to connect the lines north and south of the Thames. But the tunnel still seems to exert its paralysing influence, as by the rate of their progress to that terminus, it is doubtful their reaching their goal till the 20th century. Recurring again to London-bridge, as I said before, the cattle are fearfully worn by the constant starts and stoppages, and there are no hopes of amelioration until measures are adopted to relieve the traffic, which daily becomes more embarrassing.

I now come to the fourth project, my own. A bridge that may be built in any part of the Thames with easier gradients than any bridge over the river, but allowing through any part a clear passage for barges, steamers, and other craft, yet with the exceptional provision and capacity to allow large ships with the highest masts to pass through up to London-bridge, without stopping for one second the vehicular and passenger traffic. My patent bridge, as is seen in the drawing, has but one approach from each shore. When these approaches have extended into the river about one-third its width, the roadway splits into two roads, each the same width as the approaches, by easy inclined angles, outwardly extending till they meet midway, thus forming a sort of angular oval or loop, in the largest diameter. I have on each side two openings, practically covered and united by platforms, turning on their centres, each opening or closing by one operation. These openings permit the entrance on the port side of the largest ships that come up the Thames; there is also a sufficient width allowed for the length of the ships within the loop. From the central piers on which the turntables work, there is extended a platform uniting the two extremes, so that this platform lies with the axis of the river, dividing the loop into halves, furnishing the means of mooring the ship a few minutes alongside by mooring blocks. There are two other platforms running parallel to the chief platform, which keep the ships straight on their road. The vessels return on the opposite, still going port; thus, all risk of collision is avoided. The platform will have narrow lighters, rising and falling with the tide, thus protecting both piers and vessels from injury. As soon as a vessel is about to enter the loop, the roadway on the side by which it is to enter is closed, and the vehicular and general traffic, by closing the gates (when the roads divide), is diverted to the opposite side; then immediately the turntable-bridge is opened, and the vessel enters the loop, so that when it is fairly in, the bridge is closed behind it, and, as before described, the traffic is diverted on the road behind the ship, and the opposite turntable-bridge is opened, suffering the ship to pass out on its way. By these means the traffic will suffer neither delay or inconvenience, the vehicles and general traffic will pass imperceptibly from one side of the loop to the other. Neither frost or fog will prevent the traffic across the river, which must inevitably occur with the ferries.

London-bridge, acknowledged by all nations as one of the noblest in the world, need not be desecrated by extraneous additions, during his life strenuously opposed by Sir John Rennie; but this noble monument should be left unimpaired to fulfil its mission to ages yet unborn.

This bridge can be built in any part of the river without interfering or injuring the immensely valuable wharf property that covers its shores. It would avoid the loss of valuable time, and the wear of horses and vehicles travelling daily and unprofitably in the aggregate thousands of miles to reach London-bridge, and often returning on the opposite side the same distance to reach their destination.

It is certain that a low level bridge must shortly be built below bridge. It is also evident that an

ordinary one must stop the passage of big ships on their way to the wharves. This would ruin the wharves between it and London-bridge, in which case I am assured that either the City or the Metropolitan Board of Works would have to pay as compensation over three millions sterling.

The adoption of my patent bridge will obviate the necessity of giving one farthing compensation. On the contrary, the land required for the approaches to the new bridge at its present value could be bought at such a price as would quadruple itself by the time the bridge was built.

On the improved locality great warehouses and factories would rapidly spring into existence, and yield such profits as would more than likely recoup the whole temporary outlay.

Some enthusiastic residents in the neighbourhood of London-bridge regard with dismay the building of the bridge, tunnel, or any means that would diminish the plethora of London-bridge, apprehensive that such measures would diminish the commerce of those favoured precincts. This, of course, is a narrow and selfish view, that thousands shall suffer loss and inconvenience for the advantage of a lesser number, were it even so. But there need be little fear that facilities given to a million and a quarter will rival the great centre while it contains the Bank of England and the other banks; while it contains the Royal Exchange, the Stock Exchange, the Post-office, the head quarters of the docks, the Guildhall, and all the public offices, so many wholesale warehouses, the Corn Exchange, the wool markets, the termini of nearly a dozen railways, and the accumulated wealth of the most important wholesale and retail traders. These great elements of commerce converging to the great centre will rather be benefited than injured by a little more breathing room.

How can it be shown that thousands of drays and waggons crawling laboriously to and from London-bridge can improve the City trade or wealth other than by the absorption of a few hundred pots of beer by thirsty drivers? These vehicles in their transit through a crowded locality utterly prevent the wealthy risking their equipages under such dangerous conditions. The departure of these heavy carrying waggons, diverted into other channels, would greatly benefit the City, as well as being an act of justice, because of the great population east of London-bridge.

The time is probably not far distant when the greater part of the great streets in the City will be filled with wholesale warehouses, whose merchandise will still further encumber the roads, judging by the increased and increasing value of land in the City, every foot of which is fiercely competed for, as evidenced by the old churches which are being removed for available space.

City trades have nothing to fear from the relief of London-bridge, which must bring in its train a certain relief to all the great streets in its immediate neighbourhood. There can scarcely be a greater error in judgment than the assumption that crowding encumbrance and congestion of the public way can be conducive to trade, especially as so large a portion of that traffic is simply wares and produce in transit.

Should my patent bridge be adopted, I should propose that it be either a girder or trellis bridge, with three granite tiers on each side, on which the moveable roads should work.

Either girder or trellis bridges possess great advantages; firstly, by occupying so small a part of the stream by the columns that carry the roadway; secondly, by their costing such an inferior outlay; and, lastly, by their rapidity of construction.

I have little doubt such a bridge could be opened for traffic in less than two years from its commencement.

DISCUSSION.

Mr. F. W. Campin said he argued, as he had lately done in the Guildhall, against any scheme of this kind on the *cui bono* principle. Living on the south side of the Thames, he was constantly passing over London-bridge, and he could not see that the bridge was so choked with traffic, thanks no doubt to the admirable police arrangements. He did not see, therefore, the necessity for widening London-bridge, though at some future day it might be needful to have a wider pathway. They could not expect to walk as freely in the heart of the City as in outlying districts, as some people seemed to imagine. He was not enough of an engineer to judge of the merits of this particular scheme, but every one could see that if a large number of ships had to pass it there would be great difficulties in the constant use of a swing-bridge, but certainly if more accommodation was needed it would be better to have a new one than to attempt to tamper with London-bridge, and destroy its architectural and engineering character. He could not, however, see that a necessity had been proved for a bridge lower down.

Mr. C. E. Parker Rhodes could not agree with the last speaker that the crossing of London-bridge was such an easy matter. For the last five years he had had to be crossing it continually, and every time he did so he could not but think how unfortunate it was that such a noble structure should be so inefficient for the requirements of the traffic. He quite agreed with the general opinion that the bridge should not be tampered with, as it was perfectly unique in character, and probably would remain so, iron being now so largely used. The traffic over London-bridge was increasing daily, almost hourly, and but for the assistance of the police, there would be a constant block, so that it was necessary something should be done. He was not prepared to say how far the plan which had now been brought forward would prove practicable, but it had many advantages, and no doubt could be carried out. He had been led to consider what could be done to relieve the traffic on London-bridge itself, and had devised a scheme, the drawing of which was on the table, for narrowing the present footways to 4 feet 6 inches, half their present width, and erecting over each a light iron structure of the same dimensions, so as to give the same accommodation as at present; but he proposed that all the traffic from south to north should pass over the upper pathways, and all that from north to south on the present level, by which means all jostling would be avoided, and the addition of 9 feet to the roadway would greatly improve the facilities for carriage traffic, and prevent the necessity for widening the approaches, a matter, which if done at all, would involve enormous outlay. The advantage of this plan would be that if at any time another bridge were built, the galleries could be removed, and the bridge restored to its present appearance. This would not be so if any additions were made outside it, which he feared would affect the structure and masonry.

Mr. John Jones said the plan suggested by Mr. Barnett looked in the sketch something like a bridge of boats, such as could be seen on the Rhine, but it had one advantage over such a structure, in the alternative road to be opened while vessels were passing. He did

not see why more than one opening should not be provided if necessary. Before, however, any new bridge were constructed, he thought it would be well to open all the existing ones free, and he believed that if the toll were removed from Waterloo-bridge a great number of omnibuses which now passed over London-bridge would go by that route and along Stamford-street, reaching London-bridge Railway station more quickly than they did at present, and giving a great deal of accommodation to the thousands of people living eastward of Waterloo-bridge. It was rather a curious coincidence that just before this outcry was made about widening London-bridge an application was made to the Metropolitan Board of Works suggesting that the surplus funds of the Bridge-house Estates should be applied to the freeing of Waterloo-bridge, but the members of the Board who represented the City of London then stated that no such surplus existed. On looking over the annual accounts, however, presented by the Chamberlain, it appeared that there was a surplus of £20,000, and within a month after the memorial he had mentioned, there came a reference from the Common Council of the City to the Bridge-house Estates Committee to provide a measure for widening London-bridge out of the funds at their disposal. It would be quite legitimate to argue that the funds of the Bridge-house Estates should be applied only within the City, if they had been provided by the City, but such was not the case; they were national property, put in trust for the City of London to take care of, and apply to the care and management of the bridges across the Thames. They were originally raised by a subsidy, very much the same thing as an income-tax, over the whole kingdom, and the clergy in convocation had to subscribe to it. The Crown had also given lands for the same purpose, and placed the management in the hands of the commonalty, to elect bridge-masters, who, he regretted to say, had been turned out of their office, and the Common Council had seized on the management. The Strand district, in which he resided, claimed that these funds, being national property, should not be applied to the widening of London-bridge, but to the freeing of that at Waterloo, especially seeing that 2½ millions lived in districts which would be benefited thereby; while Mr. Haywood only claimed 1¼ millions as the number that would be accommodated by London-bridge. At any rate, he contended it would be unwise to spend money on new bridges, or widening old ones, until it was seen what the effect on the traffic would be of freeing all those which were now subject to toll. He would also suggest that a great relief to the traffic might be obtained by a police regulation, requiring all heavy traffic between certain hours to pass at a trotting pace; this would enable twice the amount to pass in the same time, and would therefore relieve the streets.

Mr. C. M. Tate, though he had been much pleased with the paper, thought the two arms suggested would occupy a great deal of space, and, considering the width of the river, he feared that would be a fatal objection. He thought, if any additional communication were needed, it should be by such a means as would not interfere in any way with the traffic on the river. Ferries were in use in some places, but they were not suited to the crowded navigation of the Thames, and the only other means was a tunnel. He begged, therefore, to draw attention to a plan patented by Mr. Raynor, drawings of which were on the table, for constructing such a tunnel by means of a tube made in watertight sections.

Mr. Usill, C.E., said his name was connected with a scheme which had been brought before Parliament for increasing the accommodation of London-bridge by means of an arcade on each side, but he was not responsible for it except to the extent of having prepared the plans for a gentleman in the City, who conceived the idea as the best mode of overcoming the difficulty. This, however, had led him to pay a great deal of attention to the subject, and he agreed with a previous speaker that the deficiency was not so much in the bridge itself as in the approaches, and he thought no expense should be incurred for widening the bridge before it had been very carefully considered whether it was really necessary. He was of opinion that the freeing of Waterloo-bridge would greatly relieve the traffic at London-bridge, and the whole eastern part of the metropolis. London-bridge was crowded because the various thoroughfares on the south side converged on an incline, and the traffic consequently became stagnated, but he could not admit for a moment that the bridge itself was inadequate to the requirements of the present day. It was no fault of Sir John Rennie that the owners of property on either side did not afford facilities for the traffic to get on to the bridge. He should much regret to see any such plan as that proposed by Mr. Rhodes adopted, as it would disfigure the bridge and fall short of the object in view; indeed he hoped no addition would be made to the bridge at all. Objections to a high level bridge had been mentioned, but he had been connected with a projected railway in the north, where the Board of Trade had fixed the height of a bridge across the Dee at 83 feet. A subway would no doubt be practicable from an engineering point of view, but he feared there would be great difficulty in getting the public to support it. One point must be borne in mind in considering any scheme for widening London-bridge, viz., that it was already loaded to its full extent, and that the foundation would not bear any additional weight. If left as it was it would stand for centuries, but an attempt to widen it by putting an additional load upon it might lead to disastrous results. Another objection to Mr. Rhodes' plan was that the public would not go up and down stairs if they could avoid it; when railway companies had been to great expense in providing bridge-crossings at railway stations, the public would rather take the risk of being run over by a train than make use of them, if they could escape the vigilance of the company's servants, and what might be expected, therefore, at a place like London-bridge, where hundreds of thousands were crossing every day? He believed the present overcrowding might be considerably relieved by police regulations, sending some of the traffic round by Blackfriars, Waterloo, or Southwark bridges. As he had already said, he had drawn plans for constructing a light suspension bridge, on either side for foot passengers, but after calm consideration he had come to the conclusion that there were grave objections to it, and he had not, therefore, brought it before the public. Though only a young engineer himself, he must compliment Mr. Barnett on the ability displayed in the scheme he had brought forward, and for this he was no doubt entitled to the full credit, though it would be unjust to a friend of his own, not to say that some eight or ten months ago he showed him a scheme very similar to it. Constructively, such a plan could easily be carried out, but the navigation of the river must be considered, and he was not quite sure that the piers on which the swing-bridges turned would not offer more obstruction to the tidal flow than was desirable. From some experience in tidal rivers, he thought the tendency at the present time was rather to remove obstructions than to increase them in tidal rivers; and not long ago he knew that it had been stated on authority with regard to a navigable river in the eastern counties, that even a small barge moored in the centre of the stream would cause such an obstruction to the tide as to lead in time to a silting up of the river. One of the great objects of the Thames Embankment was to improve the flow of the water, and he feared that such a bridge as Mr. Barnett proposed would tend in some degree to counteract the advantages gained therefrom.

Mr. Saywell said he was interested in this question as one of the ratepayers who had to find the money for anything of the kind, and considering the great weight

of local taxation at present, that was a very important point. He cordially endorsed all that had been said by Mr. Jones with reference to Waterloo-bridge, and would also include the others higher up on which a toll was still maintained. Before the erection of any new bridge was sanctioned, they ought to see what would be the effect of freeing those already existing, and that they should be freed by some tax which was thrown on the whole of the persons likely to be benefited, not simply on the ratepayers of the metropolis. He had not observed such a great amount of obstruction on London-bridge, especially since the opening of Cannon-street station, and as had been said, the difficulty was not so much in the bridge itself as in the approaches. If any new one were required, it should certainly be placed some distance down the river, say at Deptford, where it would, no doubt, be a great relief to the local traffic. He did not think any great advantage would arise from an additional one near the Tower, or within the City boundaries. Being one of the auditors who signed the balance-sheet presented by the City Chamberlain, he could confirm what Mr. Jones had said as to there being a surplus of £20,000, and could not understand how anyone could deny it, at any rate, without impugning the honesty of the City Chamberlain.

Capt. Townshend, R.N., wished to put one or two questions from a seaman's point of view, with regard to the working of the proposed bridge. In the first place, had any estimate been made of the amount of traffic likely to pass through the bridge, which would, of course, depend in great measure on the position in which it was placed? If it were put below the docks, the traffic would be so great as to cause much difficulty, he feared, but if it were near the Tower it would only affect vessels coming up to that part of the river, between there and London-bridge. Again, how long would it take a vessel to pass through what he might call the locks? If it were still water there would be no great difficulty in that, but seeing that the tide in the Thames ran about 4 knots an hour, and that in order to get steerage way, a vessel would require to go 6 knots with the tide, it would be rather awkward. Going against the tide it would be comparatively easy, but with the tide his impression was, that the only safe way would be to swing round and go through stern foremost, steaming against the tide, and so getting a fair steerage way through the water, but not really moving forward over the ground, or there would be a great danger of going smash against the second bridge. Then the time required to go through must be estimated, and the number of vessels requiring to pass, in order to see if there would be sufficient accommodation. He could not tell what effect the piers would have on the tidal flow, but if that were not important, there might be more than one bridge made, if necessary, to accommodate the traffic. It was a very ingenious plan; and if it were not open to any of the objections he had suggested, it would solve a problem, which often appeared a difficult one, where there was a great deal of traffic.

Mr. Monson thought it would be a good plan to cut off the tide altogether where the bridge was constructed. Two great questions were now occupying the attention of the people of London; one the prevention of floods, and the other additional bridge accommodation. Floods would be prevented, first, by preventing the tide going up; and, secondly, by preventing the upland water coming down. If gates were made, the tide was cut off, and this would prevent a flood going up, while reservoirs could be constructed to contain the water which came down. The scheme was very ingenious, and he did not see why the difficulties which had been mentioned might not be overcome.

The Chairman said it might be taken for granted that some relief was required for the traffic over London-bridge, and it was doubtful whether that would be sufficiently provided for by adopting Mr. Rhodes' proposal, which no doubt was a very reasonable one. But even if it did to some extent relieve London-bridge, it would not give that facility for communication between the two shores below London-bridge which was necessary at the present time. There was a great deal of intercourse now going on between north and south, and it would be much increased by some such scheme as that put forward. Whether that was the best mode of doing it was a question for further consideration, and there was no doubt that not only the traffic over the bridge but also that under it must be considered. That amount of traffic would depend upon where the bridge was placed; if it were as low down as Deptford the whole of the traffic to the docks and the Pool must be provided for, but if it were higher up it would be much less. Still there were all the vessels coming up to Billingsgate, and the continental steamers which lay just below London-bridge. Another objection was the obstruction to the tidal flow, which was very important. He had no doubt Mr. Barnett would be able to reply to some of these questions, and he would conclude by proposing a vote of thanks to that gentleman for the able manner in which he had brought this important subject forward.

The vote of thanks having been carried,

Mr. Barnett, in reply, said he believed the general feeling was in favour of putting the bridge somewhere beyond the Tower, in which case there would not be very much traffic under it, and it might also be left open after about one o'clock in the morning, which would accommodate to a great extent the vessels coming to Billingsgate. He had been assured by a shipowner that the number of vessels requiring to pass the bridge would not exceed six in the day, which would be at the rate of one in four hours. Probably the time occupied by each vessel would be about five minutes, and he did not see the necessity for their going through when the tide was running at the strongest. The tide might sometimes run four miles an hour, but just at the turn there was hardly any stream at all, and seeing that the bridge could not be built by Aladdin's lamp, but would take probably two years in construction, there would be plenty of time for pilots to become acquainted with it, and for a code of signals to be arranged, so that they might time their arrival when the tide was most favourable. Several gentlemen had spoken about the balance in the hands of the Bridge-house Estates committee, and applying it to free Waterloo-bridge, to which he saw no objection whatever, but that would not in the least degree meet the requirements of the east-end of London. He believed it had always been found that great towns were built at first at the upper end of a stream, and gradually extended towards the sea; such was the case alike with modern and ancient cities. The land lower down was less expensive, which induced people to establish wharves and factories, and this had been notably the case in London, the wharves being gradually extended further and further down. As this went on, means of communication were required; they did not want to cross at London-bridge, still less at Waterloo, but lower down. Mr. Haywood said they must provide for 8,000 vehicles to the east of London-bridge, and how could that be done at Waterloo? At the same time, he had no objection to money being appropriated for that purpose. It remained to be seen whether the City authorities or the Metropolitan Board of Works would take up his scheme; but, if they would not, he was in communication with persons who had applied to him, and were willing to undertake it, but in that case it would be a toll-bridge. Some of the very highest authorities were satisfied it would pay well as a speculation, and a very influential house had applied to him to put it into their hands, but he could not do so

until he saw whether the public authorities contemplated opening a free bridge. He did not think the loop could well be made less than 400 feet in length, but the piers would be very useful as landing stages for steamers, especially when the new street which was now being constructed from Shoreditch to Oxford-street was completed. A great deal of traffic would then be taken off from Cheapside, Tower-street, and Eastcheap, as well as London-bridge. The land in the neighbourhood of the bridge approaches could now be purchased very cheaply, there being only a very poor class of property upon it, but in a very few years it would increase in value tenfold; so that the bridge, which would not cost more than from £200,000 to £250,000, would be more than paid for.

MISCELLANEOUS.

NATIONAL TRAINING SCHOOL FOR COOKERY.

A deputation from this school waited upon the Lord President of the Privy Council (the Duke of Richmond) and the Vice-President (Lord Sandon) on the 9th inst., to submit the claims of the institution to Government assistance and support.

The deputation consisted of the Chairman (the Hon. E. F. Leveson Gower), and the following members of the Executive Committee:—Earl Sydney, G.C.B., the Viscount Barrington, M.P., Sir Daniel Cooper, Bart., Sir Henry Cole, K.C.B., Colonel Baring, Colonel Du Cane, C.B., C. J. Freake, Esq., J. MacGregor, Esq., M.A.

The Chairman read the following memorandum on the history and progress of the school during the last three years, and the work that it had effected, together with suggestions in which Government might consistently with precedent give its support to the movement.

1. The National Training School for Cookery, arising out of the lectures given by the authority of Her Majesty's Commissioners for the International Exhibitions, was founded in July, 1873, at a meeting held at Grosvenor-house, presided over by the Duke of Westminster, K.G., who has since acted as President, whilst the Executive Committee has consisted of the Hon. E. F. Leveson Gower, M.P., Chairman; the Duke of Beaufort, K.G.; Earl Sydney, K.C.B.; the Viscount Barrington, M.P.; Sir Daniel Cooper, Bart.; Sir Henry Cole, K.C.B.; Colonel C. Baring; J. Bateman, Esq., F.R.S.; Lieut.-Col. E. F. Du Cane, C.B., R.E.; C. J. Freake, Esq.; and J. MacGregor, Esq., M.A.

2. During the last three years the school has been supported by means of donations, annual subscriptions, the fees of students, and a system like that of schools of science and art under Government has been matured, by which instruction in cookery is afforded to all classes, but especially to those who seek to be teachers. This instruction is given by lectures and demonstrations, and by actual practice in kitchens. Examinations are held and diplomas given; the system may be ascertained from the papers appended to this memorandum.

3. Slowly, and by degrees, teachers are being trained who are readily employed throughout the country. The London School Board has already two, and will shortly have four centres of instruction, the children taught being selected from many schools. Whiteland's Training College has a teacher. Schools for cookery have been established in Edinburgh, Glasgow, Leeds, Liverpool, Oxford, Leamington, Shrewsbury, &c.; whilst Bristol, Birmingham, Rugby, Milford, Wycombe, &c., are urgently wanting teachers. But the action scarcely touches the elementary schools under inspection.

4. This training school is now in such national demand that it cannot properly extend its great usefulness and respond to the public wants without much more assistance than it can hope to obtain from such private means as limited donations, subscriptions, and fees. The executive committee feel that the time has arrived when they are justified in asking that it may be recognised by the State. They do this with all the more confidence as it is only through a school like this for the training of teachers that the wise introduction into the Revised Code, of cookery as a branch of domestic economy can be developed as the Government must have intended.

5. The executive committee therefore ask that her Majesty's Government will encourage the creation of trained teachers of cookery by sending annually scholars to be properly trained, say ten from each of the female training schools. This course would exactly agree with the practice of the National Training Schools for Art and Science at South Kensington under the care of the Government, which has proved to be so popular and beneficial.

6. The school at present is carried on in an unsuitable iron shed kindly granted rent free by H.M. Commissioners for the Exhibition of 1851, but is cramped in its development, and it would be consistent with Government action and precedent if a building grant were made towards providing better premises.

7. The executive committee venture further to submit their opinion that the extension of a knowledge of cookery would be promoted if instead of the annual grant of 4s. now offered in the Revised Code for food and clothing combined, the grant were divided into two equal parts, 2s. for each subject; that a special qualified inspector should be appointed to look to the interests of cookery as is done for music; that H.M. inspectors generally should be instructed to look kindly on instruction in cookery, and that the apparatus necessary for cookery in the dwellings of the labouring poor should be exhibited as part of the educational division of the South Kensington Museum.

8. In conclusion, the executive committee believe that nothing would tend to impress the benefits of education on the minds of parents in the labouring classes more than instruction in cookery, a knowledge of which children would carry into their homes and apply it direct to the benefit of the whole family.

Mr. J. MacGregor, a member of the School Board for London, said that two centres for instruction in cookery had been already established by the School Board—the one at Chalton-street, Somers-town, the other at Blackheath—and they had been attended with such good results that two other centres were about to be opened. The attendance of the girls at these centres had been encouraging, and great desire was shown by them to avail themselves of the instruction given. No charge was made for the lessons, but the children (many of whom came from long distances, and in most inclement weather) bore the expense of their locomotion to and from their homes.

Sir Henry Cole, K.C.B., said that the memorandum set forth the manner in which it was suggested State aid might be given, according to the practice of the department, to so important a movement; that the full extent of the benefit to be derived from the introduction of the subject "Cookery" into the Revised Code, could only be secured by the training of teachers in sufficient numbers for the elementary schools throughout the country; it was, therefore, asked that a certain number of the students from the female training schools be sent to the National Training School for Cookery at South Kensington, as teachers of science and art were sent; and further, if the grant of 4s. at present made for a knowledge of cooking and clothing combined (Domestic Economy), were divided into two separate grants of 2s. to each subject, and an inspector were appointed to look to the interests of cookery, as is done with music, it would greatly encourage the cultivation of a knowledge of cookery.

In reply to a remark of **Lord Sandon**, that the proposal would entail a cost of about £7,000 a year, and that cooking was already taught in the training colleges, **Sir Daniel Cooper** observed that the instruction so given was of an unsystematic nature, and unlike the methodical and regulated course of training at the School for Cookery at South Kensington. A Grammar of Cookery, so to speak, had been compiled, and diplomas were issued to those students who had satisfied the committee of their ability to instruct.

The Lord President, in reply, said the introduction of "Cookery" into the Revised Code showed a desire on the part of the Government to encourage a knowledge of the subject, and that both Lord Sandon and himself would give the points that the deputation had brought before them their full consideration. With regard to the separation of cookery from the other subjects of domestic economy, as the measure was a tentative one, it seemed that any alteration was unadvisable at present.

Lord Barrington thanked the Lord President, on behalf of the executive committee of the school, for receiving the deputation.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

March 22.—"Improvements in Railway Couplings, as a Necessity of the Day," by T. Attwood Brocklebank, Esq:

March 29.—"Model Dwellings for the Rich," by T. Roger Smith, Esq., and W. H. White, Esq. Lord Alfred Churchill will preside.

April 5.—"The Cultivation in India of Caoutchouc-yielding Trees," by Clements R. Markham, Esq., C.B.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

March 28.—"The Industries of South Africa." By T. B. Granville, Esq. Lieut.-Gen. Bissett, C.B., will preside.

April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

March 24.—"The Land Revenues of India," by Major-General Marriott, C.S.I. Sir George Campbell, M.P., will preside.

April 21.—"The Sanitary Progress of India," by Captain Douglas Galton, C.B.

May 5.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

Chemical Section.

Friday evenings at 8 o'clock. The following papers will be read:—

March 17.—"The Preparation of Dextrine-Maltose (malt-sugar), and its Use for Brewing and other Purposes." By W. Valentin, Esq., F.C.S. Prof. Williamson, F.R.S., will preside.

March 31.—"The Methods of Estimating the Illuminating Power and Purity of Coal Gas." By A. Vernon Harcourt, Esq., M.A., F.R.S. The Right Hon. Lord Aberdare will preside.

April 28.—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne.

Cantor Lectures.

Monday evenings at 8 o'clock. Third Course, "On Wool Dyeing," by George Jarmain, Esq.

Lecture II.—March 20th.

Indigo and its modes of application to the dyeing of wool and woollen fabrics.

Lecture III.—March 27th.

General principles of the fixation of colour upon wool.—Wool mordants.

Lecture IV.—April 3rd.

Logwood and other woods, and their application to the dyeing of wool and woollen fabrics.

Lecture V.—April 24th.

Ditto (*continued*).

Lecture VI.—May 1st.

Aniline and other allied colours, and their application to the dyeing of wool and woollen and mixed fabrics.—Concluding remarks.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. George Jarmain, "Wool Dyeing." (Lecture II.)
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Adjourned Discussion on Mr. Nursey's Paper "The Channel Railway."
Royal United Service Institution, Whitehall-yard, 8½ p.m. Major J. P. Morgan, "Some Specific Features in Large and Fine-grained Powders."
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion on "The Provisions of the New Valuation Bill."
Medical, 11, Chandos-street, W., 8 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Mr. J. W. Dawson, "Fossil Agricultural Implements in America."
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Ferrier, "Sleep and Dreaming." (Lecture I.)
Social Science Association, 1, Adam-street, Adelphi, W.C. 8 p.m. Discussion on "Piece-work as compared with Time-work."

Tues. ...Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "Classification of Vertebrated Animals." (Lecture X.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. S. Duer, "Hydraulic Canal Lift at Anderton, on the River Weaver."
Statistical, Somerset House-terrace, W.C., 7¾ p.m. Mr. H. S. Skeats' "Statistics Relating to the Support of Religious Institutions in England and Wales."
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.
Royal Colonial (Pall-mall Restaurant, S.W.), 8 p.m. Mr. Coleman Phillips, "The Civilisation of the Pacific."

Wed. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. A. Brocklebank, "Railway Couplings."
Geological, Burlington House, W., 8 p.m. 1. Mr. H. Lavis, "The Triassic Strata which are Exposed in the Cliff Sections near Sidmouth, and a Note on the Occurrence of an Ossiferous Zone containing Bones of a *Labyrinthodon*." 2. Mr. H. G. Seeley, "The Posterior Portion of a Lower Jaw of *Labyrinthodon Lavisi* from the Keuper Beds of Sidmouth." 3. Mr. W. Keeping, "The Discovery of *Melonites* in Britain." 4. Mr. Dawson, "Nots on the Phosphates of the Laurentian and Cambrian Rocks of Canada."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Thurs ...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. E. B. Taylor, "Races of Mankind and their Civilisation."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Spottiswoode, "Polarised Light." (Lecture II.)
Inventors' Institute, 4, St. Martin's-place, W., 8 p.m.

Fri. ......SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Major-General Marriott, "Land Revenues of India."
Royal Institution, Albemarle-street, W. 8 p.m., Weekly Meeting. 9 p.m., Prof. McK. Hughes, "Geological Measures of Times."
Quekett Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.

Sat. ......Royal Institution, Albemarle-street, W., 3 p.m. Prof. G. C. Robertson, "Human Senses." (Lecture III.)
Physical Science Schools, South Kensington, S.W., 3 p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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FRIDAY, MARCH 24, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

FOOD COMMITTEE.

A meeting of this Committee was held on the 17th inst. Present—Lord ALFRED CHURCHILL, Chairman of Council (in the chair); J. J. Manley, H. A. Pitman, M.D., Seymour Teulon, E. C. Tufnell, and James A. Youl, with P. Le Neve Foster, Secretary. The Committee inspected and tried a specimen of American meat, preserved by a process invented by Mr. Collett, of Gloucester; also some pilchards, preserved in tins like sardines, by the Cornish Sardine Company, Falmouth.

NATIONAL TRAINING SCHOOL FOR MUSIC.

1. The Ashford Scholarship has been awarded to James Lauder, aged 15 years, for his acquirements as a vocalist and violinist, and for his general musical capacity. There were seven competitors. The examiner was Mr. A. Legge, organist of the parish church. Two other candidates acquitted themselves so as to deserve scholarships.

2. A competition will be held for ten scholarships at Birmingham, on Monday, the 27th inst. Candidates are nominated by subscribers, and must be resident in Birmingham, or within ten miles. The examiners are Dr. Heap, Mr. James Stimpson, and Mr. W. C. Stockley. The hon. secretary is Mr. Charles Harding, 32, Waterloo-street, Birmingham.

3. At a meeting of the Finance Committee, held at the School on Tuesday, the 21st inst., Sir William G. Anderson was elected Treasurer of the School, and Mrs. Thurston Thompson was elected Lady Superintendent.

HEALTH AND SEWAGE OF TOWNS.

The Committee on this subject is composed of the members of Council, and the following:—

Dr. Acland, F.R.S., Oxford; R. B. Austin; Alderman Baker, Birmingham; Dr. Ballard; E. G. Banner; John G. Barry; Thomas Beggs; Matthew Blakiston; Dr. Blaxall; Mr. Councillor T. W. Bogg, Louth; Richard Brewer; Edwin Brookes; J. Brown, Chesterfield; Dr. Buchanan; Mr. Alderman Budden, Winchester; Mr. Alderman Burgess, Warrington; Dr. Alfred Carpenter, Croydon; R. Brudenell Carter, F.R.C.S.; Thomas Cave, M.P.; David Chadwick, M.P.; Mr. Councillor Chipperfield, Southampton; G. R. F. Cole, C.E.; Francis R. Conder, C.E., Guilford; T. W. Cowan, Horsham; William Crookes, F.R.S.; George F. Deacon, Liverpool; J. Bailey Denton, C.E.; John Dunning (Mayor of Middlesborough); Charles Elcock, Salford; John Evans, Hemel Hempstead; Rogers Field, C.E.; Captain L. Flower (Sanitary Engineer, River Lee Conservancy); James Fowler (Mayor of Louth); Dr. Frankland, F.R.S.; Dr. Gilbert, F.R.S.; Dr. Gill (Health Committee), Liverpool; Richard Grantham, C.E.; Thomas E. Harrison, C.E.; Thomas Hawksley, C.E.; Clement Higgins; T. Rowley Hill, M.P., Worcester; Lieut.-Col. W. Hope, V.C., Barking; Frederick W. Hunt; John James (Town Clerk of Wrexham); Edwin Jones (Mayor of Southampton); Thomas Eylin Jones, M.D. (Mayor of Wrexham); Baldwin Latham, C.E.; J. Bennett Lawes, F.R.S., Rothampstead; John Leigh (Medical Officer), Manchester; Dr. Henry Letheby; L. Levy (late Mayor of Rochester); T. Mason; Joseph May (Mayor of Devonport); J. C. Melliss, Kenilworth; Mr. Councillor J. Mellor, Oldham; G. H. Midwood, Manchester; R. Milward, Birmingham; Mr. Alderman Montague; F. Morshead (Mayor of Winchester); the Mayor of Newport, Isle of Wight; Mr. Alderman Norman, Devonport; Dr. W. Odling, F.R.S., Oxford; Philip O. Papillon (Mayor of Colchester); the Mayor of Penzance; Mr. Councillor G. P. Perkins, J.P., Southampton; Mr. Alderman Francis Pittis, J.P., Newport, Isle of Wight; J. Netten Radcliffe; Alfred Raphael; C. Rawson; S. Rawson; Gilbert G. Redgrave, Assoc. Inst. C.E.; James Rock, Hastings; Professor Roscoe, F.R.S., Manchester; Major-General H. Y. D. Scott, C.B., R.E., F.R.S.; W. Shelford, C.E.; James N. Shoolbred; Alfred Smee, F.R.S.; S. Smith; E. C. Stanford; Mr. Councillor T. Stephen, Winchester; J. Stokes (Mayor of Dudley); Dr. Sutton, Oldham; Captain J. S. Swan (Mayor of Honiton); M. O. Tarbotton, C.E., Nottingham; Mr. Alderman Tatham, Leeds; Dr. Taylor (Chairman of Health Committee), Liverpool; Mr. Alderman Taylor, Rochdale; N. E. Tooner (Mayor of Rochester); Charles Tucker (Mayor of Bridport); Dr. Voelcker, F.R.S.; Mr. Alderman Wainwright (Mayor of Oldham); Mr. Councillor William Clemens Way, Newport, Isle of Wight; S. M. Webster (Mayor of Warrington); Joseph Whitley, Leeds; Mr. Councillor Whittle, Warrington; T. Woodward (Mayor of Worcester).

A circular asking for instruction has been issued by the Committee to the Mayors, Town Clerks, Chairmen and Medical Officers of Boards of Health, and other sanitary authorities throughout the kingdom. This will appear in an early number of the *Journal*.

The Conference will be held on May 9th and 10th. A Sanitary Conference will also be held by the British Medical and Social Science Association on May 10th and 11th, in the Rooms of the Society of Arts.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1876, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his

personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (now Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., in "recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, Foreign Member of the Royal Society, Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food-economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to M. Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. Henry Bessemer, "for the eminent services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to M. Michel Eugène Chevreul, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to Mons. Michel Chevalier, the distinguished French statesman, "who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

The Council invite members of the Society to forward to the Secretary, on or before the 16th of April, the names of such men of high distinction as they may think worthy of this honour.

CHEMICAL SECTION.

A meeting of this Section was held on Friday, March 17th, Professor Williamson, F.R.S., in the chair.

The paper read was—

ON THE PREPARATION OF DEXTRINE-MALTOSE (MALT-SUGAR) AND ITS USE IN BREWING.

By Wm. Geo. Valentin, F.C.S.,

Royal College of Chemistry, South Kensington.

The Cantor Lectures on "Fermentation," delivered before this Society by Professor Williamson, in the year 1872, and the elaborate account given two years ago, in this room, on the art of brewing, by Dr. Graham, clearly show that the Society of Arts, and more recently its Chemical Section, has always been true to the objects for which it was founded, viz., for the encouragement of Arts, Manufactures, and Commerce.

I have been asked to bring before the Chemical Section some recent observations and improvements made by myself and my friend, Mr. Cornelius O'Sullivan, who, since leaving the College of Chemistry, and after having spent some time with Dr. Hofmann in Berlin, has been in the employment of Messrs. Bass & Co.

I should have preferred if Mr. O'Sullivan had been able to spare the time to give the Society the benefit of his vast stores of practical and scientific knowledge of the art of brewing, and I should certainly have hesitated to undertake the task of delivering a lecture before the Chemical Section, which comprises so many brewers of great practical and theoretical acquirements, if your secretary had not allowed me to confine myself to the limited subject indicated by the title to this lecture, viz., the "Preparation of Dextrine-Maltose (or Malt-Sugar) and its use in Brewing," to the production of which, on a manufacturing scale, I have of late given much time and attention.

The art of preparing fermented liquids, dating as it does from the remotest times, and met with among various races widely separated from each other, was up to very recent times of a purely empirical character. It is only during the last thirty or forty years that the progress of chemical science left its mark upon this art, as upon so many others. Our great brewers, among whom I would, without fear of encountering the reproach of flattery, single out the great brewing firms of Messrs. Bass and Co., and of Messrs. Allsopp and Sons, availed themselves speedily of the conquests made by pure science which promised to throw light upon their purely empirical processes, and to clear away the mist that hung over some of the chemical changes involved in brewing. Thus it has come to pass that, from the heads of these firms down to the under-brewers, a chemical knowledge was considered the requisite thing, and that we see eminent scientific chemists now superintending the chemical departments of these firms. The progress made in the chemistry of brewing, although at present locked up to a great extent and rendered unavailable to the general public, has been very great. The labours of Pasteur and other scientific investigators have been eagerly examined and applied practically by brewers; and, by following up Pasteur's microscopic researches on ferments, we are promised that, by a careful microscopic examination of the yeast or barm, we may keep disease out of the brewing-house, or arrest its propagation with freshly-brewed beers. It will in like manner be possible to predict whether such beers contain any ferments which will damage or destroy their keeping powers, *i.e.*, whether they carry in themselves the germs of inevitable destruction immediately after brewing.

Considering the great help which pure chemistry at various times has generously rendered to brewers, it may well be thought desirable, in the words of Mr. Robert Warington, F.C.S., who favoured the Chemical Society recently with his great stores of

knowledge gained in the manufacture of tartaric and citric acids, in Mr. Lawes' Millwall Laboratory, "that most of the large amount of information which is acquired in the laboratories of our great manufacturing concerns might be published without any injury to the individual manufacturer."

The chemical reactions involved in the manufacture of beer are not very numerous, and are still rather imperfectly understood. The process may be said to have for its object the production of a partially fermented and gradually fermenting liquid, termed beer, from barley, hops, water, and yeast.

In the preparation of wine, the grapes have only to be pressed to obtain the saccharine liquid, which by its fermentation yields wine. The saccharine matter—the grape-sugar—is ready formed. But when wine of barley, or beer, has to be made, nature has not elaborated so much of the process. She gives us the raw material in a different form: the alcohol producing portion of the grain is starch chiefly. It is the object of the malster and brewer so to act on the grain as to produce beer.

Alcohol results from the vinous fermentation or conversion of grape-sugar or glucose into alcohol and carbonic acid, according to the equation :—

$$\underbrace{C_6\,H_{12}\,O_6}_{\text{Grape Sugar.}} = \underbrace{2\ C_2\,H_5\,Ho}_{\text{Alchol.}} + \underbrace{2\ CO_2}_{\text{Carbonic Acid.}}$$

In grapes this sugar results, no doubt, from the slow action of the soluble albuminoid substances contained therein, during the ripening process. The wine which is made from grapes constitutes a more or less completely fermented alcoholic liquid, derived mainly from the grape-sugar, which differs from beer in being a completely fermented liquor, practically without any dextrine, and, with the exception of artificial effervescing wines, such as Champagne, sparkling Moselle, &c., also without carbonic acid.

The process of wine making has, as is well known, undergone considerable changes, especially during the last 10 or 15 years, since chemistry has thrown light upon the changes iuvolved in it. A considerable quantity of good wine is now made by repeated fermentation of the squeezed skins or husks of the grape with some artificially prepared grape-sugar. This is known under the name of "Pétiot's" process. According to another process called after its originator, "Chaptal," sugar is added with most excellent results, in unfavourable wine years, as a corrrective for the increased amount of acid.

Gall proposed to dilute acid wine with water, to the proportions found in wines of good years, and to add the requisite quantity of sugar, to produce the proportions of alcohol and acid, contained in wines made during good wine years.

There can be no doubt that all these processes are perfectly legitimate, and, if practised with the proper knowledge and care, can only be beneficial both to the wine-grower and consumer.

Cane-sugar or loaf-sugar is mostly used for such purpose, on account of its greater purity and freedom from nonfermentable constituents, as well as albuminoid substances. Its composition differs from that of grape-sugar $C_6\,H_{12}\,O_6$, by containing less water, viz., $C_{12}\,H_{22}\,O_{11}$, and during the fermentation it has to be converted into the glucose, called grape-sugar, by the assimilation of water; 86·4 parts of cane-sugar perform, therefore, the same amount of work as 100 parts of pure crystallised grape-sugar.

The stages through which the starch in barley—the grain which is almost exclusively used in this country—passes before it reaches us as the fermented alcoholic extract, called beer, are more numerous, and probably of a more complicated nature. They may be considered in the following order:—

(1) Malting.
(2) Mashing.
(3) The fermentation of the wort.

In order to show a *raison d'être* for bringing before you the new substitute for malt, which we have termed "Dextrine-Maltose," or malt-sugar, I shall first dwell upon the composition of malt, and will endeavour to show you that, by a patient study of the constituents contained in malt before and after infusion, in connection with those contained in the fermented beer, much additional insight into the brewing process may be gained.

Composition of Malt.

Chemists gain their knowledge of the composition of matter by certain analytical processes: that knowledge is the more perfect, the more perfect and reliable the analytical processes are, which they have to employ. Now we possess pretty accurate methods for the quantitative estimation of moisture, ash, fat, cellular matter, and total albuminoid or nitrogenous matter; but little or no attention has hitherto been paid to the different varieties of albuminoid bodies contained in malt. The isolation and estimation of the starchy matter, or, as I would call it by preference, of the carbohydrates which, without doubt, form the most important constituents of malt, is more difficult, and great errors have beeu made, as we have to rely mostly upon chemical methods, which are likely to mislead if not carefully checked by other observations, if possible by polariscopic experiments. I give it upon the authority of Mr. O'Sullivan, that of the mauy analyses of malt which have been published, not one can be relied on in this particular respect.

Thus it has always been stated, even by more recent careful inquirers, such as Oudemaus, that malt contains dextrine (8 per cent.). O'Sullivan cannot find any dextrine, although he looked most carefully for it, by processes which would have yielded it, if it had been present in malt. This opinion seems to be shared by other recent investigators, *e.g.*, by Kühnemann*, although the proofs which he adduces are meagre, and do not appear to be sufficient to warrant the conclusions at which he arrives.

Again, the amount of sugar (the variety is uever stated) is usually set down at from ·4 to 1 per cent. This, too, O'Sullivan considers absolutely wrong. He fiuds in malt from 16 to 20 per cent. of a fermentable sugar.

About half of this is due to the transformation of starch, or a carbohydrate of a like character, during the malting process. The remainder is

* Ber. d. Chem. Ges. Berlin viii. 202 and 387.

ready-formed in barley, and differs from the one produced by malting. O'Sullivan has not yet been able quite satisfactorily to isolate and determine the character of these sugars, but of their existence he is quite convinced.

There is in the starch of barley a carbohydrate of the starch type having a laevo-rotatory action on polarised light. Kühnemann calls this body "Sinistrin," but from its general character, O'Sullivan is inclined to think the body is "Inulin." These remarks may appear to some of you perhaps premature, and not sufficiently supported by analytical facts. I had, however, to refer to them in order to render comprehensible the subjoined analyses of malts, which may be taken as typical for most pale malts, although the percentages of albuminoids and soluble carbohydrates are capable, to some extent, of modification by changes in the malting process.

The following table gives the detailed composition of two samples of pale malt:—

	Malt No. 1.		Malt No. 2.	
Starch		44·15		45·13
Other carbohydrates (of which 60 per cent. to 70 per cent. consist of fermentable sugars) Inulin (?) and a small quantity of other bodies soluble in cold water		21·23		19·39
Cellular matter		11·57		10·09
Fat		1·65		1·96
Albuminoids—				
(a) Soluble in alcohol of sp. gr., ·820 and in cold water	·63		·46	
(b) Soluble in cold water and at 68° C	3·23		3·12	
(c) Insoluble in cold water, but soluble at 68° to 70° C.	2·37		1·36	
(d) Insoluble at 68° to 70° C, but soluble in cold water (albumin proper)	·48		0·37	
(e) Insoluble in cold water and at 70° C	6·38		8·49	
		13·09		13·89
Ash		2·60		1·92
Water		5·83		7·47
		100·12		99·76

Every item in these analyses has been estimated directly and not by difference. The further elucidation of the carbohydrates, other than ordinary starch, O'Sullivan reserves, should time allow him, for a communication to the Chemical Society.

I have on another diagram given, for comparison sake, an analysis of the Dutch chemist, Oudemans, hitherto looked upon as among the most reliable analyses of barley and malt.

Table showing composition of barley and malt (Oudemans):—

	Barley, air-dried.		Malt, air-dried.
Dextrine	5·6	..	8·0
Starch	67·0	..	58·1
Sugar	none	..	·5
Cellulose	9·6	..	14·4
Albuminoids	12·1	..	13·6
Fat	2·6	..	2·2
Ash	3·1	..	3·2
	100·0	..	100·0

Albuminoid compounds in malt (Oudemans):—

(a)	Soluble in alcohol	·34
(b)	Coagulable by heat	·45
(c)	Not coagulable	2·08
(d)	Insoluble albumin	6·23
		9·10

By starting thus with a more clearly defined knowledge of the starch present in malt, we shall have less difficulty in tracing the changes which it undergoes during its conversion into beer, and you will be able to judge whether the substitute for it, which we can produce on a manufacturing scale, and which we have called, not by some fanciful name, but by a name which expresses its proper chemical composition, viz., Dextrine-Maltose, will deserve your serious attention.

Changes produced in Malt during Mashing.

When ground malt is submitted to the mashing process, certain of the albuminoid bodies, contained in the malt, act upon the starch, and the latter is dissolved, with what changes will be shown more fully further on. The other carbohydrates, the constitution of which is as yet not fully made out, go likewise into solution. The albuminoids soluble below the mashing heat (say 68° C.) are also dissolved, and the insoluble constituents of the malt remain in the grains. The wort, therefore, contains the transformation products of the starch — principally Dextrine-Maltose — of the other carbohydrates, the soluble albuminoids, the soluble portion of the ash, and a little soluble fat.

Boiling with hops removes a portion of the albuminoids. Some of the carbohydrates, other than the starch products, undergo a slight change, which has not yet been thoroughly examined; but the starch-products are but slightly altered, in what way will be shown hereafter.

Fermentation of the Wort.

When the boiled hopped wort is subsequently submitted to the action of yeast, the carbohydrates other than those derived from starch yield alcohol first, and the portion thereof which is fermentable (60 to 70 per cent.) disappears almost altogether in the very earliest stages of the fermentation; the growth of the yeast removes a portion of the albuminoids left, and some (a very small quantity) also of the sugar, and there remains then in the beer, when the first stage of the fermentation is over, and when it is fit to go into the casks, the alcohol and a portion of the carbonic acid derived from the carbohydrates other than starch, and also from a portion of the

products of the transformation of the starch itself, effected by the ferments (which, as I shall have conclusive evidence to adduce, consist of dextrine and maltose). Hence it is found that the whole of the dextrine, a considerable portion of the maltose, the remainder of the albuminoids, the soluble matter of the hop, and a few other constituents upon which I need not touch further, are left for after-fermentation.

In order to correctly understand the part which the dextrine and maltose play in the after-history of a beer, we will examine for a moment the constitution of a typical Burton pale ale, analysed when the principal fermentation was finished.

That the constitution of ales will vary within certain limits, even when brewed in the same town, and by processes which vary only within narrow limits, will be readily admitted. Nor does it matter, as long as I can show you by a carefully-conducted analysis of a representative sample of pale ale, what the changes are which fermentation effects.

A normal sample of pale ale, showing an original gravity of 1063, gave, when finished and ready to be put into casks, a distillate of sp. gr. ·992, equal to 33·7 degrees of gravity lost.

33·7	degrees of gravity lost.
1029·39	residue.
1063·09	original gravity.

The unboiled wort of this beer, supposing it to have been brewed from No. 1 malt and reduced to the above specific gravity, viz., 1063, by allowing for concentration on boiling (in order not to unnecessarily complicate the explanations which I will endeavour to give of the changes) would contain in every 100 parts by measure the following solid constituents:—

Maltose	6·66
Dextrine	3·44
Other carbohydrates, fermentable	3·30
Ditto, unfermentable	1·48
Albuminoids	1·45
Ash, phosphates, sulphates, &c.	0·17
Total	16·50

After boiling with hop (and correction for loss by evaporation, so as to keep it at the normal original gravity of 1063), it was composed as follows:—

	Solids in 100 parts.
Maltose	6·66
Dextrine	3·44
Other carbohydrates, fermentable	3·80
Ditto, unfermentable	1·00
Albuminoids	1.05
Hop extract	·33
Ash	·27
	16·55

Hence it follows that the fermentable constituents of the hopped wort have undergone but little change.

Not so, however, when the principal fermentation with yeast is finished and the ale is ready to be put into the cask, for the beer contains now:—

	Alcohol and solids in 100 parts.
Alcohol	4·48* sp. gr. ·992
Maltose	1·52
Dextrine	3·44
Carbohydrates, fermentable	trace.
Ditto, unfermentable	1·00
Albuminoids	·66
Hop extract	·33
Non-volatile products of the fermentation	·47
Ash	·24
	7·66

Maltose and dextrine, constituting, however, by far the greater part of the remaining solids, viz., very nearly 60 per cent.

It will now become clear of what importance maltose and dextrine are to the brewer, both during the fermentation process, and during the after history of the beer, *i.e.*, for insuring keeping powers. How is it, then, you will ask, that only recently mention has been made of this body called maltose, so important to the brewer? This I will endeavour to answer as clearly as possible, so as to leave no doubt in the minds of any one present here to-night. We may perhaps then be spared in future the humiliating feeling that chemists should still be found who call a sugar "glucose," when in reality it is, as has been amply shown to all who will listen and experiment, a sugar of widely different properties; that it is, in fact, what chemists in France (Dubrunfaut†), in England (O'Sullivan‡), and in Germany (Schulze§) have shown us most conclusively, and all but independently of each other, viz., maltose. This name was given to it by the first observer (Dubrunfaut), and retained by O'Sullivan, who undoubtedly has the merit of having placed this new sugar, found in malt-wort, beyond a shadow of a doubt, and of having pointed out its character, composition, and affinities.

The sweet taste of malt led for a long time to the supposition that the starch of the grain was converted into sugar during the malting process. A very superficial examination, however, will show this, in the main, to be erroneous. Starch can be isolated from the malt, as well as from barley. Starch, then, it was found, was converted into sugar, only during the process of mashing, presumedly by the action of an albuminoid body, called "diastase," supposed to be produced during the malting process. This, too, is not altogether a correct notion, for barley contains sufficient of the transforming or saccharifying agent to dissolve the whole of its starch.

The action of this transforming agent on starch has been the subject of much investigation. Little or no attention was, however, paid to the properties of the transformation products.

The portion thereof which reduced cupric oxide was put down as glucose, grape-sugar, or dextrose, and the remainder as dextrine, and even on this supposition there has been a great diversity of opinion as to the proportion of these substances produced. It is mainly owing to O'Sullivan's

* *i.e.*, slightly less than 50 per cent. on the solid matter fermented.
† Ann. Chim. Phys. [3] xxi. 178.
‡ Journal Chem. Soc., July, 1872.
§ Ber. d. Deut. Chem. Ges. Bd. vii. 1047.

painstaking and admirable labours that we have obtained a clear and definite knowledge of the exact properties and composition of the transformation products of the starch of malt, and that the quantity of each can now be determined with any degree of accuracy. After the successful isolation of the sugar maltose found among the transformation products in wort, the relative proportions of these two bodies produced, when starch is dissolved by malt-extract, had yet to be determined, and the thought of giving a practical application to the new discovery was but a natural consequence.

If we examine for a moment the malt analyses given above, and suppose that during the mashing process the malt yielded an extract of 74 per cent., we perceive that the starch amounts to little more than 59·6 per cent.; the maltose and dextrine in the wort to a little more than 61 per cent. of the extract, the increase being due to the binding of water. This very closely corresponds to the theoretical per centage of these bodies, obtainable, if starch splits up, according to the equation:—

$$\underbrace{C_{18}H_{30}O_{15}}_{\text{Starch.}} + OH_2 = \underbrace{C_{12}H_{22}O_{11}}_{\text{Maltose.}} + \underbrace{C_6H_{10}O_5}_{\text{Dextrine.}}$$

that is, 32·15 per cent. of dextrine and 67·85 of maltose.

When starch-paste was submitted to the action of malt-extract, it dissolved, and the solution, at the end of an hour or two hours' digestion, contained of solid matter (allowing for the malt-extract employed) 67·85 per cent. of maltose and 32·15 per cent. of dextrine. Hence the starch split up under the influence of malt-extract according to the equation given above. This is the normal transformation, and it is the one obtained in well-managed mashing operations. Other proportions of maltose and dextrine are obtainable, and this is one of the reasons why brewers sometimes find, although they use the same quantity of yeast, that the attenuations are sometimes too low and sometimes too high. When this occurs they change the quantity of yeast, which is all well enough in its way, but few of them, as far as I know, go to the real root of the evil, viz., the different proportions of maltose and dextrine, formed in the mashing process. If the composition of the boiled wort given in the diagram be examined, it will be found that about 64 per cent. is fermentable matter. In all well-conducted brewing operations, at the time of racking the beer, if the original gravity be determined, few instances will occur in which the amount of matter fermented is more than 64 per cent. of the original solid matter before fermentation. There may be cases in which this number is exceeded, as in old beers, in which the after-fermentation had taken place, or badly brewed beers, in which proper attention had not been paid to the mashing operation. Every brewer present will also know that it sometimes happens that the beer cannot be attenuated low enough, that, in fact, not more than 50 per cent. of the solid matter in the extract can be fermented. The blame is then laid to the barm or the water, and it is never imagined that it is due to the too high proportion of dextrine obtained from the starch in the mashing process. It is pretty well understood that if a pale ale, the worts of which had, say a specific gravity of 1063—1064, can be got into the cask, when it is reduced by fermentation down to 1020—1021, things are going on rightly. The meaning of this is not far to seek. The wort would contain in every 100 parts, by measure, 16·5 parts by weight, or thereabouts, of solid matter of the composition already referred to. The specific gravity of the finished beer being taken at 1021, the specific gravity of the spirit contained in the finished beer would be 992, or 8 less than 1,000. The specific gravity of the finished beer, taken at 1021, the specific gravity of the beer without the acohol would amount to 1029 (1021 + 8). This represents 7·6 per 100 of solid matter, or 16·5—7·6 = 8·9 of converted matter, and when expressed in per centage numbers = 53·9, say 54 per cent., thus leaving still in the beer, as shown above, about 10 per cent. (on original extract) of fermentable matter. This matter is maltose, and it serves to keep up, by its slow and gradual fermentation, the condition of the beer in cask. Beer, in common with all fermented liquids, is always slightly acid; and this acid fluid, no doubt, converts a further portion of the non-fermentable carbohydrates into fermentable ones, and hence a portion of the dextrine into maltose, and finally into alcohol. This, in well-brewed and finished beers, is always a slow and gradual process.

Malt Substitutes.

Seeing thus what beer is, and what its requirements are, we may turn to the consideration of the substances, hitherto used as substitutes for malt, in its preparation; and an examination of the character and composition of these bodies, and their behaviour when submitted to the action of yeast, will show us the success that may be expected to attend their use. Malt being sweet—and it not being understood to what the sweetness was due—cane sugar, invert sugar, and glucose or so-called saccharines of various kinds have been proposed as substitutes.

The first substance employed as a substitute for malt to be considered is cane sugar. The properties of this body are too well known to require to be closely examined here. However, a few words will not be out of place.

Cane sugar occurs in well-defined crystals as sugar-candy, and in small crystals more or less impure in the different kinds of brown sugar, loaf sugar, &c. It has a specific rotatory power of 73·8°. A solution of cane sugar does not reduce cupric oxide. If 2·6 lbs. of this sugar are dissolved in pure water, and the solution made up to 1 barrel (36 gallons), an extract of 1 lb. brewer's gravity would be obtained; that is, 59·8 lbs. of it, dissolved in pure water, and made up to 36 gallons, this solution would have a brewer's gravity of 23 lbs. This means that the 36 gals. would weigh 23 lbs. more than the same bulk of water.

If cane sugar be submitted to the action of yeast it will be found, if sufficient yeast be added, and the temperature of the mixture be maintained at from 20° to 30° C., that the whole of it ferments in four or five days, and yields 51 to 51·5 per cent. of alcohol, together with a certain proportion of succinic acid, glycerine, and other products. If an

insufficient amount of yeast be added, the fermentation will not be complete. It is possible to ferment 30, 40, 50, and 60 per cent., or the whole of the cane sugar, by varying the quantity of yeast, &c.; but if in the solution an albuminoid, and the necessary inorganic constituents of the yeast-ash (phosphates, &c.) be present, the whole of the sugar slowly and gradually disappears. The residue left on fermenting a portion of the cane sugar always tastes acid and "thin;" the acid taste is no doubt due to the succinic acid, and the thinness to the peculiar sharp bodiless taste of the sugar.

Keeping these points in view, let it be supposed that one-third of the malt extract in the pale ale mentioned above be replaced by cane sugar; the wort before boiling would then have the following composition:—

	Per 100 parts by measure.
Cane sugar	5·57
Maltose	4·53
Dextrine	2·14
Other carbohydrates, fermentable	2·20
Ditto, non-fermentable	0·99
Albuminoids	0·98
Ash	0·11
	16·52

After boiling with the hop it would contain—

	Per 100 parts by measure.
Cane sugar	5·57
Maltose	4·53
Dextrine	2·14
Other carbohydrates, fermentable	2·53
Ditto, non-fermentable	0·66
Albuminoids	0·70
Hop extract	0·39
Ash	0·21
	16·73

The analysis is of a beer in which the same amount of hops was used as in the previous case. The numbers are before fermentation. It contains—

Cane sugar	5·57
Maltose	4·53
Fermentable carbohydrates	2·53
	12·63 in 16·73 parts.

i. e., 75 per cent. of fermentable matter.

Within certain limits it is in the hands of the brewer to ferment as much, or as little as he likes, of this, before he puts the beer into the cask finished. But after this he has no control over the beer; he cannot possibly separate every yeast-cell; hence, as long as the immediately fermentable bodies are present, the fermentation will go on, and stop only when the albuminoid and ash constituents of the beer become exhausted, and even then a portion of the yeast may live and work on the products of the decomposition of another portion. Thus it is that cane sugar can never be used as a substitute for malt in the brewing of keeping beers. Keeping, even for a short time, attenuates them so much, that all body and flavour is gone. During fermentation, of course, the normal quantity of albuminoids is taken out of the solution, and if the original gravity of the beer at any stage were determined by the method of Graham, Redwood, and Hofmann, the result would be always the same as that at first determined by the brewer before fermentation. Hence the debit and credit sides of the account of the advantages to be derived by the brewer from the use of cane sugar are, irrespective of its cost—

In its favour—

1. The reduction of the relative quantity of albuminoids in the beer.
2. Its maintaining the strength of the beer, after fermentation, by yielding the same quantity of alcohol as the sugar of the malt-extract does.

Against it—

1. Its fermentability.
2. The thin taste of its solution after fermentation. The first of these has rendered it useless to the brewer of keeping-ales, without any consideration as to its cost. No matter how it be managed, it always gives a "thin, poor" beer.

The next substance to be dealt with is the so-called "invert sugar."* Of this I have before me the analysis of two samples. They appear as semi-solid, straw-coloured, honey-like substances.

No I. gave 85 per cent., and No. II. 86·88 per cent of solid matter. Hence if they yielded as much alcohol as cane sugar they would be of as much use to the brewer as cane sugar, only that 85 parts of cane sugar would go as far as 100 parts of No. I, and 86·88 parts of cane sugar as far as 100 parts of No. II, but 100 parts of cane sugar yield 105·26 parts of invert sugar.

Percentage composition of two samples of so-called Invert Sugar.

	No. I.	No. II.
Cane sugar	13	26
Invert sugar	87	74
	100	100

Their value as substitutes for malt can be easily estimated from what has been said above upon cane sugar, and from the fact that invert sugar only yields 48 to 49 per cent. of alcohol by fermentation.

The next set of bodies with which we have to deal are the so-called "saccharines" or "glucoses," &c., produced by the action of sulphuric acid on starch or starchy substances—rice, maize, &c. One firm advertises these substances as "saccharine," containing

Grape sugar	83·65	per cent.
Moisture	14·81	,,
Ash and loss in analysis	1·54	,,
	100·00	

Another, as "patent grape sugar;" a third, as "maize saccharine;" a fourth, as "malt saccharine;" and so on.

It is only necessary to understand the action of ferments on starch, to infer pretty closely what all these bodies are, and, knowing this, we have only to look at the analyses of the wort and hopped beer given above, to arrive at a pretty fair notion as to the value of these bodies to the brewer. They are all sent to the brewer in the form of light brown to perfectly white, not brittle, lumps or chips. They can be cut with a knife, and they break with a rough fracture.

I subjoin the analyses of five samples of saccharines, from different makers:—

* I believe the manufacturers of this substance call it "inverse sugar."

Sample No. 1.—Rather brown; very hard; English manufacture.
Sample No. 2.—Pale straw colour; softish; French manufacture.
Sample No. 3.—Rather white; somewhat hard; English manufacture.
Sample No. 4.—Rather white; somewhat hard; German manufacture.
Sample No. 5.—Whiter; somewhat hard; German manufacture.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Glucose	80·0	58·85	67·44	63·42	61·46
Maltose	None.	14·11	10·96	13·50	13·20
Dextrine	None.	1·70	None.	None.	None.
Neutral carbohydrates, with a little albuminoids	8·2	9·38	4·30	8·40	8·60
Ash	1·3	1·40	1·60	1·50	1·60
Water	10·5	14·56	15·70	13·18	15·20
Total	100·00	100·00	100·00	100·00	100·00
Total solid matter	89·5	85·44	84·30	86·82	84·80
Percentage of matter of use to the brewer	80·0	74·66	78·40	76·92	74·60

These analyses require little explanation, and very little comment of any kind.

The glucose is of the $C_6 H_{12} O_6$ type, and yields only 48 per cent. to 49 per cent. of alcohol on fermentation; that is, 105 parts of it are only of the same value to the brewer in producing alcohol for his beer, as 100 parts of cane sugar or maltose. From this and the low percentage of fermentable matter which these saccharines contain, it is obvious of what little value they are to the brewer, especially when it be considered that he has to pay duty on the total weight, water included.

Four out of the five contain maltose, and only one contains a small percentage of dextrine.

The neutral carbohydrates are useless to the brewer, for although they increase the specific gravity of the beer, they are devoid of taste and "body-giving" properties. They, under no condition, yield alcohol, and cannot be converted like dextrine by the slow and gradual action of the beer into bodies capable of yielding this substance. My time will not allow me to pursue the consideration of these inert bodies.

If the analyses of these saccharines be examined and compared with that of the malt-wort given above, it will be seen that they have only one constituent in common, viz., maltose, and this exists in the saccharines in such small quantity, as to be of little consequence. It will be noticed also that the malt-wort contains a small proportion, 1·6 per cent. of non-fermentable carbohydrates, other than dextrine, but this, like dextrine, is capable of complete conversion into fermentable sugar by the slight acid action of the beer, and infinitely more rapidly than that body. In an old beer it is almost altogether absent, whilst the "body-giving" dextrine remains almost intact. These carbohydrates of the malt-wort are the low ones of the $C_6 H_{10} O^5$ type, and not the high ones (contained in the saccharines) of the $C_6 H_{14} O_7$, &c., type.

The latter may be looked upon as the result of a chemical reaction, which has gone too far, *i.e.*, the continued assimilation of water molecules has given rise to non-fermentable bodies.

A consideration of these facts, a knowledge of the action of malt-extract on starch, and the discovery that the same reaction takes place with sulphuric acid, within certain easily definable stages of the process, led us to the idea that a substance could be produced from the starch of rice, maize, &c., by the action of an acid which would have the same composition and properties as that derived from the starch of malt by the mashing process in the manufacture of beer, and thus render the cheaper grains, such as rice, &c., more available and suitable for brewing operations. This substance is dextrine-maltose. A slight consideration of its composition and properties will show at once its great superiority over all other malt substitutes offered to the brewer.

It contains in 100 parts in round numbers:—

Maltose	67
Dextrine	33
	100·0

Maltose yields the same proportional quantity of alcohol as cane sugar does, and the alcohol it yields is, in flavour, as far superior to the raw alcohol of the glucose of the saccharines, as that of fine malt whiskey is to potato spirit. In fact, the fine flavour of malt spirit is due to the fermentation of maltose, and that of the so-called potato spirit to that of glucose. This is another reason why the saccharines have not come into more general use. If we go back to the analysis of the most carefully prepared wort of pale ale, we find that it contains maltose 6·7 grams in 100 c. c.; dextrine 3·3 grams in 100 c. c., and as these substances, within certain limits, are the most important to the beer, it will be easily seen that we can increase them, without in any degree altering the character of the beer, either in composition, colour, or in flavour, by the addition of a proportion of dextrine-maltose. It will be seen too that the fermentability of the beer is not materially changed. 64 per cent. of its solid matter is fermentable, whilst 67 per cent. of the solid matter of the proposed substitute "dextrine-maltose" can yield alcohol in the first stages of the brewing process. Thus it is obvious, too, how by its use the proportions of albuminoid matter in the beer can be reduced without changing the fermentability of the liquid. There is far more yeast-forming albuminoid matter in malt-wort than is required to ferment its saccharine constituents, and an addition of dextrine-maltose in varying proportions will have the additional effect of removing a further quantity of this yeast-forming matter from the beer before it goes into the casks.

Manufacture of Dextrine-Maltose.

The process which we have adopted is a close imitation of the transformation process which the starch of malt undergoes during a properly conducted mashing process; only instead of making use of the converting action of the soluble albuminoid bodies found in malt, we employ dilute sulphuric acid, in order to effect the conversion of the starchy matter found in rice and other grains,

and we arrest its converting action, as soon as the requisite proportion of dextrine and maltose, which I have shown you to be present in properly-mashed malt, has been reached.

The opinions held by chemists, even within more recent years, have varied considerably, regarding the actual nature and proportional quantities of the products of transformation found in malt-wort. The French chemist, Musculus* who may be said to have made starch and sugar his special study, thought that the starch molecule consisted of $C_{18}\ H_{30}\ O_{15}$ and was resolved by diastase, with assimilation of water, into one molecule of glucose, and two molecules of dextrine, according to the equation:—

$$\underbrace{C_{18}H_{30}O_{15}}_{\text{Starch}} + \underbrace{OH_2}_{\text{Water}} = \underbrace{C_6H_{12}O_6}_{\substack{\text{Glucose}\\\text{(one third)}}} + \underbrace{2\,C_6H_{10}O_5}_{\substack{\text{Dextrine}\\\text{(two thirds)}}}$$

Another eminent French chemist, Payen† contested this view, and held that more than 50 per cent. of glucose formed, and that diastase possessed the power of converting dextrine likewise into glucose, but that the conversion ceased as soon as a certain quantity of sugar had been produced. This he thought of proving by the fact that in the alcoholic fermentation, the dextrine is acted upon by diastase, and the conversion recommences, as soon as the sugar, previously formed, has been converted into alcohol and carbonic acid.

A German chemist, Schwarzer,‡ agreed with Musculus' view of the splitting up of the starch molecule, but differed from him in supposing that dextrine is formed first, then sugar, and that the reaction ceases, when definite equivalent proportions have been produced. He also held that the product obtained when the reaction takes place above 65° always contained less sugar than that produced at a lower temperature. Above 65° to 70° C. the proportion he stated to be as one mol. of glucose to three mol. of dextrine, below 60° C. as one mol. to one molecule.

I mention this briefly in order to show that the views held by the chemists of the day, up to a very recent date, regarding the breaking up of the starch molecule were anything but orthodox or concordant. The confusion, as we can now readily see, arose evidently from the fixed idea that the sugar formed was glucose.

With the discovery of maltose, and the clear definition of its character and properties, the difficulty altogether disappeared. This body being a simple compound, reducing only two-thirds as much cupric oxide as glucose, and being totally fermentable, led to the idea that dextrine was fermentable and soluble in alcohol, because the portion of it, if I may use such an expression, which did not reduce cupric oxide was looked upon as dextrine, whereas in reality it was part and parcel of the new sugar-maltose. This is not an isolated case. Lactose, a well-defined body, reduces only as much cupric oxide as $\frac{7}{10}$th of glucose. The other $\frac{3}{10}$ths might just as well be called a dextrine as the one-third was which corresponds to the non-reducing power of maltose.

This conception of a dextrine, soluble in alcohol, or, Gamma dextrine, is but of recent growth. It did not matter that such a dextrine had never been isolated, nor that it ran counter to all the knowledge we possess of the chemical and physical properties of dextrine, such as insolubility in alcohol, total absence of copper oxide reducing power, colloid nature when dialysed, &c. Nor need I have troubled you with this phase of chemical opinion if an attempt had not come to my knowledge, to jeopardise, as I venture to think, a well-earned discovery by manufacturing the all but identical article, which we have called, in accordance with its well established chemical constitution and properties, dextrine-maltose, calling it, however, by the unmeaning name, "dextrum." I must crave your indulgence for having even for a moment detained you with this subject, but I would not pass on without entering a decided protest against this new evolution of the theory on the fermentation products in malt-wort.

That maltose is not a mixture of a mythical dextrine, soluble in alcohol (or of any other known or unknown properties), and of ordinary glucose, has been conclusively shown by O'Sullivan in a paper recently read before the Chemical Society, and submitted through that channel to the chemical world. From among several conclusive arguments brought forward in that paper, I will only quote that when a mixture of dextrine and dextrose is fermented, the dextrose alone undergoes transformation into alcohol and carbonic acid, and the dextrine remains untouched during 10 or 12 days even. Again, in a carefully prepared mixture of maltose and dextrose, the latter ferments first, and the maltose remains untouched until the dextrose has entirely disappeared from the solution, and, lastly, when maltose itself was submitted to fermentation it disappears as a whole, and yields 51 to 52 per cent. of alcohol.

I will now proceed to describe as briefly as possible the process and apparatus we employ.

When rice is employed for the purpose of manufacturing dextrine-maltose, it should be husked and finely ground. The rice-meal is first steeped in from one to one-and-a-half times its weight of cold acidulated water, or in water not higher than 40°C., and thoroughly agitated by mechanical means. It is then gradually introduced into acidulated boiling water, in the proportion of 100 parts by weight of rice to 250 by weight of the latter, care being taken not to allow the temperature to fall much below 90° C. The amount of acid—by preference sulphuric acid—may vary. We employ from one and a half to 2 or 3 parts per cent. A dilute acid is preferable, for although the converting action is not quite so rapid, it proceeds much more regularly.

The vessel in which the rice-meal is converted consists of an ordinary mash-tun, lined with sheet-lead and provided with steam coils and a stirrer.

As soon as the rice has become thoroughly diffused throughout the boiling water, a rapid conversion is observed. The liquid boils up briskly, and the steam has to be checked for a while to prevent its boiling over. This action is evidently owing to a chemical change. The rice-paste becomes rapidly thinner, when kept at a boiling temperature for about an hour, or an hour and a quarter. It is best and most expeditiously tested by

* Ann. Chem. Phys. [3] iv, 203.
† Ibid. [4] iv, 286.
‡ Journ. pr. Chem. [2] I. 212.

neutralising a sample with baryta-water or chalk, filtering and examining the clear solution by means of the polariscope.

The conversion may be considered complete when the rotatory power is + 171° or thereabout, indicating two parts of maltose (rotatory power + 150°) and one part of dextrine (rotatory power + 213°), *i.e.*

$$\frac{2 \times 150^\circ + 213^\circ}{3} = 171^\circ$$

By always infusing the same quantities of rice-meal and keeping up the same temperature, it is possible, after a few experiments, to dispense with the polariscopic determination altogether, and to obtain a liquor containing the proportionate quantities of dextrine and maltose, as they are found in malt-wort. The acid liquor is then carefully neutralised with good chalk to the extent of about 90 per cent., finishing off with milk of lime. This operation can be carried out with the greatest delicacy. It is preferred to leave the liquor, however, rather a trifle acid than alkaline. The strength of the liquor, after filtering off the grains and the gypsum through Taylor's filtering bags, usually amounts to 1,115 to 1,125, or 30 to 32·5 per cent. of solid matter, *i.e.*, about double the strength or original gravity of malt-wort required for brewing strong ales. It is of a light amber colour and filters very readily. It is next evaporated either in an open pan, or with greater advantage in a vacuum pan, to a concentration of about 1,200, or about 52 per cent. of solid matter. A little more gypsum and a little flocculent albuminoid matter are at this stage best separated by filtration, and the concentrated liquor finished off in a properly constructed vacuum pan, or in an open steam-jacketed pan, provided with an agitator, till it acquires a stiff viscidity. It is then run off hot into forms and cast into cakes of convenient weight, which on cooling, set hard, and are ready to be sent to the brewery. 78 to 80 per cent. of the starch in rice, in fact every particle, can be converted into dextrine-maltose.

The cost of manufacture, as you will perceive from the description, is not more than 25s. to 30s. per ton.

It is obvious, however, that there would be a considerable advantage arising to the brewer if, by an alteration of the present Excise laws, a concentrated solution of dextrine-maltose could be employed. As the law stands at present, I am informed, no saccharine matter—in fact, no fermentable substance of any kind—is allowed to enter a brewery in a liquid condition. This law presses all the more harshly upon dextrine-maltose, as this particular saccharine material could be readily obtained in the form of a concentrated liquid containing as much as from 75 to 90 per cent. of solid dextrine-maltose, in which form it could be kept as easily as any solid sugar.

I have no doubt there will be a time coming when these laws will be altered, and when the brewer will manufacture his dextrine-maltose as easily as he now infuses his malt, and will run it into the coppers, together with the proper proportion of malt-wort.

I need not trouble you at this late hour with any comparative statements as to the cost of production. Knowing as you all do the cost price of rice, maize, &c., and being now familiar with the mode of manufacture, you will be able to make out your own estimate. Considering, however, that we can offer to the brewer a malt substitute containing 95 per cent. of solid available matter, the saving upon Excise duty must constitute an additional recommendation. I have therefore no hesitation in saying that our dextrine-maltose (for the manufacture of which I have made arrangements with Mr. John Schwartz, sugar refiner, Pelham-street, Mile-end New Town) will be found to be the cheapest and most suitable malt substitute ever brought under the notice of brewers.

The objections sometimes raised by brewers to the use of saccharine substitutes for even a partial replacement of malt in brewing cannot be urged against the perfectly natural and legitimate substitute which we have called dextrine-maltose. It must be held to be quite a legitimate object for investigation, based upon correct scientific principles, and guided by experience, to solve the question what materials are capable of at least partially replacing malt in brewing, so long as the character and composition of the beer does not suffer thereby. In how far we have succeeded in doing this I may leave you to judge.

In conclusion, I will now only call your atten-to the results of the brewing experiment which Mr. O'Sullivan made, and of which I have bottled specimens on the table for your inspection.

DISCUSSION.

Mr. O'Sullivan said he had worked out this subject in conjunction with Mr. Valentin, and the result of their investigations into the composition of dextrine-maltose was such that any chemist who wished to isolate these particular bodies now could do so with the greatest ease and accuracy, and he could satisfy himself as to their character and composition.

Mr. Fordred asked how the maltose contained in this new body (termed dextrine-maltose), could be identified with the corresponding maltose found in real malt.

Mr. O'Sullivan replied that its identity was shown by its similar behaviour under the polariscope, and by its reducing only two-thirds of the quantity of copper oxide which glucose reduces. If cane sugar were split up into lævulose and dextrose, there was an increase of solid matter of 5·26 per cent.; but if starch were split up under this process into maltose and dextrose, there was a theoretical increase of 3·7 per cent. If these substances were submitted to the action of alcohol, and the alcoholic extract evaporated nearly to dryness, about 95 per cent. of the maltose was dissolved; it was impossible to dissolve the whole of the maltose at the first operation, but the alcohol solution contained nothing but maltose. If the solution were evaporated to dryness, and again taken up—in order to eliminate any slight trace of dextrine—with stronger alcohol, and to the saturated solution a small quantity of ether were added, it would be found that the sugar crystallised out.

Mr. Fordred said he wanted to know how this artificial maltose was identified with the natural maltose obtained from germinated grain.

Mr. O'Sullivan said that maltose could be crystallised out from malt-wort, though it was rather more difficult to isolate it, because the malt-wort contained other bodies. It could be done, however, and was found to have precisely the same rotatory power, and the same action on cupric oxide.

Mr. Reid asked how the nitrogenous matter in the rice was got rid of.

Mr. O'Sullivan said that when rice was subjected to the action of sulphuric acid, very little of the albuminoids dissolved out; they were much more soluble in alkalies than in acids.

Mr. Fordred asked if this new article (dextrine-maltose), produced by the action of acids on starch, was supposed to represent 50 per cent. of dextrine and 50 per cent. of glucose.

Mr. Valentin said no; it represented 67 per cent. of maltose and 33 per cent. of dextrine.

Mr. Fordred said the exact proportion did not matter; he wished to know if the whole of it could be fermented with yeast.

Mr. Valentin replied that this point had been mentioned in the paper. He had already stated that maltose was perfectly fermentable, and yielded the same amount of alcohol as cane sugar, viz., 51 to 52 per cent. All the specific matter was fermentable, except the dextrine. When dextrine and maltose were mixed together in certain definite proportions, the maltose fermented out, and the dextrine was left perfectly unchanged, even at the end of 15 days, whilst the fermentation of the maltose was over in four or five days.

Mr. Fordred said, it was difficult to follow a paper containing so many new facts and figures, without having it before one in print. It was well known that an extract of malt, say of 50 gravity, could be reduced, as was done by the distiller, below the specific gravity of water, so that the whole of the solid matter was converted either into alcohol or carbonic acid. It had, however, been ascertained recently with regard to this artificial glucose made from starch, that when yeast was applied, fermentation was set up, but it stopped as soon as the whole of the glucose was decomposed, andthe dextrine remained unattacked by the yeast. Now, an infusion of malt could be entirely attenuated down, under certain conditions, and he wished to know, therefore, if a solution of this material had actually been attenuated down below the specific gravity of water.

Mr. Valentin said Mr. Fordred was under a little misapprehension. The sugar which had to-night been brought under the notice of this meeting consisted of dextrine-maltose, and not of what the speaker was pleased to call glucose, andwhen handed over to a distiller, would ferment so far only as the maltose was concerned; the dextrine would not ferment. He had been dealing with brewing, not distilling, which was a different process altogether, and the material he had produced represented the natural product of the brewer as he obtained it in mashing. The sugar fermented most readily by yeast, but the dextrine remained unfermented. The attenuation therefore could only be carried to the extent that two-thirds were converted into alcohol, one-third remaining as dextrine for the slight after-fermentation. As he had showed by the analyses, a brewer would as soon think of fermenting the sugar-maltose entirely, as of throwing his beer away altogether; he must leave in the beer a certain amount of sugar; if he left too much, the beer when put either into cask or bottle would ferment too rapidly, if he left too little, he would leave it to any gentleman present to say what would be the result, the beer would be worthless.

Mr. Fordred wished distinctly to know if the whole of the solid matter of the new material (dextrine-maltose) could be converted into alcohol and carbonic acid.

Mr. Valentin—No. Nor is it desirable for the brewer to do so.

Mr. Fordred said that hitherto the object of the glucose manufacturers had been to convert the whole of their starch into glucose, and to leave as little dextrine as possible in it. They had always endeavoured to produce it as rich in sugar as the Inland Revenue standard formerly allowed, which was 80 per cent. Foreign glucose usually contained a large percentage of dextrine (15 to 20 per cent.), and was therefore not so valuable to the brewer. Another point was this, he understood Mr. Valentin to say that the proportion of dextrine and glucose in malt infusion was a fixed quantity, but in Dr. Graham's lectures on brewing in that room the whole matter had been for the first time made plain to any ordinary chemist, and it was shown that the proportion depended on the temperature, and the way in which the mashing was conducted; that in fact it was possible for the brewer to obtain from 100 parts of starch either $\frac{2}{3}$ glucose and $\frac{1}{3}$ dextrine, or $\frac{1}{3}$ glucose and $\frac{2}{3}$ dextrine, or any intermediate proportions. It seemed to him, therefore, that it was an error to take any definite constitution of the wort as a starting point.

Mr. O'Sullivan wished to explain what was meant by attenuation below the specific gravity of water. Mr. Fordred seemed to think that if this were done, it was a proof that the whole of the solid matter had been converted into alcohol or carbonic acid, but this was not so. The low specific gravity of the alcohol reduced the specific gravity of the whole below that of water very considerably, and the difference would be made up by the solid matter still remaining. If it were all converted into alcohol, the specific gravity would be about ·907. The distiller wanted to get as much alcohol as possible out of the starch, but the brewer's object was different; he required a liquid which had been fermented, but was still partially undergoing fermentation, and one which retained a certain amount of "body." If he proceeded in the same way as the distiller, he would obtain a solution altogether fermentable, but beer made in such a way would be very unpalatable. Hitherto even amongst chemists very crude ideas had prevailed as to what dextrine was; it had never been properly isolated and described, but it was upon it, substantially, that the brewer must depend for the body of his beer. It gave the round, full-mouthed flavour, which was generally found in well-brewed beer of the best quality.

Mr. Bosdet asked if this dextrine-maltose had been applied to any other manufacturing purposes, as he understood Mr. Valentin to say it might be. It had been stated lately in the *Tanners' Journal* that glucose might be used in various processes connected with tanning, and he should like to know if this new substance could be similarly employed.

Mr. Valentin said that if the paper had not been already of great length, he should have referred to a few other points, which would, no doubt, have been interesting, though, as yet, the dextrine-maltose had not been applied practically to any other purpose but brewing. He had been told, however, that it would very likely b useful in the evaporation of milk, and for other purposes, especially as it appeared to stand any temperature without change, as shown by the polariscope. As they said in the laboratory, it could be "bullied" to any extent, and this property would probably render it useful in many ways, which he was not yet prepared to specify.

Mr. Nash proposed a vote of thanks to Mr. Valentin, and took occasion to inveigh against the injustice, as he considered it, of the brewers' license duty.

Mr. Valentin, in reply to a question, said that the samples of concentrated syrup exhibited had not been in any way decolorised.

Dr. Graham said he had some two years ago, when delivering a course of lectures on brewing, called attention to the important researches of Mr. O'Sullivan, with reference to the action of albuminous matters on starch, and showed that his own work corroborated his results. It was not, indeed, until the publication of Mr. O'Sulli-

van's work that they knew anything about the constitution of starch, and the way in which it was modified in subsequent processes of brewing. Reference had been made to a statement of his, in the eonrse of those lectures, that within certain limits the brewer eould make a more dextrinous, or a more sugary, wort, but of course he did not wish it to be understood that in any ease the whole of the starchy matter, when converted into sugar, would disappear in the process of fermentation, and be converted into carbonic acid and alcohol. On the eontrary, a portion would remain, which he spoke of as dextrine. The analyses now given of pale ales, and malt, and the other details which had been brought forward were very important, and he had no doubt that this patent process, if the details were properly attended to, would be of great value to the brewer. He would not at all enter into the question whether there was anything distinctly original in the process, or how far it differed from that employed by French chemists and others.

Mr. Thorpe said the use of the various saccharine matters hitherto employed by brewers had this effect, that the beer produced was deficient in body, and most persons could tell by the taste whether or not such materials had been used. In the case of this new substance, however, it appeared that a certain amount of dextrine was introduced, as well as the readily fermentable material present in other saccharine bodies. This appeared to be a distinct advantage, and would lessen the danger of having the beers deficient in body. But there was another point, viz., the flavour. That was probably due to some little known bodies present in malt, and you might obtain a beer containing a sufficient quantity of sugar, alcohol, and all the well-known substances, and yet from deficiency in these nitrogenous flavourings it would not be so pleasant as ordinary high-class beer. It, therefore, appeared doubtful whether it would ever be possible to use these artificial aids to any great extent for first-class beer. If, however, they were only used in moderation with sufficient malt to furnish the flavour, very good results might be produced.

Mr. Valentin said the process could be regulated with the greatest nicety, and could reduce the angle shown in the polariscope from 213° down to 171° If the process were carried farther, the maltose underwent another change, and became converted into glucose; which had quite a different angle. He might point out to any practical brewer that he had in this way four or five hours of slow fermentation before him, and he gained so much time for his fermentation. He might say in reference to the question raised by Mr. Thorpe, that the odour given off in the evaporation was very pure and sweet, and the brewer might draw, so to speak, upon this additional time for producing his flavour, and that beer made from this sugar must yield more of the flavouring matter produced from the fermentation and chemical changes which the sugar underwent on the way to the formation of alcohol. The flavour of wine was due to these ehanges, though whether the presence of albuminoid matter was connected with it, he would not then discuss.

The vote of thanks having been passed,

The Chairman said it was peculiarly the province of science to examine with accuracy what the process was which took place in these wonderful changes of form and structure, as, for instance, in the fermentation of tho juice of fruits, or of malt infusion; and then to isolate those conditions which were found favourable to the desired result. It was certainly natural and proper in wine-making for the chemist to add sugar of various kinds, when the juice yielded was too acid; and also to add to the expressed skins and seeds of the grape, which were capable of imparting a fresh fermentation and a certain flavour, other sugars, and it was found that the product was as useful for the same purpose as the original grape juice. In the case of beer, it was sure to be useful to endeavour to arrest the proeess of change which went on during fermentation, at that particular point which had been found by examination to be most advantageous. He should like to ask, therefore, if that process could be relied on for eonstancy and regularity, so that a constant proportion of dextrine eould be depended upon.

Mr. Valentin said the change was so remarkably equal and steady, that a difference of five or ten minutes in the length of the process could be traced with the greatest ease by means of the polariscope. When the angle of + 171° was passed, the maltose underwent a change towards glucose. The change through which it passed would probably be marked by another sugar of an intermediate polariscopic angle. In many experiments he had succeeded very well without taking a polariscopic reading at all, simply by observing the time of digestion. There was no difficulty in obtaining any quantity of precisely the same character.

The Chairman said there could be no doubt that this process would prove very useful in the hands of practical men, and of course its value would greatly depend, amongst other things, on the certainty with whieh it could be obtained of any particular composition. It seemed to be within the power of the operator to modify it, and if, as he now understood, it was practically possible without an undue amount of skilled labour to stop it at any desired point, it would add greatly to the value of the process.

A vote of thanks to the Chairman for presiding, which was carried unanimously, brought the proceedings to a close.

SIXTEENTH ORDINARY MEETING.

Wednesday, March 22nd; William Galt in the chair.

The following candidates were proposed for election as members of the Soeiety:—

Arteaga, Alberto de, 9, Austin Friars, E.C.
Brown, Samuel Stanley, 19 and 20, Cornhill, E.C.
Dougall, Archibald, Kidderminster.
Hille, Fritz, Chiswick.
Jevons, William Stanley, Withington, Manchester.
Kimber, Henry, 79, Lombard-street, E.C.
Marston, John, 24, Bradford-street, Birmingham.
Montefiore, Sir Moses, Bart., F.R.S., F.R.G.S., F.R.A.S., 35, Park-lane, and East Cliffe-lodge, Ramsgate.
Moon, J. F., 39, King Henry's-road, N.W.
Moon, Robert, M.A., 45, Cleveland-square, Hyde-park, W.
Salamon, Nathan, 41, Gordon-square, W.C.
Sanford, Henry Ayshford, 29, Chester-street, Belgrave-square, S.W.
Swain, Thomas Septimus, 5, Addison-crescent, Kensington, W.

The following candidates were balloted for and duly eleeted members of the Society:—

Banmann, F. W., Neva-cottage, Clapham-park, S.W.
Borthwick, Lord, F.S.A., 35, Hertford-street, W.
Brett, Robert W., Gas Works, Hertford.
Brothers, Francis William, 16, Priory-street, Cheltenham.
Curtis, James, Alpha-villa, Stanstead-road, Forest-hill, S.E.
Furnival, Thomas, junr., The Brampton, Newcastle-under-Lyme.
Hancock, Peter, Gas Works, Sandbach, Cheshire.
Jones, Charles Edwin, Tintern-villa, Compton-street, Chesterfield.
Martin, Josiah, Model Training School, Auckland, New Zealand.

Nicholson, Benjamin, Annan, N.B.
Pixley, Stewart, 21, Leinster-gardens, Hyde-park, W.
Stewart, Duncan, London-road Iron Works, Glasgow.
Walduck, Charles Edward, 148, Gresham-house, Old Broad-street, E.C.

The paper read was—

IMPROVEMENTS IN RAILWAY COUPLINGS, AS A NECESSITY OF THE DAY.

By T. Attwood Brockelbank.

However much I may doubt my own ability to place before you in an attractive manner the subject of improvements in railway couplings, I am in hopes that the importance of the subject will be sufficient to warrant me in bringing it before you to-night.

My object in view is, to demonstrate as fully as the time at my disposal permits, that this is a problem urgently demanding solution, and in the course of my address to impart some of the practical experience I have gained in an endeavour to solve it.

At the outset of my paper I am careful to state this, because I am conscious that on such a practical question, the author can hardly fail to appear to his hearers partly as a critic. Now I desire to remark that no practical opinion shall I offer, unless it is founded on experiment made by myself or others. Again, in statistics I shall be careful to appeal to Blue Books and other authorities for any statements I may make. Further, I know the reader of a paper here is looked upon as something of a teacher.

Many whom I have now the honour to address are well able to educate me on this subject, and could our positions be reversed, at their feet most gladly would I sit for instruction.

Railway officials in general, and some in particular, must be well nigh weary of the title, railway improvements. Signalling, the block system, and doubled lines, constitute a continuous break to their peace of mind, and they must feel that for them in this life there can be no good permanent way. For between the desire to develop the traffic on their own lines, and the necessity of providing satisfactory dividends for importunate shareholders, and their efforts to fulfil the requirements of the Board of Trade, they must earnestly wish that either one or the other—it is not for me to suggest which—should be buried in the deepest depths of the sea.

To most people the term railway accident signifies collisions between trains, in fact, as something dreadful in the papers. Each receives from his own pet journal the idea that the block system, a continuous brake, an electric apparatus, either singly, or perhaps the whole in a lump, will immediately do away with all accidents whatsoever.

Upon the occasion of any disaster, our old friend, the "constant traveller," rushes into print with most impossible suggestions, closely followed by the equally erratic "anxious passenger," who wants to know who it is that winds up the station clocks? or why it is the express trains are not compelled to carry a hospital surgeon, instruments and all. These persons I can only class with an old but inestimable lady of my acquaintance, who until lately fully believed that locomotive Jehus drove the train from the down to the up line, and *vice versâ*, at their own sweet will, and was impressed with the belief that the engine whistle meant that her train was coming; and when she sees a train crossing a multitude of points, say, for instance, at Clapham Junction, that really that was something like driving a train.

But apart from the many paltry and ill-considered suggestions so constantly offering, there is one opinion which appears to have taken great hold, viz., that accidents will not cease until all the lines in the kingdom are doubled throughout. As practical people, all those here to-night cannot fail to acknowledge that the realisation of this project may have very serious results to all immediately concerned. One would be purchase of lands at an enormous price, the pulling down and wholly or partially rebuilding every bridge and tunnel in the country, with the possibility, after all this outlay, that at some points the multiplication of crossings would intensify existing evils, whilst great reduction in dividends, if not in some cases temporary stoppage of their payment, must ensue.

Since these lines were penned, I have come across some weighty remarks, which, as they show my opinions are well supported, I must ask your permission to quote.

At the British Iron Trade Association Meeting, held a few weeks since, a director of one of the large railways spoke upon the subject of "Separate Lines for Mineral and Passenger Traffic" to this effect:—"It seemed quite clear to him that, if this suggestion were adopted, there must be a great increase not only in the passenger but also in the goods rates: the duplication of the lines would even not secure the safety of the passengers, for the goods trains would be compelled from time to pass over the other lines in order to communicate with the other side of the railway."

He could quote the opinion of an engineer, who was not only very eminent but strictly honest in matters of this kind, who, when consulted by the board, stated that he did not think there would be any increased safety whatever by the doubling of the lines, because the accidents did not commonly happen in consequence of one train overtaking another, but in shunting (and, gentlemen, I pray you, mark that opinion) one train crossing the line occupied by another.

At the same meeting, the chairman of a railway said, "no gentleman present would dream of asking for legislative action to compel railway companies to construct two sets of lines; the impracticability of the scheme was manifest, if there was taken into account the cost that would be entailed upon the railway companies; and he submitted that it would be impossible to spend the hundreds of millions sterling that would be required without getting some dividends for it."

Having thus introduced my paper, and shown you that the project of doubling the lines is one having very little prospect of realisation, I want you to consider with me whether in the adoption of improved couplings of vehicles in trains a more expeditious means may not be found by which chances of collision may be reduced, a more punctual despatch of traffic arrived at, and increased

safety and large economy in working be the result.

My first task is to show the necessity which exists for such an alteration, and upon this point I cannot do better that consult the opinions of the Chief Inspector of Railways, who, in his annual return for 1873, says on page 1:—

Accidents to servants do not appear in many cases even now to have been reported by certain of the railway companies, and the number would, if the whole truth could be ascertained, be considerably increased.

The returns for that year, viz., 1873, show 1,944 servants killed and injured; in the following year they rose to 3,603, or within a few hundreds of double the number of the previous year. On page 7 he continues:—

I cannot do better than repeat, as applicable to the experience of 1873, the means of safety which were also demonstrated in previous years to be required.

In a list of ten such recommendations, we find that No. 5 is "Improved Couplings of Vehicles in Trains," and towards the conclusion of this paragraph upon the means of safety he adds:—

It is by the introduction and the employment of these and other means of simplicity, safety, and convenience in working, that increased punctuality may be obtained, and accidents may in a great degree be avoided.

In the returns for 1874, the Chief Inspector repeats the principal requirements, among which again appears "Improvements in the Couplings of Vehicles," and on page 30 occurs the following important opinion:—

The total number as above stated killed and injured of employées alone is in itself a startling and melancholy result of a year's working, but the much greater proportion in certain classes of railway servants demands the most serious attention: it will be right not only to dwell upon it for one year, but to scrutinise annually with increasing care and accuracy the causes of so many casualties, not for the sake of producing excitement on the subject nor for the sake of censure, but in order to calmly consider the means by which so much destruction of life and limb may be lessened, and to determine deliberately upon the improvements in construction or in working, in appliances or in system, in training or in discipline, which may with that view be advantageously adopted.

The remarks thus expressed by one whose official position is a guarantee that his opinions are well weighed before they are publicly delivered, become entitled to grave consideration, and I would ask you to bear in mind that in treating of the accidents to servants I am simply bringing forward evidence of the extent of the evils complained of, in no sense as implying censure either on companies or individuals, but solely as demonstrating the grave necessity of the adoption of such an improvement. We have seen that in 1873 the accidents to servants were 1,944. On 31st December last, for the year 1875, they reached 4,383. What are then the "certain classes of railway servants" whose condition of working "demand the most serious attention." From the same report the answer comes with unmistakeable clearness. "One in every twenty men engaged in shunting operations received death or injury during that year." Could any words of mine add greater force to the serious import of such a statement?

In this same return I find that of eight shunters in one part of this kingdom who were working in health and strength on the 1st January, 1874, two had been killed, and four others injured; thus making six out of eight by the following Christmas.

This leads me to the question, "How do these accidents occur?"

Now, in preference to giving you a description penned by me, I propose to read you a graphic account given in the *Times* newspaper in October, 1873.

The *Times*, after referring to the mortality from accidents to railway servants, and dissecting the Board of Trade returns, continues:—

The first question which suggests itself is, How do these men come by their deaths?

Mainly in two ways:—

First, by slipping when attempting to climb upon or to descend from an engine or carriage in motion. Secondly, by being nipped by the buffers or knocked down by carriages while going or standing between them for the purpose of fastening or unfastening the couplings.

In a tolerably extensive station, the men engaged in shunting have to travel such distances in the course of the day, that, in order to save themselves exertion, as well as in order to save time, they never walk when they can ride. A man is wanted at a spot a hundred yards from where he is standing, and an engine comes towards him, going to that spot at the rate of five or six miles an hour. He turns and faces towards it, catches hold as it approaches, jumps upon a step and climbs up, in most cases easily enough. But one day he is tired and less nimble than usual, or habit has made him careless, or the step is slippery, and he misses his footing. His hand instinctively retains its grasp, and he is thrown, as a matter of course, obliquely under the wheels; so that in most cases both his legs are crushed, even if he be not instantly killed.

Another typical form of accident occurs when, in making up a train, carriages moved by an engine, are propelled against others standing on the line; it is the duty of a man to go in between them, so that he may seize the time when the buffers are driven in by the shock, and the carriage frames are close together, in order to slip the coupling ring of one carriage over the hook of another. He ought to be at his post before the moving carriages come up, but sometimes he is a little behind-hand, and he tries to dash in at the last moment. If he miscalculates by a hair's-breadth, he is caught between the buffers and squeezed to death without the possibility of escape. Sometimes the moving carriages approach too quickly, or with too much force, and if the man fails to move back with sufficient promptitude, he is knocked down and injured or killed. Of course there are other causes of accident, but these cases are comparatively exceptional, and in dealing with the great mass of accidents to railway servants they may be fairly left out of account."

It may be asked, What is being done to lessen and abolish such dreadful risk as is now attendant upon these duties of railway *employés?* And, in answer to such a natural question, I propose to take a passing glance at the attempts made in this and other countries to find a remedy.

Partly owing to the development of railways in this country, and to some extent, doubtless, to the comparative safety which attends the annual conveyance of so many millions of passengers, one

is very apt to suppose that the adoption of improved appliances usually begins in England; and this idea is fostered by the fact that improvements adopted in this country do, as a rule, ultimately find a place on Continental and other railways. But with respect to railway couplings, as far as I can judge, a very superficial search for them shows that in this question we are by no means first.

Inventive minds in America, Belgium, Canada, France, Germany, Russia, Spain, and in some of our colonies, have exercised themselves in this direction.

America, of course, is behind no nation. Car-coupling inventions with them are reckoned by the thousand. In this country we reckon by the hundred (barely two hundred), and Germany follows.

As we progress, some of the reasons why no change has been made in this country will become evident, and the retention of the old hook-and-chain, which is substantially the same as it was fifty years ago, may not appear so wanting on the part of the railway companies as it has hitherto seemed to some people.

I was told by one railway official that not nearly so many railway accidents occur in shunting operations as there used to be. This gentleman spoke, I presume, from personal investigation, but certainly the following Board of Trade Returns do not bear out his opinion :—

	Shunting and Coupling.			Falling from Vehicles.	
		Increase on 1873.			Increase on 1873.
1873	.. 504	—	..	318	—
1874	.. 972	468	..	421	103
1875	.. 1,038	534	..	583	265

This gives a total in three years of—

Shunting.		Falling off Vehicles.
2514	..	1322

3,836.

Let us hope that these additions are really owing to better records; and, assuming that this is so, we may fairly conclude that at least 15,000 servants have been killed or injured in these two ways since 1856. Now, it may be said, what have coupling operations to do with falling off vehicles? and to those unacquainted with railway working I would say, that in a very large number of shunting-yards nearly all vehicles are brought to be coupled up on the run, and are also uncoupled when on the move, and for this purpose the men hang on the wagons or stand on the buffers, and tilt the coupling chain off the hook with the toe, and are conveyed, for the purpose of coupling, riding on the buffers; hence a very large percentage of accidents from the falling from vehicles is caused by these proceedings.

Before we plunge into a consideration of the remedies offering, we will, for easy reference, jot down what are the requirements of traffic which must be fulfilled in this country, and having these well in view we will proceed to examine a few types.

The most important point of all, as I take it, is to do away altogether with any necessity of servants being engaged in the coupling of vehicles, and for this purpose an automatic connection is imperatively needed; again the uncoupling must be accomplished without any necessity for servants going between the vehicles, consequently any gear we put must work from either side of the vehicle. Of course we must be able to connect and retain our hold and to disconnect equally well on straight roads, on inclines, and on the very sharpest curves. Moreover, as there are now nearly a million of vehicles, engines, passenger carriages, horse-boxes, wagons, both companies and traders in this country, immediate alteration is impossible. We must, therefore, provide effectively for a gradual replacement of the present system. It follows also that having such an immense number of different styles of vehicles on hand we must not interfere with any of their present fittings, we must permit free drawbar action, we must allow for any reasonable difference in the height of vehicles, and provide for great varieties of length of buffers (in this country some are 11 inches only, others two feet and over) and yet further we have to deal with doors in the flooring, doors in the sides, doors in the ends, none of which must be tampered with.

When we have dealt with the vehicles themselves we get face to face with that eternal subject of conversation in this country—you will anticipate my allusion—I mean the weather; even snow in June is not unheard of, and if our coupling be one needing nice adjustment, say working by springs or counter-weights, or even requiring that hinges should work smoothly, rusting will inevitably bring it to grief some time or other, even if it survives concussion and vibration; the force and effect of the latter anyone who has experienced the delight of sitting in a brake carriage which is defective needs not to be reminded of. These provided for, the importance of tightening up the passenger carriages must be considered, and to crown all, mechanical ignorance on the part of those employed in working it has to be borne in mind, and we may safely conclude that unless our coupling is one that the most ignorant shunter cannot mistake, we shall be in a strait.

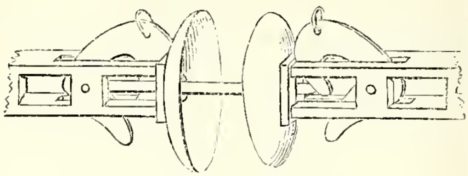
To enable you to follow me with ease, I place before you in order the coupling requirements of English traffic. I take them to be :—

1. Gradual replacement.
2. Retention of spring action of drawbars. Allowance for—Different heights of vehicles. Variety of buffers. Loading and unloading.
3. Weather—Frost, snow, fog.
4. Night, darkness.
5. Working on sharpest curves.
6. Easy disconnection under all circumstances.
7. Tightening of passenger carriages.
8. Simplicity, a main characteristic.

We will now proceed to consider some different types of couplings.

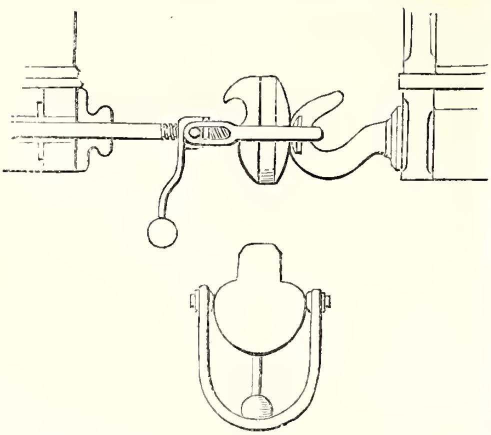
The earliest patent record in this country is dated 1825, and with the chain and hook about that date generally adopted, we now find ourselves surrounded. There are a few exceptions in this country, they are notably — the Pulman car, which, as a coupling type, stands alone; there is the connection on the Festiniog Railway, narrow gauge; one other, which I believe is common to the Isle of Man, the Isle of Wight, and the Sutherland railways; and on some of the Brighton trains there is a central buffer connection, and in the close coupled trains of the Under-

ground lines and the Charing-cross lines and North London railways, with which many here may be familiar. A few patents, most of them very crude ideas, appear in the English Patent-office during the next 20 years. In 1847, or nearly 30 years ago, a link and pin connection, much the same as that now in use so generally, was patented.



In the following year an invention was patented which is worth attention; in lieu of a pin to hold the link, the inventor designed a hook of novel shape, hung upon and revolving on a pin, which, on collision, rose and dropped into the link. I think you will agree with me it is not equal to the link-and-pin connection.

In 1854, a very sanguine inventor proposed to connect vehicles by means of a piston working in an oil chamber; the idea was original and ingenious, but I should hardly think it ever obtained trial by any of the railway companies.



In this we have an inventor whose soaring imagination is apparently far in advance of his practical knowledge; here is an attempt at a combination of centre buffer, loop, our old friend the hook, and a tightening apparatus. The loop, which is to be hinged to the buffer, has first to be placed over the hook, then by revolution of the screw the loop is drawn in, and the vehicles are tightened up.

Since 1861 about 150 couplings have been patented in the country, and these may roughly be said to resolve themselves into four or five different types. Of these types or classes I select one each for illustration, but before we do this I will illustrate two inventions, which although they are unsuitable to the general traffic of this country, are so complete in themselves as to merit attention.

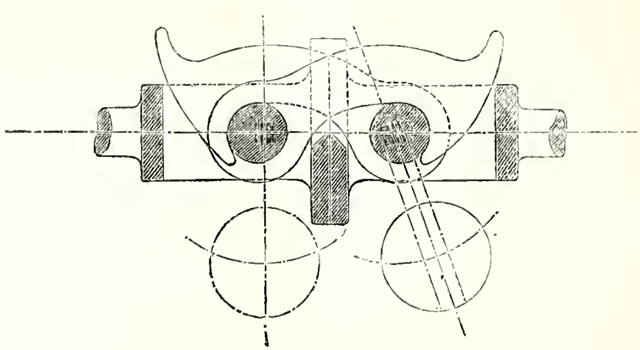
The first is that adopted by the Festiniog Railway, in Wales. It is the invention of Mr. G. Percival Spooner, and I am given to understand it is the only continued buffer and draw-bar that will couple together, and I am assured it works well.

The combined arrangement of draw-bar, buffer, and coupling consists of a round rod of sufficient strength, having a suitably shaped head of the forked form to admit a coupling link or hook connecting one to the other, without interfering with it when buffing; at the other end is a spring box, so arranged that whether drawing or buffing, a spring action is obtained. Each buffer-head is fitted with an eccentric and hook, and the coupling can be effected with both hooks as shown on drawing, or only one.

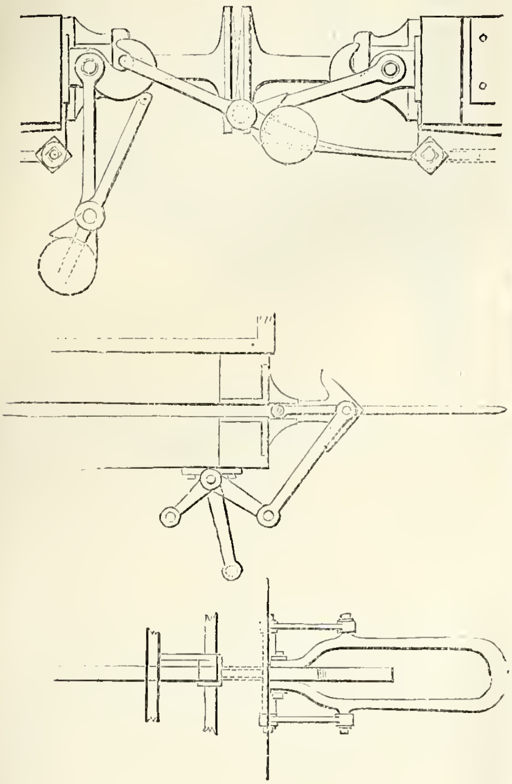
When it is desired to couple, the coupling weight should be lifted up until the hook or hooks will pass over the eccentric-pin, and then allowed to fall back again; this it will do to nearly its lowest position.

One end of a light chain is attached to each hook, the other being fastened to the carriage; by this means the hook can be more readily lifted up for the purpose of uncoupling, or suspended at pleasure.

The second is one patented by Mr. Louis Sterne, (see page 421), this, as far as I know, is most original in getting first at setting the pin in position, then by the shape of the buffer curves inside compelling the support, first to release its hold to get out of the way, and then, after allowing the pin to effect its connection with the link, comes down itself on the link to keep it in its place. To those among you who are interested in automatic mechanical working, I would add that for simple efficiency it is

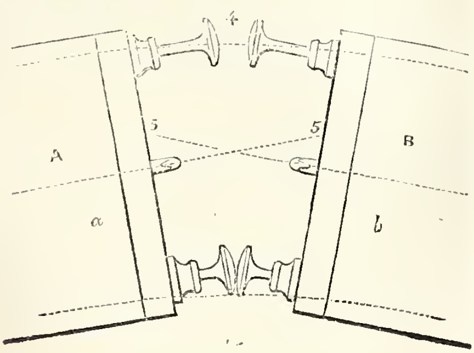


good; but beyond this you must understand I do not venture on an opinion. It is not fitted for English traffic, and therefore any opinion I might have can hardly find place in my address.



The largest number of patents of any particular type is that which show an endeavour, by means of levers or cranks, to place the present chain or a long link (we shall see it is immaterial which it is) upon one wagon over and round the hook of another wagon. In some years there are two or three patents with this object, numbering in 14 years about the same total.

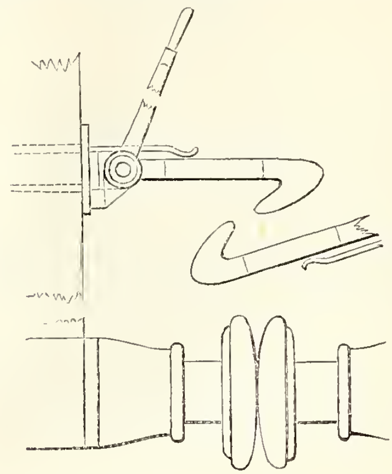
The promises of advantages in this direction were so evident that it is not surprising to find that several of this type have been well tested, others never tried at all, but there is one point upon which they fail.



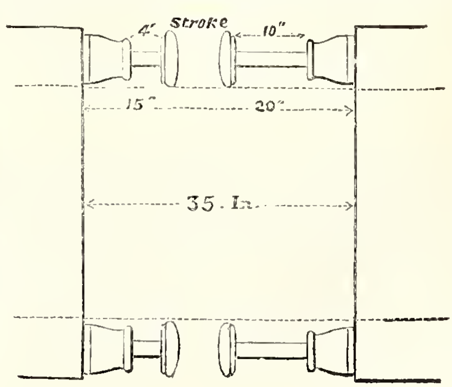
On a curve $3\frac{1}{2}$ chains a wagon A is approaching another wagon B, to be attached to it. Now if we follow the line of A's drawbar until we arrive at the headstock of B we see that we miss B's drawhook centre by nearly half a foot, and it follows as a matter of course that if we reverse our curve we shall miss B's drawhook on the other side by a like difference, so that we have nearly a foot of loop necessary to connect. Now I must here tell you that there are many curves in shunting yards as sharp as $2\frac{1}{2}$ chains; therefore, after allowing say an inch each side for increased loop for these sharper curves, and three inches for strength of arms, we have some 15 inches across as necessary to obtain a connection.

A glance at our list of requirements may suggest other points unfulfilled in this type.

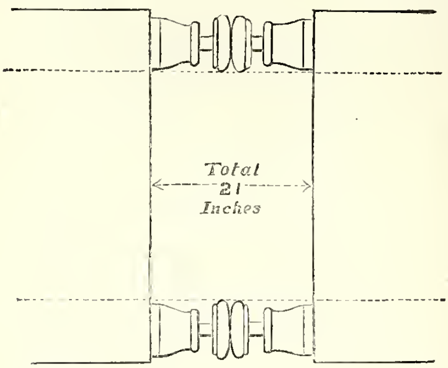
I pass on to next diagram.



In this type we have a principal not unlike the Pulman car connection. Deep-sided vertical hooks all turned the same way; each of these hooks are made to yield to springs, so that on collision they each yield sufficiently to allow of the hooks to fly back and unite. This connection is automatic. The disconnection is accomplished by drawing back one or the other hook. This is a very taking coupling, and apart from the springs, which will never act for any length of time in railway work, it is simple, but there is one point in our list of requirements which it will never overcome,



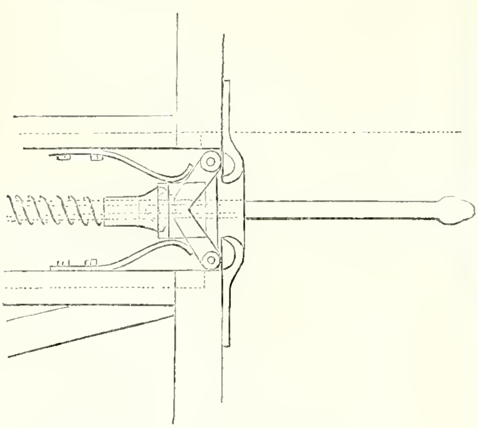
I mean different lengths of buffers. I must ask you to take for granted, that when you fit up a carriage which has a long buffer, you must have your hook the right length of that carriage. Consequently, a vehicle with a 20-inch buffer and 10 inches of stroke has a hook, say 26 inches long, for we must allow for thickness of end, and also for sharp curves; this vehicle comes into contact with another, with a 15-inch buffer, also supplied with its proper length of hook, and this connection when on the run is all right, but suppose our engine



suddenly puts on the brake, or the vehicles are shunted against buffer stops, what will be the result?

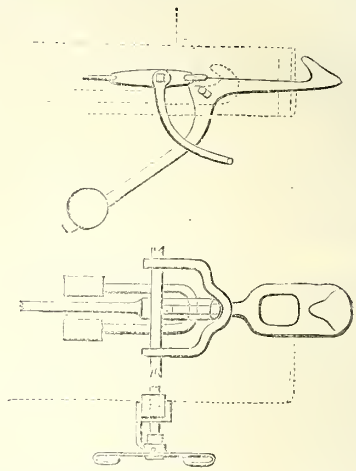
A's buffer is reduced to 10 } 21
B's „ „ 11

so that we have 21 inches of space in which to put 26, where must the other five go unless right through the opposite headstock?



In this type we have a truly ingenious connection. A round-pointed bar is placed in the jaws of an opening in the end of one carriage, which on being propelled against another similarly furnished, forces itself between the jaws of that carriage and is securely held by them. Upon the jaws being parted by a peculiar wedge, the rod is free to leave as it entered.

Now in this type the length of buffers again appears to prove an obstacle, but from a different aspect. In this instance the bar between two carriages must be double the length of one buffer. Now suppose we have twice the length of a fifteen-inch buffer, we have thirty inches in all, and we are short five inches of the connection distance necessary to attach to a twenty-inch buffer carriage. You must, therefore, either always have some different lengths of bar ready at hand, or when your bar is short must drive in your buffer against stops to get your connection. A most dangerous, and often fatal experiment.



One more illustration before we take up the working of English traffic.

This coupling has been very well tested. A flat-shaped iron plate with a hole in it, and a hook on its upper surface, is placed at one end of a long rod, which is hinged about half way on to the drawbar of the wagon, and at the opposite end of this rod is a weight to counterbalance the connection.

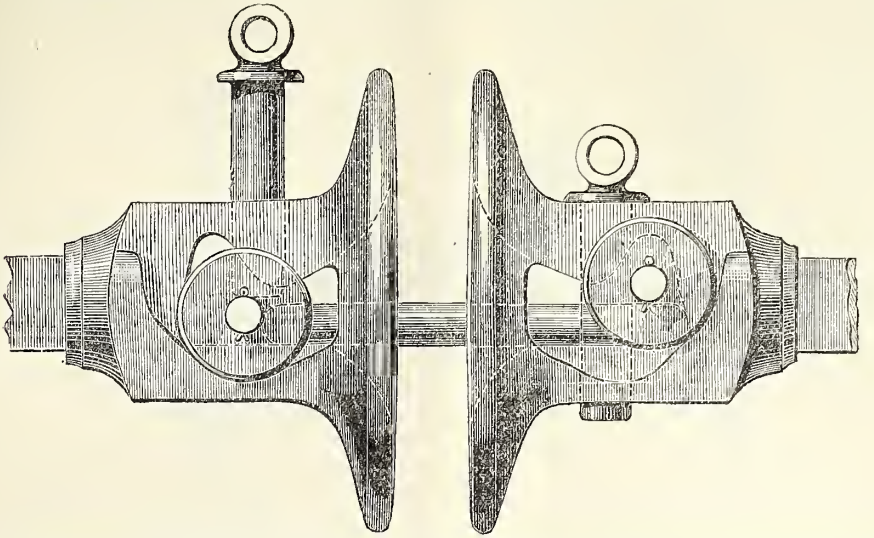
Both vehicles are fitted alike, and on approaching each other, one plate slides under the other, thus lifting its own counterbalance up to the underframe of the carriage, until such time as it gets under the hole in the opposite plate, when the counterbalance forces the hook into it. By depressing the coupling, or by raising the weight, the coupling is freed.

The experience on working this coupling appears to be that the oscillation of the counterweights is liable to disconnect the coupling.

It may have been noticed that I have said nothing upon the tightening of passenger carriages in any one of these types. I have not done so for this reason; when the coupling has possessed tightening gearing, there are so many details to be entered into that they would have taken up too much time.

Let us now observe a few of the conditions of traffic, and endeavour to find out whether each of us here have not, as passengers, a very great interest in the adoption of improved couplings.

Imagine I am a goods' train guard. I leave London at noon with thirty-five loaded wagons. I ought to have started at 10.45; but, owing to my engine being busy shunting, and the shed goods not ready, I did not get away till 12. We ran on to Blackley, and arrived there at 12.50; put off three wagons, and took up two. Well, we



get on to Yellowby, Bluefield, and Redtown; of course, much behind time, but, by dint of working hard—I and my mates have been doing everything on the run, mind you—we have caught up our time by eleven minutes, and we did hope to make a good journey; but at Purple-road, where we are timed to take off and on for 15 minutes, it took us 78 minutes. And by this time we had run nearly a hundred miles, and, as you will see, we have lost two hours and twenty-two minutes, and, of course, had so much less spare time.

On the return journey we started in pretty good time, but yet, in consequence of delays in shunting, arrived in London an hour and a half late. Perhaps you may conclude that this is an unusual sample. It is a fiction, it is true; but, that I might satisfy myself, I timed one train four journeys in succession. This journey should have been performed in $7\frac{1}{2}$ hours, including stoppages. The best journey was done in $8\frac{3}{4}$, or $1\frac{1}{4}$ late; the longest took 13 hours 50 minutes, or 6 hours and 20 minutes over time. Moreover, I was informed by a manufacturer in the midland counties that one train has been as many as twenty hours late more than once during the past winter.

Now you will understand that I bring forward these examples to show that, if despatch of traffic can be facilitated by automatic coupling, passengers, as well as the companies themselves, are very much interested in its adoption. Of this we may be sure, that a main element in the delay of any goods train is the overtime occupied in shunting and coupling. When we consider the conditions under which a countless array of passenger, goods, mineral, and empty trains in each day's traffic is worked, the conviction is forced upon us most strongly how wonderfully well the work is done. How traffic managers, inspectors, station masters, pointsmen, signalmen, guards, shunters, and drivers (many of them at the risk of life and limb), each dependent on the other, so well carry on the traffic is a mystery. It can only be by individual effort, which in an army, numbering as it does 300,000, becomes difficult to realise.

So far as we have been able to judge, the couplings we have already looked at do not sufficiently meet traffic requirements, but for the immediate purpose of my argument, I will assume one has been found, and that we have still a lion in the way, in the cost of its adoption. There are about 400,000 vehicles, more or less, owned by the companies, to be refitted, and with the cost, say, for example, at £5 per vehicle, we have a total expenditure of £2,000,000 to be divided amongst some 400 railways and branches.

In 1874 the working expenditure of railways, renewal of stock, compensation, &c., was £31,182,503, whilst the receipts from passengers and goods only were £57 millions, and I can quite understand it is most necessary that companies should be careful how they rush into expenditure, but let us see whether expenditure in improvement does not sometimes mount up. Taking six of the leading English lines whose reports have, so far, been issued, we find that in the half-year ending with June next, it is intended to expend upwards of six millions, and in subsequent half-years, upwards of fifteen millions. The precise particulars are as follows:—

	During this half-year. £		In subsequent half-years. £
Great Northern ..	1,065,000	..	1,970,136
Lancashire and Yorkshire	690,000	..	2,287,618
London and North Western	1,124,813	..	5,567,529
Manchester and Sheffield	265,600	..	1,425,000
Midland..........	1,650,000	..	1,899,703
North Eastern....	1,303,433	..	1,998,400
	6,098,846		15,038,386

It will be seen that the London and North Western takes the lead in this statement, having in hand an expenditure of nearly seven millions. The Great Northern, the Lancashire and Yorkshire, the Manchester and Sheffield, the Midland and the North Eastern come next, with from nearly two millions to upwards of three.

In addition to this, the amount of new capital powers being sought for by the leading railways are as follows:—

Midland	£4,033,333
London and North Western	3,066,800
Lancashire and Yorkshire	2,000,000
Manchester, Sheffield, and Lincolnshire	1,333,300
North Eastern	1,332,000
Metropolitan	1,282,333
Caledonian	1,113,300
Furness	800,000
South Eastern	666,666
Great Eastern	640,000
Great Western	600,000
North British	586,000
Glasgow and South Western	550,000
Glasgow (City) Union	550,000
London and South Western	501,858
London, Chatham, and Dover	500,000
London, Brighton and South Coast	266,666
Other existing companies	2,264,109
Together	£21,087,365

It may be very fairly urged that such an enormous outlay should not be swollen by further demands.

Acknowledged, but I do not urge the outlay all at once, but gradual replacement as old rolling stock wears out. Let us estimate the cost if thus gradually adopted. In about ten years from now, judging from past experience, every vehicle now running will have to be replaced, and in about the same period the traffic will increase 50 per cent., and even if we put the extra cost of automatic coupling to be as much as 30s. per wagon, this gives only £600,000 as the total cost of the improvement, and this expenditure will be spread over ten years—a bagatelle for railways. But you will say, how about traders' wagons? what do you say to them? Merely this, that as each wagon which enters a company's territory has to conform to the rules of that company as to the build, shape, and strength of materials, and pass a rigid inspection, the companies, on this point, are masters of the situation.

In the working expenditure of 31 millions, to which I alluded, there are two little items, of both of which passengers hear a good deal. The first is compensation to passengers and goods, which it is estimated, with its attendant expenses, cost the companies for the 12 months ending 30th June last, just one million of money.

Now without entering upon the large subject of reduction of cost of labour, which must result on the adoption of an improved coupling, it will be conceeded that if only 20 collisions were prevented by the better dispatch of goods traffic thus gained, that in this item alone of compensation, and its attendant cost, a very handsome dividend on the expense even of immediate conversion would be realised. On the second item, I shall have something to say at the close.

Now I have touched upon saving of time, of labour, of collision, saving of life and limb, both of passengers and servants, and of reduction in cost of compensation for goods and passengers, but there is a subject on which I must touch, it is one which can hardly be ignored by employers of labour. I mean compensation to employés for death or injury received during work, and caused by the non-adoption of known appliances and conditions of safety in working.

I have but to direct your attention to this list, and we see death or injury received in one year.

Mines (say)	10,000
Railways, 1875	4,383
Boilers (defective)	1,600
Factories	3,155
	19,138

a total of for ten years say, 191,380.

Now I could go into these figures and deal with the percentage of arms and legs lost, and point out how hundreds of little children fall victims in what are termed the peaceful pursuits of this merry England, but as that might be considered sensational I hold back; but after making good allowance for carelessness of workpeople, nearly 200,000 every decade fall victims. Therefore, I say, no employer of labour can ignore this more than possibility.

At the outset of my address I started the proposition that the problem for solution was to to find a coupling that would fulfil the various conditions of English traffic.

The tenor of my remarks on this head have, I trust, shown that I by no means underrate the obstacles to be met. Consequently I do not venture to come before you with a crude idea for discussion, if I can demonstrate that I have overcome ninety-nine railway requirements, and should one other arise I think I may be confident I shall surmount that one.

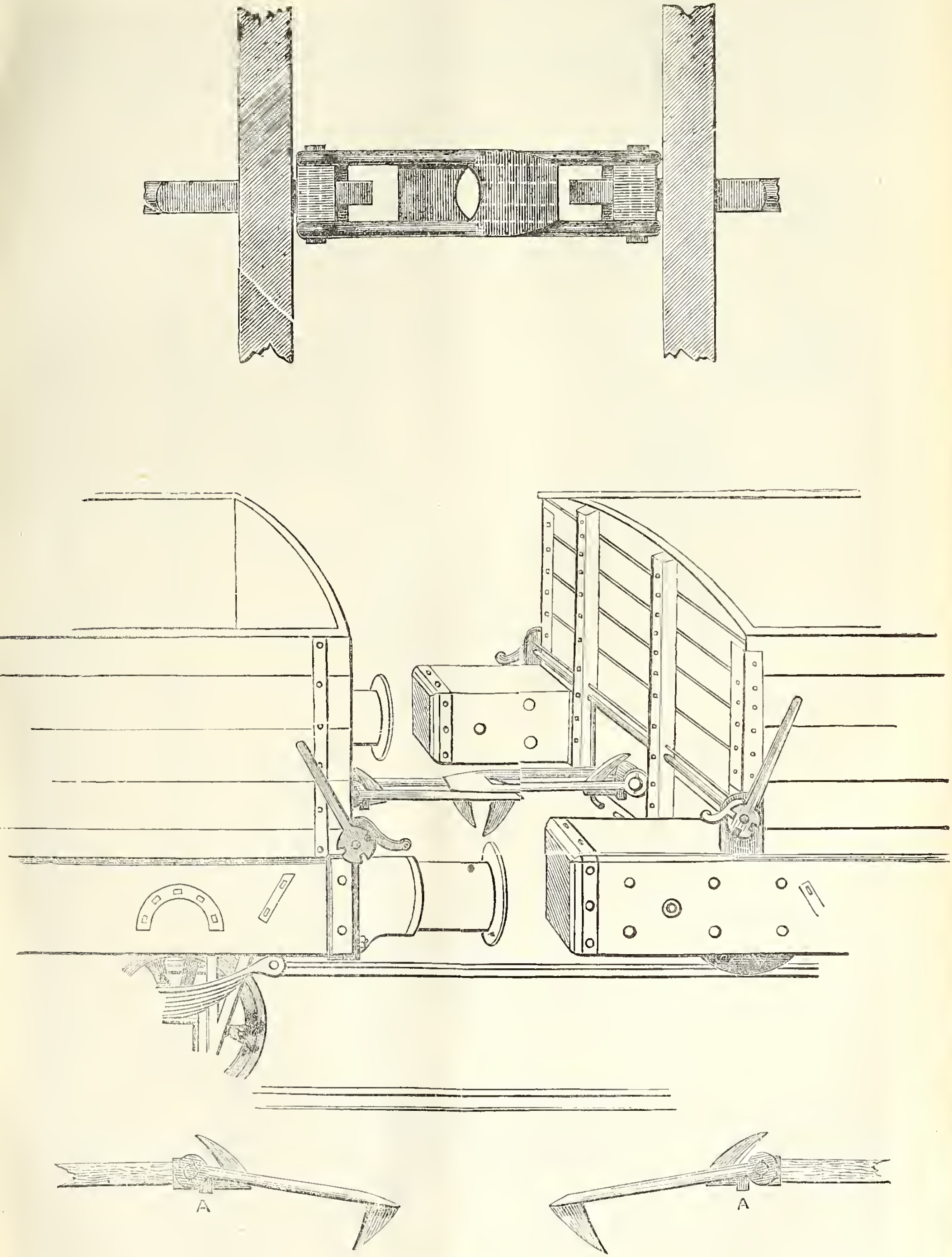
As you may naturally suppose, very many people indeed have discussed the invention I submit, and the conclusion I arrived at is that only practical testing can convince. I will, therefore, run through the result of actual experiment.

Here are two arms forming a loop, flattened into a wedged shaped end, at the underside of which is a hook. Upon coming together, either coupling runs over into the other. When slack each coupling rests on its support at an angle. Upon the tension of the drawbars each rises to a straight position, and the action on the run is ever varying on the sharpest curves, on inclines, with a light wagon or a train, with steady running or violent collision. I have never in actual practice succeeded in getting it unhooked.

To show you the certainty of connection, there are some in this room who have seen a heavy engine run sharply at a light passenger carriage standing alone on the line and hold it. Again on the run three or four wagons have been sent running away on an incline, and followed and brought back several times to a dead certainty by the engine and other vehicles sent after them.

Some friends of mine—I regret they are unable to be present to-night—vividly remember the violence of concussion which threatened to send them out of the wagons *nolens volens* into the six-foot way. Some of you may say, well, but have you not more to explain about its shape and form? No, there it is, and as regards the coupling itself, I have nothing more to say. But now let us see how it meets the general requirements.

Gradual Replacement.—On the present drawbar of the vehicle I weld a square-shaped head, with a drawhook or an eye for chain if desired. The chain of an approaching wagon can be placed on the hook, and the drawbar action is complete.



WAGGON COUPLINGS.

Variety in Length of Buffers.—This is met by making my loop correspond to length of buffers.

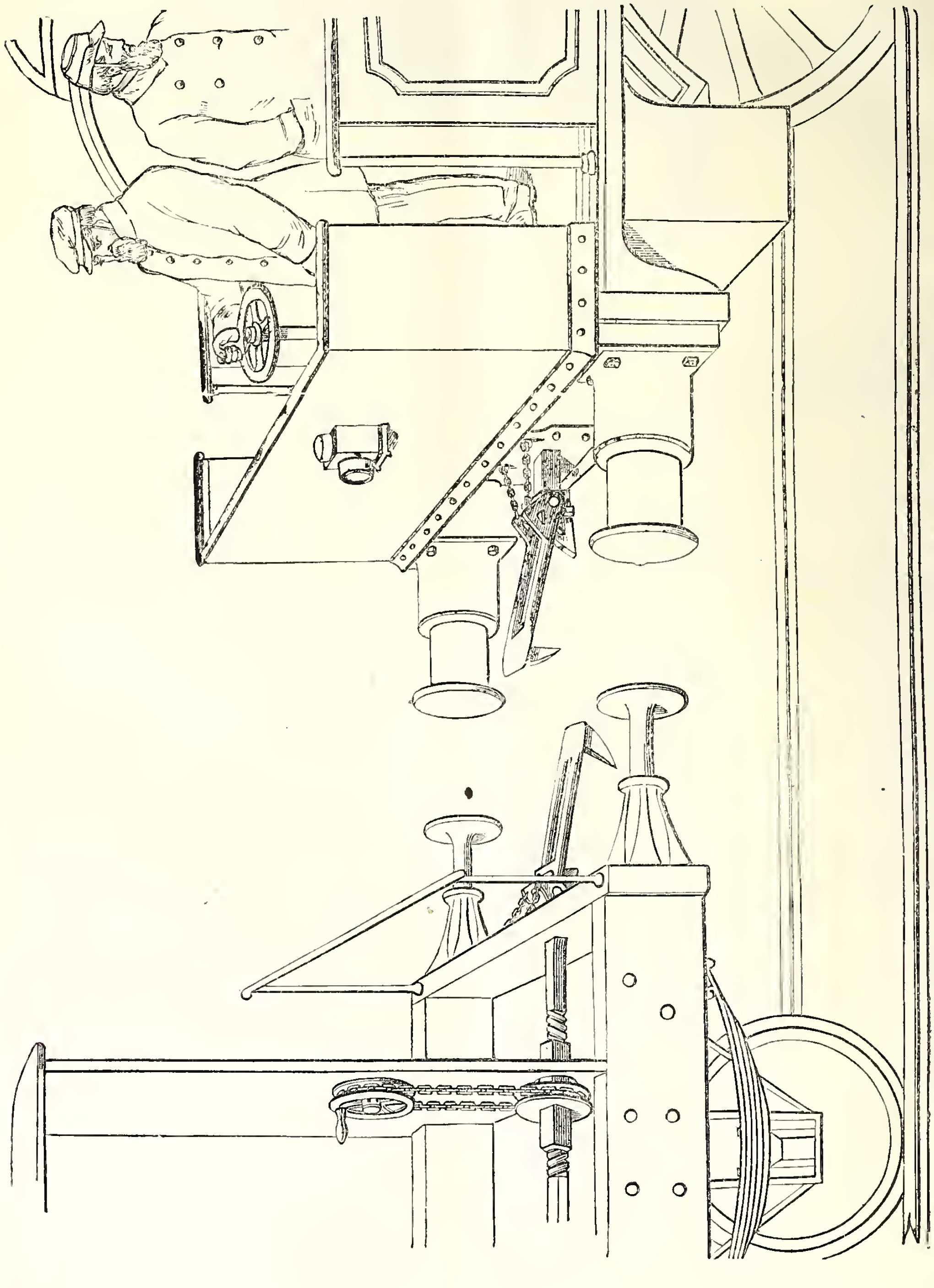
Height of Vehicles.—I can secure connection at least seven inches of difference.

Loading and Unloading.—The uncoupling gear being entirely free from, and independent of, the coupling itself, is restricted to no position, angle, or place, and can be adjusted to suit every description of vehicle.

Weather.—As every joint is loose, and as the very working on the run of one other vehicle in connection leaves one coupling easy, no rusting can harm it.

Night Darkness.—This is the first time I have touched upon this requirement, but it is self-evident that the disconnection must be as sure with your eyes shut as wide open. In fact there is no necessity of looking after it if your wagon buffers touch.

Simplicity.—I hope it speaks for itself.



Engine and Carriage Tightening Gear.

Tightening Apparatus for Passenger Carriages.

To some persons this may appear complicated, but it is one of the simplest things in engineering. Here is the drawbar of a vehicle fitted with my coupling. I cut it in half, and make on this piece a right-handed screw, and on that a left-handed screw. I take a piece of iron about 8 or 9 inches long, and about 2½ square, and pierce it to receive these screws, and we have a continuous drawbar upon this square. I place a wheel, the revolution of which turns the bar, and either elongates or contracts its length; on elongation the coupling comes out from headstock, the little chains tighten, and the coupling lifts to release itself.

The first trial I ever attempted with this coupling was with the carriage apparatus, and I mounted the brake van, and with a train of five carriages behind me, signalled the engine to couple up on approaching the brake coupling, and ran into that of the engine. Naturally enough great interest surrounded my actions, and I directed the driver to do two things only, go on when I signalled, and stop when called upon. We started and got up a brisk pace, and without any warning to engine-driver, I unloosed and released the train from the engine by a few turns of the wheel; at the same moment I signalled go on, the engine flew away without its load; the driver, fearing something was wrong, at once shut off steam, and put on the engine brake. The impetus of the train carried it gently up to the engine, and the connection was again complete.

The driver and stoker jumped down and commiserated with me upon the supposed failure of my apparatus, saying new attempts very often failed at first.

Slipping carriages, I know, is done daily; but I have never yet seen a coupling which you can tighten, loosen, and uncouple by one and the same action on the run.

One advantage I may be permitted to draw attention to. There need be no anxiety with this coupling lest an engine attached to a train should, through careless tightening, have to run loose for, say, fifty miles without being rectified. Either the guard or engine-driver, or both if necessary, can render the connection completely rigid.

At the commencement of my address, I showed, first, that the chief inspector has over and over again called for improvements in this direction. We inquired how it was these accidents occurred, and, with the requirements of couplings well before us, we proceeded to examine the various types; then, pausing to consider the relative cost of compensation, &c., to the railway companies, arrived at the conclusion that the expense of such improvement, when set beside the outlay they incur in other directions, is a mere bagatelle. But you will remember I said that there was another item in working expenses reserved for consideration. That point was railway passenger duty, which, in 1874, cost the companies about £600,000. I offer a suggestion to the companies. The Railway Companies, we are repeatedly told, desire the repeal of this tax to enable them to provide increased facilities, such as workmen's trains. Suppose, instead of doing this they think of their own workmen, and appear before the Select Committee, now being appointed on the subject, with a proposition to this effect.

"As responsible employers, we are deeply concerned at the awful sacrifice of life, and the injuries incurred by our servants annually in the working of traffic, but, we cannot ask our shareholders to incur the expenditure necessary to carry out the recommendations of the Board of Trade in improved couplings, without prospect of recouping themselves such outlay. But, Parliament may aid us to carry out this improvement upon the following arrangement:—

"We want five years in which to complete this alteration. During that period all passenger duty paid by us shall be lodged in the hands of trustees. On completion of alteration, all such money shall be repaid to us, and the duty itself from that date repealed entirely.

"Thus might this improvement be provided without any real cost whatever to the companies, and with the advantage that on repeal of the tax, not only would a handsome bonus be in hand, but dividends in future would be largely augmented. Would Parliament grant this? Undoubtedly, especially if it were enforced on its notice, that unless something is done 16,000 servants out of a total of 40,000 must be killed or injured in the next ten years over shunting operations, and falling off the vehicles."

Ere I close, I would draw attention to the fact that many of these couplings here before you have been tried on different lines in Scotland and England, and that, therefore, we must not for one moment assume that the companies have been doing nothing in this direction. Where they do appear to be wanting is the ability to understand the imperative necessity for united action on the matter. This is, as many of you know, an almost impossible position for them to assume; for, as we have seen in a figure, there is no union in the whole body.

DISCUSSION.

Mr. George Smith had taken a great deal of interest in the subject of such apparatus, and had found that as railway buffers took a pressure of from five to six tons to force them home, the consequence was that in a collision in a train of ten carriages there was a force of about 200 tons pent up and tending to recoil, and this was often the cause of a great deal of the damage which ensued. Having, as a railway engineer, devoted a deal of attention to this subject, he had patented in 1875 a buffer with an air cylinder, so arranged that when driven home beyond a certain point the air escaped, and there was no recoil. To bring out the buffer there was a travelling beam from one buffer-rod to another, and to that the draw-hook was attached, so that when the connection was made the buffer-heads were always together. He thought such buffers might be very well used in connection with these patent couplings.

Mr. Brockelbank asked whether there were two buffers, or one in the centre, and how they acted going round curves.

Mr. Smith said there were two buffers, and the travelling-bar allowed for curves. It would also remove the difficulty of long and short buffers.

Mr. Tomlinson did not quite understand how Mr. Brockelbank got over the difficulty of coupling when running on a curve, it being a central action.

Mr. Brockelbank said his coupling answered perfectly on a curve; allowing for 3-in. variation either way, he only had to make the loop 6-in. wide.

Mr. Bancroft said that at present if the coupling gave way, the safety chains at the sides preserved the communication, but this protection would be gone under the proposed system. He doubted also if the click of the coupling would bo hoard amidst the multitude of noises which were often going on in a shunting yard. The sharp curves spoken of were, he thought, very exceptional in a shunting yard; and the life of a carriage was rather understated at ten years. He had known carriages run for twenty.

Mr. Brockelbank said the remark about the safety chains had been made by more than one eminent engineer, but his reply had always been that, if they could show him that in any collision or accident the chains had really been of service, ho would allow there was something in it. He admitted that in starting from a station, if from some mistake a coupling had not been fastened, the chains would take the train on to the next station, but in an accident the sudden jerk would assuredly break the chains ninety-nine times out of hundred. They were only of the same strength as the coupling, and as you could never have two chains so exactly adjusted as to take the pull at the same moment, they would go one after the other as tho tension came upon them. It was true that a curve of 2½ chains was very rare, but even in private yards where space was limited he had known cases in which the curves had been altered from 2½ to 3 chains, so that engines might go in and fetch their loaded wagons, and in the neighbourhood of London he could point out two shunting yards where there were curves of 2½ chains on which he had tried his couplings with success. The question of the ring of the coupling was a question which could only be decided by practical experiments.

Mr. Bancroft could state from experience that drawbars did sometimes break, and the train come safely in with the side chains.

Mr. Brockelbank thought from his investigations that no severe accident had been prevented, or the evil consequences averted, by the use of the side chains.

Mr. Robert Manuel asked if this apparatus were applied to every passenger carriage, whether inquisitive travellers might not wind it up, and so leave half the train behind?

Mr. Brockelbank replied that the apparatus could be so applied so as to work with a key from outside the carriage, or any convenient place, where only the guard could have access to it.

Mr. Manico asked if provision was made for the great difference in the vertical height of the buffers or centre coupling, as he had known as much as 8 inches difference. Also, if it was anticipated that the coupling links would stand at the required angle without constant attention and setting up. With a mass of iron 6 inches wide, which must weigh something considerable, he thought the leverage over the small stop would be so great that there would be a constant dropping.

Mr. Brockelbank said he had provided for a difference of 7 inches in the height of the wagons; and practically he had found the coupling to work with a difference of 9 inches. He could not answer the last question, which must depend on practical experience. It had not, however, been raised hitherto by any one to whom he had shown the apparatus.

The Chairman said they had heard a very interesting and instructive paper, for which all would agree that they were much indebted to Mr. Brockelbank. Improvements in railway management, and inventions connected therewith, especially anything which might tend to diminish accidents, were of the highest public importance, and therefore anything which was brought forward with a view to enabling the public to travel with greater safety, and to lessening the number of accidents amongst railway servants, ought to be most thankfully received, and fully discussed, especially by those practically acquainted with the subject. There was scarcely any matter more closely connected with the cause of accidents, especially in the case of shunting operations, than the system of coupling, and there was no doubt that any invention which would tend to diminish the danger of accidents in this direction would be eagerly welcomed by all classes, and would be a cause of congratulation from a national point of view. For reasons which some present would no doubt understand,* he must decline to express any opinion one way or the other as to the success of Mr. Brockelbank's invention, but this he might say, that if he could show to practical men, and it could be successfully carried out, that it was superior to any other, and that thero was no insuperable difficulty in the way of its practical application, there could be no doubt it would be speedily adopted. The question which had been raised with regard to the side chains could only be met by those who had a thoroughly practical acquaintance with the subject, but it was certainly an important question whether those chains were absolutely requisite, and whether cases did not occur in which they were of great use, and prevented a severance of the wagons. The settlement of this question would decide the applicability of the invention, but it could only be settled as he had said by men of great practical experience. In any case, however, they were all indebted to Mr. Brockelbank for his able paper. He had stated with great clearness the principles he contended for, had gone to great expense and trouble in showing how they could be carried out, and had presented his statistics in a most interesting way. He had no doubt the subject would be brought under the notice of railway managers and directors, to whom, after all, they must look for the introduction of improvements, but it was manifestly to their interest to adopt anything which was practically useful. Mr. Brockelbank had shown that the expense would not be considerable compared with the vast expenditure of the railway companies, and, therefore, he had no doubt, if it could be shown that side chains could safely be dispensed with, and these couplings only depended upon for keeping trains together, that the railway companies would take up and adopt the invention. He concluded by proposing a vote of thanks to Mr. Brockelbank.

The vote of thanks having been passed unanimously,

Mr. Brockelbank, in responding, said he was now making up a train consisting of 16 vehicles, which he intended to show under all the conditions which railway companies could desire; and if they would only give him facilities for trying it, he was quite prepared to stand or fall by the result of the experiment.

Errata in Mr. Seyd's remarks in the discussion on the 13th inst., on the "Fall in the Price of Silver," in the *Journal* of the 17th inst. Page 360, right hand column, line 37 from top, for 100,000,000 read 1,000,000; page 361, right hand column, line 12 from bottom, for £500,000 read 400,000 ounces; page 361, right hand column, line 6 from top, for 250,000 millions read 250,000.

The production of quicksilver in California has acquired considerable importance since 1830, when it was first prepared there from cinnabar. According to a German authority, the entire production last year was 28,200 jars (at 76½lb.). In 1869 it reached 48,700 jars. The principal works are those of New Almaden, New Idria, and the Redington mines. The production of the first have been decreasing for some years; that of the second is stationary; while the third is rapidly advancing. With each of the three furnaces recently erected at Redington 20 tons of ore are treated daily, so that 1,200 jars of mercury can be supplied every month. The export of mercury from California is on the decrease; from about 15,000 jars in 1871 it fell to some 6,700 in 1874. Most of it goes to China, Mexico, South America, and Australia; no cargoes have come to Europe for some years past.

* Mr. Galt is a member of the Commission on Railway Accidents. [Ed. *Society of Arts Journal.*]

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(*Subsidised by Parliament.*)

The results, giving important information for public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. Number of visitors for the month of February, 1876. When they are counted by sight the letter "S" is used, when by turnstile the letter "M":—

INSTITUTIONS.	Amounts voted in 1875.	Number of Visitors in February.	How counted.	REMARKS.
	£			
1. British Museum	107,471	24,058	S	Return refused. Number given for January of year last published in estimates. (1)
2. National Gallery, Charing-cross	6,346	45,288	S	Open 17 public days. Total for the year 1875, 806,250. (2)
3. Kew Gardens and Museum	21,257	7,705	S	Open on Sundays and week days. (3)
4. South Kensington Museum	39,019	57,279	M	Total for year, 839,212. Open daily all the year and in the evening, except Sundays, Christmas Day, and Good Friday. (4)
5. Bethnal-green Museum	7,325	34,980	M	Total for year, 522,098. Open daily all the year and in the evening, except Sundays, Christmas Day, and Good Friday. (5)
6. National Portrait Gallery, South Kensington	1,956	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines & Mining Record Office, Geological Museum, Jermyn-street	9,070	5,153	M	Open daily, except Sundays and Fridays, and in the evenings of Mondays and Saturdays.
8. Patent Office Museum, South Kensington	..	17,675	M	Total for the year 1875, 265,233. Open daily, except Sundays. (8)
9. Edinburgh National Gallery	2,100	5,291	M	(9)
10. Edinburgh Museum of Antiquities	..	4,245	M	(10)
11. Edinburgh Museum of Science and Art	10,509	22,430	M	Total for 1875, 455,784. (11)
12. Edinburgh Botanic Gardens	1,750	2,273	M	(12)
13. Dublin Museum of Natural History	1,717	8,250	M	Open daily, and in the evening. (13
14. Glasnevin Botanical Gardens and Museum	2,224	3,749	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland	2,389	7,410	M	(15)
16. Museum of Royal Irish Academy, Dublin	200	..	M	(16)
17. Zoological Gardens, Dublin	500	3,341	M	Open daily, including Sundays. (17)
18. Tower of London	1,500	21,864	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall	..	16,684	S	Open daily, including Sundays. (19
20. Royal Naval Museum, Greenwich	1,190	1,806	S	Open daily, except Fridays & Saturdays. (20)
21. India Museum, South Kensington	5,883	1,928	M	Paid for by Indian Government. (21)
22. Hampton Court Palace	3,465	..	M	Open on Sundays, and on week days except Fridays. (22)

(1) Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays.
(2) Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays.
(4) (5) Open morning and evening till 10, on Mondays, Tuesdays, and Saturdays. Students' days—Wednesday, Thursday, and Friday, 6d. entrance.
(7) (8) Open till 10 in evenings of Monday, Tuesday, and Saturday.
(9) (10) (12) (15) (16) (20) No information as to opening.
(11) Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days, Monday, Tuesday and Thursday; admission 6d.; other days, admission free.
(21) Open on Mondays, Tuesdays, Fridays, and Saturdays, one penny admission; on Wednesday and Thursday, sixpence admission.

CORRESPONDENCE.

AQUARIA.

SIR,—On the 1st of March, 1876, Mr. W. S. Kent read, at the Society of Arts, a paper on Aquaria, and I was invited by the Chairman, General Cotton, to join the discussion which followed the discourse, but I preferred, to make my remarks in type, and I now will do so having before me the paper (as printed in the *Journal of the Society of Arts* for March 3rd), crowded with errors both of commission and omission, from end to end.

Mr. Kent's chief point seems to be his objection to the plan of aquarium construction which I have successfully pursued for many years, and which consists in using unchanged sea and fresh water, kept in constant circulation, between a series of show tanks containing animals and plants exposed to light, and an underground dark cool reservoir, containing several times as much water as the collective capacity of the show tanks, Mr. Kent maintaining that large dimensions in the reservoir are unnecessary, for reasons which he does not set forth. I therefore have now to describe why I believe and know they are requisite.

The average temperature of the air of the British islands, as determined from observations made during about one hundred years, is about 48° F. This, however, does not express the true temperature in its great variations, which range from occasional extremes of 102° F. above zero, to 8° F. below it, thus giving so great a range as 110° F. Before me is a chart of British temperatures from the year 1771 to 1853, in which these variations are shown in zig-zag lines, which Mr. Hugh Gordon has in a very beautiful manner converted into series of elliptically equated curves, which place befor

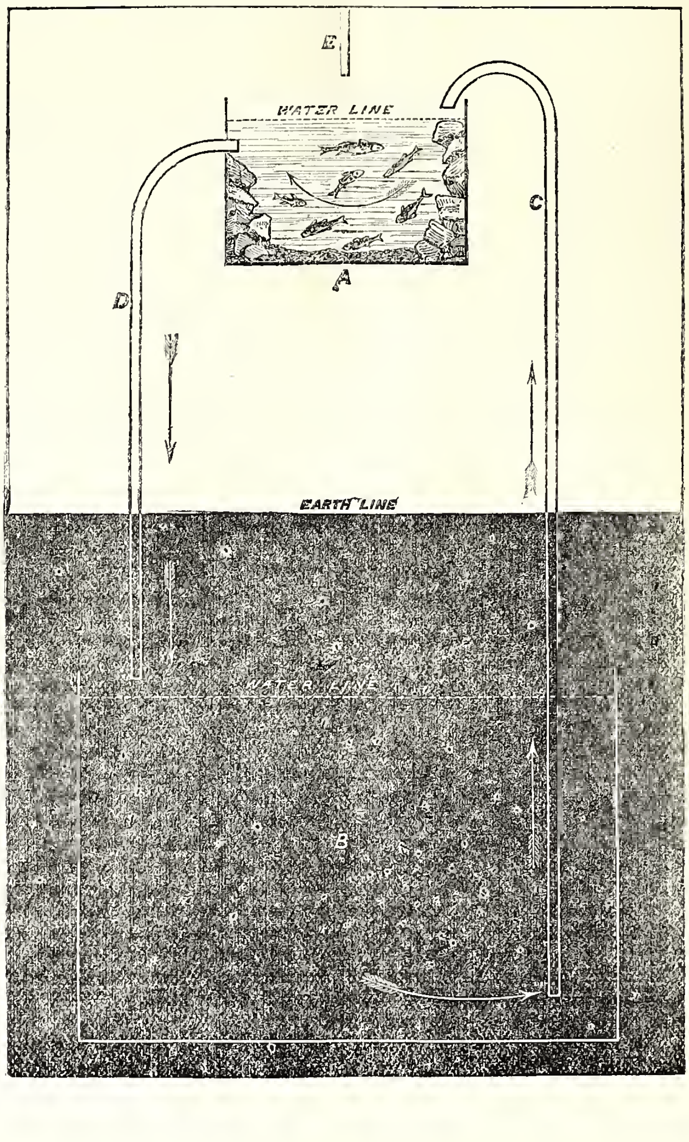
the eye in a striking way the cycles of years of hot and cold temperatures which mark our very variable climate.

At or near the surface of the seas of our islands, where aquarium animals came from, the range, however, is very much less, the water being neither so hot nor so cold as the air, especially of the air in inland places, the temperature of our sea water being from 45° F. to 65° F., and having an average of about 60° F. This tolerably uniform temperature of the sea water tends to give a similar uniformity to the air immediately in contact with it, which accounts for the mildness of the climate at seaside places in winter.

In the *Engineer* of October 15th last, is an illustrated aquarium communication by me, but not signed, in which I have described the manner in which this uniformity is effected. The water is heated at the earth's equator, and a surface current of warm water flows towards both of its poles, and there becoming cold, it sinks and returns towards the equator in an under-current, the sinking, and therefore the primary cause of the motion, being caused by the behaviour of sea water under the influence of cold, as a consequence of the density which it acquires from the salts it holds in solution.

Dr. W. B. Carpenter, who has devoted much attention to oceanic circulation, has also explained all this, and has testified to the correctness of the means which I have introduced in aquaria to represent what nature does.

Fresh water behaves somewhat differently to sea water when exposed to cold, but our rivers and other streams, and ponds, and lakes, similarly to the sea, do not have such great ranges of temperature as our air, and, to sum up on this point, it has been found that the best temperature for the sea and fresh water of aquaria in which to keep British aquatic and non-lung-breathing animals is from 55° F. to 60° F. throughout the year. In winter this temperature might be easily maintained by means of fire, and in summer it might be kept down by refrigerating apparatus; but without some such counteracting means of warming and cooling, an aquarium would injuriously follow the temperature of the atmosphere. It occurred to me, however, in the year 1854, by seeing what was done in the aquarium of the Regent's-park Zoological Gardens, where the sea-water reservoir was, and is, too small, and by the familiar domestic appliance of a cool cellar or underground back kitchen, that a much easier mode of equalising temperature in aquaria might be used, and the various steps by which I



reasoned-out and worked-out such success as I then, and have since, attained are described in a five column communication I made to the *Gardeners' Magazine*, and in pages 65 to 102 of the "Handboook to the Royal Westminster Aquarium," both published on January 22nd last, and both written during the week previously. The main principles involved in the water circulating system in all public aquaria constructed under my supervision, turn on the law governing the following facts:—If a quart of water at 100° F. be added to a quart at 50° F., the mixture of the two will be 75° F. If one at 100°F. be added to two at 50°F., the result will be 66·6°F. If one at 100° F. be added to three at 50° F., the mean will be 62·5°F. If one at 100°F. be added to five at 50°F., the result will be 58·3°F.; and if the proportions be one to twenty, the mixture will be 52·3° F., and so on; the larger the proportion of the colder mass being to the warmer, the nearer the mean of the two masses will approach to the temperature of the larger mass. The entire thing is shown in the accompanying diagram, where B is a large underground, cool, dark, reservoir, C is a pipe conveying water from B to the show tank A, containing fishes, or other animals, and D is a pipe conveying water from A to B. The six arrows indicate the direction in which the water flows. E is a pipe to re-supply the water which evaporates. As this is an ideal representation, showing only results, all the machinery (as engines and pumps) giving these results, by moving the water, are omitted.

Now let it be supposed that—which really would be the case in an English summer, without any circulation going on between A and B—the tank B would have its water at about 60° F., and A would have its water at about 75° F. On the circulation being established, and continued for some time, the water in A would become cooler, and that in B warmer, than before, and the mean temperatures of the two, varying according to the proportionate quantity of water in B., would be according to the seven following formulas:—

No. 1. A., 2; B., 1; result, 70° F.
No. 2. A., 1; B., 1; result, 67·5° F.
No. 3. A., 1; B., 2; result, 65° F.
No. 4. A., 1; B., 3; result, 63·7° F.
No. 5. A., 1; B., 4; result, 63° F.
No. 6. A., 1; B., 5; result, 62·5° F.
No. 7. A., 1; B., 20; result, 60·7° F.

So that by increasing the quantity of water in B, that in A is made to approach very near to the temperature of B, whether the surrounding atmosphere tends to increase or decrease the temperature of A. The water rises through C at an even temperature, exactly as it would if rising from a natural well, or spring, whether the spring be cold or hot, as in nature, and we can so increase the speed of the flow through C. that the fluid is not allowed time to become unduly warm or cold in A. We know, by many years of observation in the Observatory at Greenwich, that at a depth of six feet below the ground there, the mean daily range of the thermometer is less than one degree, while at the surface it is often twenty degrees. These facts, and the results to to be deduced from them, are alike incontrovertible. We also know, from Bunsen's tables, how much atmospheric air in solution water will retain when not under pressure at varying temperatures, and it is also known that it is upon the presence of such air in solution that the value of the water for aquarium animals proper mainly depends. It is true that, as Mr. Kent states, the quantity of air injected into A under the conditions No. 1, may be increased by accelerating the flow, but that does not diminish or increase the temperature, and *that* is the primary thing. It is also true that some local circumstances may affect these results, such as a very equable and mild climate, or an aquarium building of extreme temperatures either way, or the use of tanks which are very shallow or very high, which increase or diminish the surface absorption of air, but, as giving general and broad results, the figures just quoted may be depended upon, and they were true in their results at the Manchester Aquarium, which Mr. Kent cites as a contradiction to my theory. This, under Mr. Kent's supervision, containing show tanks aggregating 150,000 gallons, the amount in animal life was no greater, if so great, than is contained in the Crystal Palace Aquarium of only 20,000 gallons in the show tanks. Even in the reserve tanks in the latter place we often keep almost as much living food alone, in the shape of prawns, shrimps, crabs, mussels, and oysters, all of which tend to sully the water, and which themselves have to be fed, as were kept in all the Manchester Aquarium, which has no reserve tanks. There is no truer test of the amount of healthy organic life in an aquarium, of the kind which admits of manual feeding, than is to be found in the quantity of food consumed. Mr. Kent told me that in the vast aquarium at Manchester, containing show tanks collectively of 150,000 gallons, and a reservoir of 50,000 gallons, total, 200,000 gallons, the food amounted to no more than £40 or £50 a-year. But in the Crystal Palace Aquarium, with only 20,000 gallons in the show tanks, and 100,000 gallons in the reservoir, total 120,000 gallons, the food amounts to £120 a-year. In the Manchester Aquarium, with animals of precisely the same kind as at the Crystal Palace, and with the water always absolutely clear and well oxygenated, the quantity of food consumed should be of the value of about £200 a-year, but as it comes to only about one-fourth or one-fifth of that sum, proof is thereby given that the animal life must be much less in a much larger space, and that, therefore, there must be a waste of capital in erecting excessively large, because sparsely occupied, water spaces above ground. I noticed particularly at Manchester that the large sea-anemones, as *Actinoloba dianthus*, in the greater tanks, instead of standing up, like tall columns with overhanging tentacles, as at the Crystal Palace, where they are always fed individually by hand, one by one, were nearly all flat, contracted and closed, because insufficiently fed. Few things seem more surprising than that in the sparklingly clear Crystal Palace sea-water, which is not changed or added to further than having two per cent. per annum of new sea-water introduced to compensate for unfortunate leakages, and one-half per cent. per annum of fresh-water to supply for evaporation, we have in five years given our animals over £600 worth of animal food (excluding vegetable food), and yet we very rarely remove uneaten food, or the excrementitious results of food. The cost of such food in Manchester and London is the same, and though it may be that Manchester, for unwise economy, may purchase but very little of the same expensive food, as living shrimps and prawns, yet nothing is gained by such an omission, as aquarium animals, like human and all other animals, thrive best when the food is not only abundant, but varied.

In all aquaria, the work to be done is the oxygenation of certain organic matters, so that the animals may be healthy and the water clear, and if sufficient means be not used to do this work, the water must be more or less turbid, or the amount of organic matter must be proportionately lessened. Now, at Manchester this was the case, for the water, when I saw it, was not sparklingly bright, nor was the amount of organic matter to be oxygenated, *i.e.*, the animals and their food, adequately large in comparison to the size of the place. Once I remember, on a very hot day in July, I telegraphed to Manchester that our Crystal Palace temperature was as follows:—

Maximum external air at Sydenham and Greenwich	92° F.
Maximum air in shade in Crystal Palace	84 „
Maximum air in shade in Crystal Palace Aquarium	77 „
Maximum in water in Crystal Palace Aquarium, everywhere	61 „

and I asked for similar information about the Manchester, but it was refused me. Indeed, our great success at the Palace depends very much on our temperature being nearly that of the actual English ocean in all seasons; and it is this, conjoined with complete and constant aëration by our machinery, that enables us to keep in a comparatively small space so many animals, and many of them of kinds which, when we once get them uninjured, are maintained nowhere else under the same inland conditions. Among these we kept were some young herrings, till they were eaten by a nocturnally prowling eel. And we now keep Sepia (one of the cuttles), and it feeds and grows vigorously as it feeds and grows in no other aquarium.

Irrespectively of the consideration of temperature (which, however, cannot be really left out), and if, indeed, it be necessary to argue that a given amount of any diffusible matter sullies a given large body of fluid less than a small body, we possess a good illustration of the effect which great masses of water exert when brought into contact with smaller masses, containing much decomposing organic matters, which the larger masses rapidly dilute by their bulk, and gradually resolve into their constituents, by referring to the improvements made in late years in the drainage system of London. Formerly, the sewage matter resulting from a great mass of human beings and other animals was permitted to flow into the tidal river Thames, the bulk of which did not then allow it to become very seriously polluted. But as the metropolis rapidly grew larger, and as the river did not so increase, the pollution of the stream increased in the same proportion, until at last the decomposing organic matters it contained, upon being washed up and down as it ebbed and flowed, before it ran into the sea, became so intolerable from the poisonous gases they evolved, especially in warm weather, when the decomposition was more rapid, that it was resolved to make the sewage flow more directly into that infinitely larger receptacle, the sea, which even the enormous mass of London sewage has no power to permanently and seriously effect. This brings me to explain why I chose the formula No. 6—five to one—for the great London aquarium now preparing to be opened at Westminster, where the circumstances are quite different to those at Manchester, and where the aquarium is not, as at Westminster, placed in the very midst of a great city, with a soot-laden atmosphere. Moreover, in this latter aquarium, some of the tanks measure twenty feet wide from back to front, being more than in any other aquarium where the water is maintained in so clear a condition as to satisfy my fastidiousness. When this width is so great, the size of reservoirs must be relatively increased, because a very small addition of foreign matter in suspension or solution then increases the apparent turpidity. Moreover, the Westminster building itself is not exactly such a one as I should prefer for an aquarium, if I could have controlled it, with reference to all things, but as it has to be used for many other purposes I must make the best use of it that I can for my purpose. It is, in effect, a huge conservatory of glass and iron, supported on brick walls, and, in spite of much good ventilation, it will be very hot in summer. Yesterday, for example, was a cold and blowing March day—the 9th—with strong sunshine, and at noon the temperatures were thus:—

External air, maximum	true temperature.	55° F.
,, minimum		35 ,,
Internal air in Westminster Aquarium building		61 ,,
Water in reservoir of Aquarium at bottom......................		49 ,,
,, ,, at top		50·5
Water in Crystal Palace Aquarium everywhere		*54 ,,

This water at Westminster was fresh water, used to test the soundness of the reservoir, and as it had been in for ten days, it had had time to assume its normal temperature, and it was ten feet deep vertically. No water was in the show tanks, and no circulation was going on. This indicates, clearly, that a valuable equalising effect will be gained by the reservoir, which these figures show, is not at all too large; in fact, I tried to get it made to hold a million gallons instead of only about 600,000 gallons. Really, such a reservoir cannot be too great for the general purposes of an aquarium, the goodness of which a naturalist, if he be true to his cause, will only regard, and for such excellence, and for the animals it contains, he will alone care. He will, if he be genuine and zealous, regard the creatures he has to keep, not as unfortunate prisoners for whom it is policy to do as little as possible for their comfort, but as friends and guests, for whom he cannot do too much. Therefore, the only limits to the dimensions of aquarium reservoirs are considerations of cost and space. But long experience points out that for all general purposes the proportion of formula No. 6 is an excellent one as a minimum, and to gain this, or better, a much larger proportion, as even ten or twenty to one, as being, in the end, an excellent investment of capital, a right-minded naturalist will do much, even to the extent of recommending the sacrificing of the features of building which are not constructurally necessary, but merely decorative. The slight enrichment of surfaces of necessarily constructive parts is all which a well educated man will aim at. He cares only for the decoration of construction, and is content to leave the construction of decoration to the ignorant and vulgar.

With reference to the curious circumstance of sea and fresh water becoming greenly opaque from an excess of light, Mr. Kent is in error in saying that at the Brighton Aquarium the water is constantly exposed to light, and does not, therefore, become green. The water in that establishment is periodically changed, wholly or in part, and allowed to run into the sea, and therefore the ocean itself is the dark and great reservoir of the Brighton Aquarium. This arrangement would be an excellent one if the water could be drawn from so great a distance from the polluting land that the in-coming current of sea water would be pure and constant. But as it is impure and inconstant, the result is biologically most unsatisfactory compared with the large money expenditure on this Aquarium, as Mr. Kent well knows, and as he has stated in print, in *Nature* for October 23, 1873.

As to any "judicious screening" of show-tanks against too much light, such screening, to be effective, can only mean the keeping them dark by day, when visitors want to see their contents.

It is true, that, as Mr. Kent says, the thirty-five show tanks, and the twelve reserve tanks, at Westminster, contain collectively only about 115,000 gallons, or little more than the largest one tank at Brighton—not, as he states, the largest *two* tanks there. But, in these forty-seven receptacles at Westminster I shall permanently maintain a far more varied collection of marine and fresh-water animals, with comfort to themselves, than is contained in the entire Brighton Aquarium, and this will be chiefly because of the great dimensions of the reservoir. In this reference to animals, I of course reject all lung-breathers, as porpoises, seals, turtles, &c., for which the Westminster Aquarium, as now arranged, is intentionally quite unfitted.

I will now take a general view of Mr. Kent's published paper, beginning at its commencement, premising that nearly all of its historical narrative is gleaned, without acknowledgment, from matter published by me, but introducing errors which are not mine.

* It will be seen that the Crystal Palace water is higher than that in the Westminster reservoir, because the show tanks above are exposed to warmth, while at Westminster there are at present no show tanks to raise the temperature of the reservoir. The minimum of the external air was for the previous 24 hours. The instrumen used were made by Negretti and Zambra.

When Mr. Kent, who has worked for only a few months at each of three public aquaria, and who has never carried out one from its beginning to its completion, says that Bowerbank, Lankester, Warington, and Gosse, were among the earliest aquarium workers, then Mr. Holdsworth, Mrs. Anna Thynne, and myself, must not grumble at being omitted, though we all three were experimenting at the same early period; and indeed Mrs. Thynne began seven years before—in 1846; and it was she in that year, and not Mr. Gosse in 1853, as Mr. Kent states, who first pointed out the advantage of motion by a simple system of circulation.

Mr. Kent states that Dr. R. Ball's air-blowing in the first Dublin Aquarium by visitors was effected by their feet in walking to and fro, but it would not be easy to make a comfortable floor which could be contrived to do such work. In reality it was done by bellows, which visitors were invited to work with their hands. But Mr. Kent never saw the arrangement, and I did see it; nor has Mr. Kent ever seen the Berlin Aquarium, or any other continental one, otherwise he would never write of the "great success" of that at Berlin, which I have seen, with most others. Then he writes of two systems of oxygenation, one being by "circulation" and the other by "aëration." Both, however, are circulating, and both aërating plans, only one is sufficient and the other insufficient, under ordinary circumstances.

The late Mr. D. W. Mitchell did not "devise" the Regent's-park Aquarium; he only projected or thought of it, and the work was planned and carried out by Mr. John Sanders. Equally and amazingly wrong is Mr. Kent in saying that Mitchell personally supervised and constructed the aquarium in the Paris Acclimatation Society's Gardens. He, not professing to understand the subject, consulted me about it in 1857, and died when the shell of the Paris building to contain the tanks was only just began. It (the shell) was then finished, and finding that Mitchell had left no instructions for completing the entire work, and no one knowing what best to do, the Society engaged me to finish it. So I did my best with a very imperfect conception, modifying it much in every way, even to reconstruction in many parts, and I added the circulating apparatus which now exists in action, and which drawings afterwards proved formed no part of Mitchell's design. This apparatus, however, is quite dissimilar to that in Regent's-park, just the same as the air-injection at Berlin is different from that at Brighton, and from that which existed at Dublin, so Mr. Kent errs as to all four of these places. He refers to the coming aquarium at Scarborough as being "fine," but before me is a statement of his to the contrary, as well as statements referring in the same contradictory terms to the persons engaged in that and the Brighton Aquarium.

Mr. Kent, in referring to the Yarmouth Aquarium Society, where he is now engaged, does not state that I, too, am officially employed there, and that I seriously disagree with much which he is there doing, as being contrary to the interests of our mutual employers, and as to having the Yarmouth Aquarium open in this coming summer of 1876, it is quite impossible. He is not only ungenerous in thus omitting my name in reference to the Yarmouth, Paris, Crystal Palace, Naples, Frankfort, Rhyl, Teignmouth, Rothesay, and other Aquaria, but he does not even mention the one at Hamburg, I being more or less intimately connected with all of these. The Hamburg one especially, is noteworthy as being of much importance, because it was there that having had the advantage of commencing the work from the very beginning, I had not, as at Paris, to correct the errors of a predecessor, and, introducing abundant steam power for the first time as a prime mover, and causing the water to run from tank to tank, instead of letting it run from each tank into the reservoir, I found, as I anticipated, that these advantages, conjoined to the advantage of possessing a relatively much larger reservoir than at Paris, were great strides in improvement, as the coolness and clearness attained, and the quantity of fluid circulated at a small rate of cost, was very great. Then, too, I added after awhile, another improvement, that of circulating the same unchanged fresh water, instead of being subjected to all the disturbances and costs of being supplied from an outside source, and using the water only once. Being in the year 1864 visited by the late Baron Justus von Liebig, and seeing how much that illustrious chemist and physicist was interested in my work, and how attentively he examined it, as being an intentional representation of what goes on in nature, I got him to give me his written opinion, and of this I shall be glad to send, gratis, a fac-simile copy to anyone asking for it.

There came to Hamburg many naturalists to see the aquarium, among them being Professors Leuckhart, Gegenbauer, Möbius, Carl Voght, Dr. H. A. Meyer, Dr. Anton Dohrn, and others, and Liebig's verdict convinced all these eminent men of the correctness of the entire system, Dr. Dohrn, with my assistance, even recently going to the extent of making, at Naples, a large aquarium, which is now in admirable working order. Mr. Kent, however, not having the learning of these learned Germans, is not to be convinced. He mentions Mr. C. L. Jackson, of the Southport Aquarium. When that establishment was commenced I was consulted, and I gave the best advice I could; but the architect, being no physicist, determined to make one-half of the place on the Crystal Palace system, and one-half on the erroneous Brighton plan. The whole is, however, now being changed into the former system (as I advised at first), under the direction of Mr. Jackson. If I had had him to deal with at the beginning, he being an engineer, some thousands of pounds would have been saved, and I have his fullest written permission to say that he believes in the large reservoir system, and not at all in Mr. Kent's unreasoning crotchet of small reservoirs.

Mr. W. B. Woodward, the proprietor of a large aquarium at San Francisco, has just been to Europe to examine all public aquaria, and he is convinced that the turbidness he is troubled with is due to his having a too small reservoir, and he intends enlarging it. As to saying that a large reservoir is necessary at Calcutta, but not in England, I possess the sea and air temperatures of Calcutta, and find they have the same relations, nearly, as in Britain. The isothermal charts of Professor Dove and others may be consulted in proof of these points. So with three places in Australia, respecting which I am being consulted for great public aquaria.

With regard to what is said about the lump-fish (*Cyclopterus*) being not easy to keep, because in the sea it is found in rapid rushes of water; that may be so, but the evidence adduced by no means proves it, as other marine fishes of similar habits which do not frequent similar places in the sea are still harder to keep in aquaria. I am inclined to ascribe the difficulty to a question of food.

With no intent at habitual fault-finding do I allude to the proposal Mr. Kent refers to as having been made by him to the Westminster Aquarium for the temporary peopling of that aquarium with fishes. His proposition was, however, immediately rejected because of its impracticability, and the unscientific character of the idea caused it to be unfavourably reflected upon.

All that Mr. Kent has said on the maintenance of the higher marine algæ in aquaria has been better said by Mr. Warington a quarter of a century ago. But it is a positive error to state that the silk weeds (*confervæ*), marine and fresh water, do not grow in fast running currents. What affects them is light more than motion, for I have known these plants to be developed and to grow freely, attached to the polished interior surfaces of glass tubes through which water was flowing rapidly, with exposure to light. And it is a most astounding mistake to compare these chlorosperms to the infinitely lower fungoid forms of

vegetation, when both grow on other and higher plants. A fungus does, or may, destroy another plant, or an animal, upon or in which it grows, as *e.g.*, the "smut" in wheat, or the "ergot" of rye, or the "potato disease," or the fungus which appears on some fishes or insects, but a conferva which attaches itself to a red seaweed, or to the shell of a crab or lobster, or to oysters, or to the hard parts of other plants and animals, does not destroy the plant or animal upon which it is parasitic. Thus, Warington has shown that when a conferva has grown upon and obscured some rhodosperm, as *Chondrus* or *Iridæa*, because of excess of light, yet that when that light is artificially coloured by the interposition of glass of a particular hue, the chlorosperm dies, and leaves the rhodosperm as fresh and beautiful and uninjured as before it was grown over.

As I have pointed out in the *Athenæum* of February 5th and 19th last, so many reckless and unreasoning statements make the writer or utterer of them absolutely unreliable.

With regard to the discussion by the gentlemen named below, and by others which followed Mr. Kent's paper, much of it was of interest as touching on the formation of the shells of mollusca, and to aid in such investigation I shall be glad to furnish any competent chemist with some of our Crystal Palace seawater exactly as we got it in 1870, to compare with it in its present state, so as to determine how much, if any, of its constituents have been absorbed by animals in six years.

My experience with oysters and other bivalves in aquaria is that they do sometimes add to their shells, but not to their flesh, and I think that possibly, as I aim at great clearness of water, it does not contain sufficient nutriment for these animals. Clearness, however, must override all other considerations in a public aquarium, as being that which suits the majority of circumstances.

Mr. Henry Law (an engineer whom, from his great knowledge, I should choose by preference to all others to be associated with in aquarium construction), in stating that large underground reservoirs are valuable in preventing a large growth of conferva, stated that which is just possible, but which is not proved. What they do prove is that they prevent the multiplication of what are called "zoospores," which cause turbidity, but Professor Ferdinand Cohn, as an authority on these excessively minute bodies (they being but $\frac{1}{2000}$ of an inch in diameter) is not certain if they are ultimate forms of plants or not.

Lieut.-Col. Stuart-Wortley's opinion is, and always has been, that at the Crystal Palace and other similar aquaria, all the water, and not a part of it, should enter in fine pencils, which must pulverise the air they carry down into the water. This, however, in a large establishment, would require much additional engine power, which would be wasted, because, as it is, the water can only absorb a part of what is already purposely supplied in excess, and the rest escapes at the surface.

Col. Wortley also thinks that such aquaria should possess filters, but at the Palace they are needless, because we have nothing to filter, as the water at the end of its circuit is as good as at the beginning of it. When the water is quite clear we work our steam-engines slowly, to save fuel, and when it becomes slightly turbid, from a sudden accession of organic matter in the shape of food or otherwise, we, knowing what a large and cool supply of water there is in the reservoir, increase the speed of the machinery, which draws more water from the reservoir, and cools the other water above, and at the same time, while by its greater bulk diluting the temporary turbidness, drives into the show-tanks enormous quantities of very minute air-bubbles, which cause the water to become highly effervescent, and the bubbles, coming into contact everywhere with the decaying matters which cause the turbidness, soon dissipate those matters, and all becomes speedily clear again.

Rightly considered, an aquarium is a beautiful philosophical contrivance for illustrating the manner in which the various forces of nature harmoniously balance each other. Thus, cold balances heat, and produces a certain mean temperature, while darkness balances light, and represses an excess of vegetation which is so constantly being urged into existence by that light, in order to decompose the poisonous carbonic acid gas which animals evolve. Then, motion, gained from whatever source, balances the quiescence which water is ever desirous of attaining, and without such motion vegetation would be useless, just the same that motion would be useless without the vegetation. And, if these things are rightly understood, and applied skilfully by thoughtful mechanical adjustments, there can be attained a tolerably accurate control over the growth and decay of organic matters, both vegetable and animal, to suit named and definite circumstances. It is impossible for mere human beings to refine too much on the means by which these ends are endeavoured to be secured, seeing that nature herself is most infinitely painstaking in the construction of the objects which are wished to be maintained in life and health in aquaria. The only limits to such refinements are such great money costs as may be plainly and evidently prohibitory.

Thus, by endeavouring to follow Nature in a humble and inquiring spirit, we succeed in our trials to a certain extent, and we are thankful, but are always trying to do more and more; and, to attain the highest excellence, we do not adopt the motto of "rest, and be thankful." To a real and earnest seeker after knowledge there can be no rest, and no contentment to do anything but his very best. He who aims at the highest excellence will always rise above mediocrity, but he who aims at mediocrity will always fall below it, and I earnestly put this truth before Mr. Kent.—I am, &c.,

W. A. Lloyd.

March 10, 1876.

Sir,—The very interesting paper read on Wednesday week, by Mr. W. Saville Kent, on "Aquaria," induces me to call the attention of your readers to an improved form of tank, which, it appears to me, can alone secure the health of the fish, because it alone fulfils the natural conditions of their free wild state.

This improved form consists in the tanks being united into one by the removal of their party walls, and so arranged that the water may be made to circulate through the series like a tide or river.

Draw an oval on paper the size of a common egg; outside that, at the distance of half an inch, draw another, and again a third. These three lines represent each a continous tank, forming a group of three continuous tanks independent of each other, having glass sides, and of the same width as those in ordinary use.

In each tank is to be a screw propellor, similar to those used for propelling steam vessels, except that it is made of wood, and caused to rotate by steam power and an endless band. Such an apparatus would set the whole volume of water in motion, producing a continous current like a natural tide, so many hours in one direction and so many in the other, compelling the fish to resume those habits of activity and unrest, which are not only natural but necessary for their health.

The outer tank should be occupied by larger or more powerful fish, accustomed to strong, and on occasion to violent motion of the water. The centre tank by those requiring less movement, and the inner tank by fresh water. In this arrangement the public promenades would be between the tanks,

Whether the fish should be allowed liberty to range the entire length of each tank or river, or whether they should be separated into compartments by wire-work is a matter of detail.

The great gain in either case would be, sustained, natural, active motion, as opposed to the present system of unnatural stagnation.—I am, &c.,

Robert Howden.

Gracechurch-street, March 4th, 1876.

THE FALL IN THE PRICE OF SILVER.

Sir,—Allow me to point out to you an error, which appears in the report of the few remarks I made on Mr. Seyd's paper on "The Depreciation of Silver," on Monday last. In the last sentence, at page 344, I am reported as saying "therefore, if prices were falling, it would only be necessary to restrict the coinage, when prices would rise." It ought to be, "if prices were rising, it would only be necessary to restrict the coinage, when prices would fall."

I also beg permission to explain that the use of an inconvertible currency, founded on gold, was intended by me as an example of the way in which a gold standard might exist without a gold currency; and not as a means of retaining the rupees in India, the opposite effect to which it might bring about, if mismanaged.—I am, &c.,

J. Smith.

33, New Broad-street, March 20th, 1876.

Sir,—The report in your *Journal* of the 17th inst., page 857, of the observations I made on the relation of India to her creditors, contains a few mistakes or misprints, which are not self-evident to persons unacquainted with the subject.

May I ask for space in your next number to explain that the Government receive in India from their revenue, including the railway receipts in silver coins, say, some 60 millions sterling annually. They have to pay in England, in English money, among other payments, on account of India, interest on about 125 millions sterling, including 5 per cent. interest, at the rate of 1s. 10d. the rupee, on the greater part of the railway debt. The nominal loss to the Government on their annual remittances to England, is now, at the present rate of exchange, nearly equivalent to raising the interest on the national debt of India from 5 to 6 per cent.

There is little or no difference of price betwen different kinds of English government securities, carrying the same rate of interest; but I mentioned three securities issued within a comparatively recent time by the Indian Government, for which they received the same value (£100); and I showed that there was a difference of £40 between the present market price of the highest and lowest of these securities, if they were estimated as bearing 5 per cent., owing to the difference between a fixed and a variable rate of exchange, or, in other words, a single or double valuation.—I am, &c.,

J. T. Wood.

10, Pembridge-gardens, W.,
March 20, 1876.

OBITUARY.

Mr. Samuel Redgrave.—The death of Mr. S. Redgrave took place on the 19th inst., after an illness of some length. He had been a member of the Society since 1847, and almost up to the time of his death he was a most active worker on its behalf. It was only last year that he retired from the Council, having served first as treasurer, then as an ordinary member of the Council, and, lastly, as a vice-president of the Society, since 1860. He was also the Society's trustee for the Soane Museum, having succeeded Sir Wentworth Dilke in that office. During his long labours in the Home-office he completed a system of criminal statistics of the most perfect character, and afterwards a thorough registry of proceedings in the Civil Law Courts. Since his retirement from official life he devoted himself to art literature and labours. He was connected with several of our international exhibitions in having charge of the Fine Arts section. The Exhibition of Minatures of the British School was got up by him, and the elaborate catalogue compiled by him; and the three annual exhibitions of portraits of distinguished personages, proposed by the late Lord Derby, was wholly carried out, and the exhaustive catalogues compiled, by him. Of his literary works his "Guide to the Public Offices of the Country," published by Mr. Murray, was one of his earliest. His "Century of Painters of the English School" was written jointly with his brother, Mr. Richard Redgrave, R.A. His "Dictionary of Artists of the British School" was wholly his own, and he was gathering materials to extend it until his last illness. He was also engaged in preparing for the museum at South Kensington a catalogue, with a preface, of the "Historical Collection of Paintings in Water Colours" in that museum, a work wholly completed and in the press.

Lieut.-Colonel A. Strange, F.R.S.—By the death of Colonel Strange, the Council has lost a valued and respected member, and one whose peculiar place it will not be easy to refill. He died on the 9th inst., at the age of 58. He was the fourth son of Sir Thomas Strange, and was born in 1818 at Westminster. He was educated at Harrow, and went direct from school to the Indian Army, where his special talents caused him to be employed in the great Trigonometrical Survey of India, a work with which his name must always be connected. Before his retirement from the work of the Survey (in 1869), he had held for some years the post of Astronomical Assistant to the Survey. In 1861 he returned to England and retired from the army as Lieutenant-Colonel, and in the following year he was appointed Inspector of Scientific Instruments to the Indian Government, and was entrusted with the task of superintending the construction of the scientific instruments required for the Survey. To this task he devoted himself with the greatest skill and perseverance; and the instruments prepared, or now in course of construction, at the Observatory in Lambeth, bear testimony to the mechanical and scientific knowledgo bestowed on them. Colonel Strange became a member of this Society in 1870, and in 1872 he was elected on the Council. He read papers before the Society on "The Relations of the State to Science," and "The Channel Passage." He served on many of the committees of the Society, on all of which his wide scientific knowledge was most valuable. He also contributed memoirs and papers to the Royal Society, the Royal Astronomical Society, the British Association, the Royal United Service Institution, and the Meteorological Society. He was a juror for the Exhibitions of 1862 and 1867 (Paris). The Commission on "Scientific Instruction and the Advancement of Science" was in no small degree the result of his efforts, and the views adopted in its reports differed but little from those advocated by Colonel Strange when the movement first began.

The Rev. Muirhead Mitchell.—The Rev. Muirhead Mitchell, whose death was announced last week, had been a member of the Society since 1852. He had the arrangement of the Exhibition of Educational Appliances, which was held by the Society in 1854, in St. Martin's-hall, and which eventually resulted in the establishment at South Kensington of a permanent educational collection. Mr. Mitchell was one of H.M. Inspectors of Schools.

Mr. Evan Leigh.—The death has been announced of Mr. Evan Leigh, who was a member of the Society since 1861. Mr. Leigh was president of the Manchester Scientific and Mechanical Society. He was the author of several works on mechanical subjects, the chief of which, "The Science of Modern Cotton Spinning," has

passed through three editions. He was the inventor of several improvements in cotton spinning machinery, and also patented some inventions in naval architecture. In 1849 he took out a patent which included the twin-screw principle. He contributed several communications to the *Journal* on the "Steering of Ships," "Patent Laws," &c.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

March 29.—"Model Dwellings for the Rich," by T. Roger Smith, Esq., and W. H. White, Esq. Lord Alfred Churchill will preside.

April 5.—"The Cultivation in India of Caoutchouc-yielding Trees," by Clements R. Markham, Esq., C.B.

April 12.—*No Meeting.*

April 19.—"The So-called Deposits of Onyx near Mexico, and their Value as a Decorative Material in this Country," by W. Eassie, Esq., C.E., F.L.S., F.G.S.

April 26.—"Sericiculture in Australia," by Mrs. Bladen Neill.

May 3.—"The Preparation of China Clay," by J. H. Collins, Esq., F.G.S.

May 10.—"A New Method of Propulsion for Street Trams," by E. H. Leveaux, Esq.

May 17.—"Railway Safety Appliances," by F. J. Bramwell, Esq., C.E., F.R.S.

May 24.—*The same continued.*

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

March 28.—"The Industries of South Africa." By T. B. Glanville, Esq. Lieut.-Gen. Bissett, C.B., will preside.

April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

March 24.—"The Land Revenues of India," by Major-General Marriott, C.S.I. Sir George Campbell, M.P., will preside.

April 21.—"The Sanitary Progress of India," by Captain Douglas Galton, C.B.

May 5.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

May 26.—"Thaumatodendra, or the Wonders of Trees in India," by William Tayler, Esq., late Commissioner of Patna.

Chemical Section.

Friday evenings at 8 o'clock. The following arrangements have been made:—

March 31.—"The Methods of Estimating the Illuminating Power and Purity of Coal Gas." By A. Vernon Harcourt, Esq., M.A., F.R.S. The Right Hon. Lord Aberdare will preside.

April 28.—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne.

Cantor Lectures.

Monday evenings at 8 o'clock. Third Course, "On Wool Dyeing," by George Jarmain, Esq.

Lecture III.—March 27th.

General principles of the fixation of colour upon wool. —Wool mordants.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. George Jarmain, "Wool Dyeing." (Lecture III.)
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. Capt. S. Anderson, "The North American Boundary from the Lake of the Woods to the Rocky Mountains."
British Architects, 9, Conduit-street, W., 8 p.m. Mr. Thos. Brassey, "The Rise and Fall of Wages in the Building Trades."
Institute of Actuaries, Quadrangle, King's College, W.C. 7 p.m.
Medical, 11, Chandos-street, W., 8 p.m.
London Institution, Finsbury-circus, E.C., 5 p.m. Prof. Ferrier, "Sleep and Dreaming." (Lecture II.)

Tues. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (African Section.) Mr. T. B. Glanville, "The Industries of South Africa."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "Classification of Vertebrated Animals." (Lecture XI.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. G. R. Redgrave, "Sewage Interception Systems, or Dry Sewage Processes." 2. Mr. W. Shelford, "The Treatment of Sewage by Precipitation."
Anthropological Institute, 4, St. Martin's-place, W.C. 1. Mr. W. L. Distant, "The Term 'Religion' as used in Anthropology." 2. Mr. E. Burnet Taylor, "Japanese Mythology."

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. T. Roger Smith and Mr. W. H. White, "Model Dwellings for the Rich."

Thurs...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. E. Dannreuther, "Richard Wagner and the Nibelungen Ring." (Lecture I.)
Chemical, Burlington House, W., 8 p.m. Annual Meeting.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. J. Forbes Robertson, "Art in 1476."
Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Spottiswoode, "Polarised Light." (Lecture III.)
Philosophical Club, Willis's Rooms, St. James's, S.W., 6 p.m.
Civil and Mechanical Engineers Society, 7, Westminster-chambers, S.W., 7 p.m. Mr. A. Payne, "Concrete Flooring."
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m. Mr. H. A. F. Duckham, "Gas Regulators Specially Applicable for Lighting Railway Trains, Trams, and other Purposes."

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Chemical Section.) Mr. A. Vernon Harcourt, "The Methods of Estimating the Illuminating Power and Purity of Coal Gas."
Royal United Service Institution, Whitehall-yard, 3 p.m. Captain J. C. Ardagh, "The Comparative Cost of Armies of different Nations, including the Loss to a Country by Conscription."
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Prof. J. Dewar, "The Physiological Action of Light." (Part II.)

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. Dannreuther, "Wagner and his Trilogy." (Lecture I.)
Institution of Foremen Engineers (at the House of the Society of Arts), 7 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, MARCH 31, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PROTECTION OF SHIPS FROM FIRE.

A meeting of this Committee was held on the 28th instant. Present—Vice-Admiral Erasmus Ommanney, C.B., F.R.S. (in the chair), F. A. Abel, F.R.S., Lord Alfred S. Churchill, and Donald Currie, with P. Le Neve Foster (Secretary).

REVOLUTION INDICATOR.

A meeting of this Committee was held on the 29th inst. Present—Lord Alfred S. Churchill (in the chair), W. Froude, F.R.S., Capt. Nicholson, Rear-Admiral Nolloth, Vice-Admiral Erasmus Ommanney, J. R. Ravenhill, and Seymour Teulon, with P. Le Neve Foster (Secretary).

NATIONAL TRAINING SCHOOL FOR MUSIC.

The opening of the school for study is fixed for Thursday, April 27th, on which day all scholars who may then have been elected are requested to be in attendance at 11 o'clock a.m.

The Northampton Scholarship has been awarded to Miss Eliza Cosford, aged 18 years, for her good soprano voice and her general musical taste. There were three candidates. The examiners were Steven Cramer, Esq., of London, and the Rev. S. J. W. Sanders, head master of the Northampton Grammar School.

The Worshipful Company of Saddlers have founded one scholarship in connection with this school.

At a meeting of the Court of Common Council, held at the Guildhall on Thursday, the 23rd inst., it was resolved that Mr. John Bath should be elected to represent, on the Committee of Management of the National Training School for Music, the ten scholarships founded by the Court of Common Council.

INSTITUTIONS.

The following Institutions have been received into Union since the last announcement:—

Cardiff Free Library.
Model Training School, Auckland, New Zealand.
St. Bernard's Evening Classes, 39, King Henry's-hill, N.W.

INDIAN SECTION.

A meeting of this Section was held on Friday, March 24th, Sir George Campbell, M.P., K.C.S.I., in the chair.

The paper read was—

THE LAND REVENUE OF INDIA.

By Major-General Marriott, C.S.I.

I did not myself choose the Indian land revenue as a subject on which I desired an opportunity to speak publicly. When asked to treat it, I recalled the story of Jacquemont, the French traveller, who said to Thomason, "Just tell me all about the land revenue in ten minutes;" and Thomason replied, "I have studied it for more than ten years, and do not yet know all about it." Nevertheless it is a subject on which public opinion amongst those interested in India is periodically stirred, and it seemed to me that one might, perhaps, give, even in an hour, something like a complete outline of the problem, and of the views and arguments which lead to conflicting policies concerning it, and that doing so impartially, seeking rather to state the true issues than to establish particular conclusions, I might give some clear general notions, by which all arguments and facts which you may hereafter meet may be so ranged as to show their real significance.

The importance of any policy touching the land revenue may be partially seen at once from a mere statement of the net revenues of British India. They are—

From Salt	about	6 millions.
„ Stamp duties	„	$2\frac{1}{2}$ „
„ Opium	„	8 „
„ Excise on spirits and drugs	„	$2\frac{1}{4}$ „
„ Custom duties	„	$2\frac{1}{2}$ „
„ Land revenue	„	21 „

But the importance is only fully shown when it is seen how everything affecting the land revenue touches the rights of the occupants of the land, and when we perceive that land tenure is a principal root of social as well as economic growth, and that transformations of land tenure may have larger effects to help or hinder the general weal than almost any other kind of social change which it is in the power of a Government to make.

I shall try then to give an outline, which can be seen as a whole and retained by memory, of the existing state of land tenure, and of the land revenue, and of the larger questions which divide opinion concerning these. In doing so I shall not hide my own opinion, but what I offer as worth your attention is not my opinion, but the facts and principles which I shall set forth.

The land tenures are so various and intricate that volumes would be required to exhaust the subject. Nevertheless they all have some features in common, for they have a common origin. It is not only in physical science that we have learned to seek the explanation of specific difference, in evolution from a common source. Sir Henry Maine has shown in his most interesting lectures on "Village Communities," and "The Early History of Institutions," how largely this applies to the various land tenures throughout the world.

Absolute individual property in land, such as we have in England, subject to no services or payments, and restricted by no subordinate proprietary rights, speaking generally, does not exist in India. Although there are large numbers of tenants-at-will in Bengal and the North-West Provinces, yet the modern English notion of property in land held by a single owner, under whom all the cultivators, in the absence of express agreements, are tenants-at-will, is a foreign notion even in those provinces, and is unknown through a large part of India.

Read Sir George Campbell's account of the Indian tenures (in the Cobden Club papers), and Sir Henry Maine's treatises, and you can have no doubt that property in land, as a thing to be held on the same conditions, and to be bought and sold like any other property, is a purely modern notion. The possession of certain lands was originally the property of a community. The right of any family or person to cultivate a certain portion was a privilege conceded on grounds of convenience, restricted by common rights, and liable to common burdens. The modern English notion of a landlord or tenant had no existence in India until introduced by us. There were persons who by grants from Princes stood in the place of the Prince or State as receivers of revenue; but the property in the land remained unaffected thereby. There were descendants of principal families who acquired hereditary privileges; but the utmost extension of such privileges never tended to the notion of exclusive possession until we came on the scene. The most prevalent notion of property in land was that it belonged to the village community, the cultivated land being distributed to separate families, whilst the waste and pasturage were held in common. The subordinate claims and privileges by subdivision of family shares and by various customary rights, were most complicated. But, whatever the peculiarities of tenure, the claim of the Sovereign power or of some one to whom the Sovereign might transfer it, to a share of the produce, was recognised. Such share is the land revenue which the British Sovereign power receives.

In 1793, Lord Cornwallis' Government made the famous permanent settlement of the land revenue of Bengal, which has been the subject of so much dispute. Men dispute both its purposes and its effects. What it expressly did, was to make all who paid land taxes or rent charges to the State, the proprietors of the lands from the produce of which such payments were made, and to fix such payments in perpetuity. One purpose certainly was the development of agriculture, but I have never met with any evidence that it has certainly had that effect. A comparison of the well-being of the provinces under that settlement with other British provinces, by what they pay in excise duties, or paid in income-tax, or by what they consume of imported produce, or by the outward circumstances of life, affords strong evidence that the distinctive character of that settlement has not benefited the mass of the people. Sir George Campbell says that this regulation of 1793, in intention, settled the payments of the sub-holders and actual cultivators, as much as the payments to the State by the superior holders. The fact that it did not do so, he attributes to subsequent interpretations of the law by English notions. I find it difficult so favourably to read the enactment of 1793. Whilst the proprietary rights of the zemindars and talookdars are expressly declared, the rights of subordinate holders are not specified; and it is only feebly recognised that some such exist; and the maintenance thereof is made dependent upon future discretionary action of this Government.* Certainly the enactment was recognised by its authors as a creation of new rights. In Regulation No. 2 of 1793, published about six weeks afterwards, by which suits concerning land were transferred from the revenue courts to the ordinary judicial courts, it was said:—

"As being the two fundamental measures essential to the attainment of it" (the improvement of agriculture), "the property in the soil has been declared to be vested in the landholders, and the revenue payable to Government from each estate has been fixed for ever. The property in the soil was never before formally declared to be vested in the landholders, nor were they allowed to transfer such rights as they did possess, or raise money upon the credit of their tenures, without the sanction of Government."

The regulation adds:—

"Other security must be given to landed property, and to the rights attached to it, before the desired improvements in agriculture can be expected to be effected. Government must divest itself of the power of infringing, in its executive capacity, the rights and privileges which, as exercising the legislative authority, it has conferred on the landholders."

Complete ownership of land implies an exclusive right to the use of it. In this sense, ownership, so far as it existed previously, was rather with the cultivators than with their rent-receiving and tax-receiving superiors. It was impossible wholly to convey full ownership to the latter, but the Regulation of 1793 seems to intend it to the utmost practicable extent. It certainly had that effect, for it introduced the modern English notion of landlord and tenant, and of a general right of the former to increase rent indefinitely, a right which was at one time affirmed by the law courts, and the exercise of which produced agrarian disturbances. Such rights have since been restricted by the Legislature.

Few will dispute that the general intention of the permanent settlement to define the rights of all connected with the land was good. But defining existing rights and creating new rights are different things, and the Act did the latter with much more emphasis and completeness than it did the former.

As we extended our territory, the question of land-revenue settlement arose in other parts of India. There was a general intention to make a permanent settlement in the North-West Provinces. But the more the Government learned about the condition, the more difficult it became. In those

* The words of the enactment are,—"To prevent any misconstruction of the foregoing article" (which refers solely to the zemindars, independent talookdars, and other actual proprietros of land) "the Governor-General in Council thinks it necessary to make the following declaration to the zemindars, independent talookdars, and other actual proprietors of land: It being the duty of the ruling power to protect all classes of the people, and more particularly those who from their situation are most helpless, the Governor-General in Council will, whenever he may deem it proper, enact such regulations as he may think necessary for the protection and welfare of the dependant talookdars, ryots, and other cultivators of the soil, and no zemindar, independent talookdar, or other actual proprietor of land shall be entitled to make any objection to the discharge of the fixed assessment which they have respectively agreed to pay."

provinces the village is treated as a whole in respect of liability for revenue, and the settlement is made with every village and for thirty years. This does not now prevent the subordinate properties being bought and sold as private property, and Sir George Campbell describes the normal tenure in the North-West Provinces as land held by "moderate proprietors, with ryots under them who possess a right of occupancy at a fair rent."

As respects both the permanent and the thirty-year settlements in Bengal and the North-West Provinces, there is now no such thing as absolute property held by anyone, so that he can legally demand what rent he please, except from tenants-at-will, who, though numerous, are exceptional. After continuous occupancy of land for twelve years, the occupier ceases to be a tenant-at-will, unless there be special agreement to the contrary. Superior holders may, by process in the revenue courts, obtain authority to raise rents if the value of the land has been increased by other agency than the ryot's labour or expenditure, and, in the Bengal provinces, if the prevailing rates paid by the same class of ryots in adjacent places be higher. And all rents are liable to be raised if the Government land revenue be raised. So that the superior holders are far from being in the position of an English landlord. As Mr. Fitz-James Stephens says (quoted in the "Life of Lord Mayo"), "Experience showed that to establish such a system," as that it should be in the power of the landlord to rack-rent all the cultivators, "would be to destroy the whole framework of native society;" and "the different interests in the land are classified as those of landlords; of tenants at a rate perpetually fixed, who are, in fact, sub-proprietors; tenants at a rate liable to enhancement on cause shown; and tenants-at-will."

In a great part of Madras and in the Deccan districts of the Bombay Presidency, was adopted what is called the ryot-waree system, *i.e.*, the settlement is made with each several cultivator; the consequence of this was to supersede the property of the village community in waste lands, which are treated as the property of the State. The rights of property consequently are simpler. The cultivators are for the most part peasant proprietors. But the village community is not obliterated. Each village has its patell, or headman, its kulkurnee, or accountant, and its scavengers and watchmen, who all hold their positions, privileges, and emoluments by inheritance.

The ryotwar settlements in Bombay are made for thirty years. In Madras they are made for no fixed period. They are always liable to revision; but no general revision has yet been made.

In the Southern Concan, the strip of country between the sea and the Ghauts, to the south of Bombay, there is a large class of superior holders named Khotes, the nature of whose tenure has been much disputed. The notion most accepted hitherto was that they are the descendants of farmers of the State revenue (the name Khote is said to be derived from a word signifying a contract) who have usurped more and more of proprietary right, which nevertheless is only complete in respect of the lands which they themselves cultivate. But in the light of recent researches, such as those by Sir Henry Maine above mentioned, there can be little doubt that, though the Khotes may at one time have been employed to collect State revenues, the origin of their status must be sought in some headship in more primitive village communities. The Khotes cannot evict subordinate cultivators who pay the customary rent; and even if such cultivator abandon his land for a time, and the Khote give it to a stranger or a neighbour, the original cultivator returning after many years absence, can eject the other and resume the cultivation of the land.*

In the Guzerat province of the Bombay Presidency there are other varieties of tenure, based as are all others more or less on the village system; and I am told that they show much similarity to the existing tenures in the North-West Provinces. In some parts there are considerable landlords, named gurasseas, the reputed descendants of the ancient Rajput rulers. The villages have their several establishments of artisans, scavengers, and watchmen, for whom certain portions of land are set apart and allowed to be rent-free; and each village has its hereditary patell. The revenue is collected in many cases under what is called the Nurwadar system, *i.e.*, a general demand upon the village, which is distributed by the village community according to what each cultivates. In other cases this system of a single assessment on the whole village is much modified; but the details would too much prolong this account.

Such are the land tenures in outline. The general picture shows the land cultivated by very poor agriculturists on very small estates; these men paying customary rents, either to the Sovereign power or to an intermediate superior. Sometimes the agriculturists hold the lands of a village to a certain extent in common, and make a collective payment. The rights, privileges, and liabilities of those concerned are, in many cases, various and complicated; but all have one character in common, that there is no such exclusive possession by any one as gives a general right to indefinite enhancement of rent. Further, although the legal position given to the zemindars in Bengal by the settlement of 1793, and the action of the courts of law, on the whole, tended to translate the rights and privileges of the superior holders in those provinces into more exclusive ownership, yet some recent legal action has been in a contrary direction; and speaking generally, exclusive ownership in the English sense is yet unknown; whilst with respect to non-liability to eviction, so long as customary dues are paid, ownership of the land may as easily be imputed, for the most part, to the cultivators at the bottom of the scale of those who have claims upon the land, as to the zemindars and others at the top of the scale; exclusive ownership being, really, neither with one nor the other. If I describe the most characteristic tenure as "a peasant proprietorship subject to certain customary rent charges payable to the State, or to some one who by inheritance or purchase has a heritable and transferable claim to a certain portion of the produce," I believe I give as correct a general impression as can be given by any short general description, the technical objections to the term "proprietorship" notwithstanding.

* Lieut. Cowell's Report quoted in a report to the Government of Bombay by Sir George Wingate in 1851.

Such are the tenures which are subject to the payment of land revenue; and as the rights of subordinate holders and of the cultivating ryots are all matter of law, it is inevitable that the process of settling the land revenue, whether for thirty years or in perpetuity, is accompanied by the ascertainment and definition of existing rights. The process tends, as experience shows, to the creation of rights; and, hence, the large political influences of a settlement of the land revenue and the wide range of dispute thereon.

We have seen that the land revenue is a share of the produce of the land always considered due to the Sovereign power. But let us consider the nature more particularly. My Indian hearers will wince, expecting a repetition of the never-ending dispute whether it be a rent or a tax. I cut the dispute short by saying, what the very endurance of the dispute proves, that it partakes the character of both. If by "rent" be meant what Ricardo, Mill, and others mean by the name, a competition rent, such as would be paid by capitalist farmers farming for profits of capital, then it is indisputable that such rent is a purely modern fact which has little existence in India at present, and had none anywhere when the Indian land revenue had its origin. If by "rent" be meant a payment for the use of land, or a claim to a part of the produce of the land, then, undoubtedly the land revenue is in some aspects "rent." If, on the other hand, a tax be a payment levied by the State for purposes of general revenue, and on that account only, the land revenue is undoubtedly a tax.

There is one very important respect in which it must be regarded as a tax. Every one almost is agreed that if the land revenue be fixed in perpetuity, no land tax in addition can ever be levied. If it were not a tax, this would be an absurd inference.

There is one very important respect in which it must be regarded as a rent. Throughout the North-West Provinces, the land revenue being regarded as one-third of the rent, the enhancement of the land revenue by one rupee is regarded as sufficient warrant for increasing the zemindar's charge by two rupees, so that the levy by Government of an additional land tax of one rupee, can in such cases only be effected at the cost of really levying three from the cultivator. If the land revenue were not a part of the rent, this would be an absurd inference.

In short, the land revenue has the principal characters of both a rent and a tax, and cannot be exclusively treated as one or the other. When we have ascertained what is its nature in fact, the name ought to be of little consequence. But experience shows that these names of "tax" and "rent" will continue to have great influence.

Of the principal notions which underlie the different policies in connection with the land revenue, some are political and some economical; and these are combined and conflict in various ways.

The principal political notion is, that the agriculturists are the largest, most warlike, and on the whole, the most important part of the community, and that their contentment is of first importance. This is generally accepted, but subordinate to it arise two conflicting opinions:—

1st. That the principal means of securing the contentment of the agricultural class is to preserve the ancient and traditional tenures and customs undisturbed.

2nd. That the principal means for the same purpose is to give greater value to the tenures.

The principal economic notions are several and antagonistic, as follows:—

1st. That the limitation of the State's share of land produce is the most effective means which the State can use to promote general wealth.

2nd. The very opposite of the foregoing, viz., that the State revenue will be obtained with least hindrance to the general wealth, if levied on the land, so far as this can be done without rack-renting the land.

3rd. That because the free transfer of property tends to promote general wealth, it is desirable to promote the transfer of land by creating a more absolute property therein, and so making that property more valuable.

4th. And, antagonistic to the foregoing, that because peasant proprietorship tends to agricultural industry, and consequently tends to general wealth, it is not desirable to favour the purchase of the peasants' proprietary rights by the rich.

These notions, and the various combinations of them, find their expression in the following questions of general policy:—

1st. Whether we should look to an increase of the land revenue as the best means of meeting the inevitable need for a gradual increase of the income of the State, or whether we should favour agriculture by precluding all increase of taxation of the land.

2nd. Whether we should promote the growth of a more absolute individual and transferable property in land by promoting the transfer and sale of occupancy rights.

3rd. Whether, if a more absolute individual ownership be either desirable or inevitable, it would be better that such ownership be developed in the representatives of ancient families, so as to make, as it were, aristocratic landlords, or amongst the rich, so as to make what we may call plutocratic, landlords, or amongst the peasant cultivators so as to make peasant proprietors.

These questions are much intermixed. But they are really distinct. The first, the question of a permanent settlement of the land revenue, has been disputed more constantly than any other question of administrative policy. Its importance is great, because a permanent settlement once made cannot be recalled, and its consequences, if evil, are, for the most part, irremediable. Consequently, I thought that a review of all the best arrangements on either side of the question would be useful. I read all I could find on the matter. But the more I have read, the weaker seem the arguments for permanency, until I have been obliged to remind myself from time time that, after all, it is a policy which was advocated by Lord Canning, Lord Lawrence, and others of equal weight, in order to prevent my throwing the question aside as one about which there could be no real doubt by responsible persons after due enquiry.

I find that all existing arguments in favour of a permanent settlement of the land revenue may be classed under two general propositions.

1st. That the certainty of enjoying the whole profit of additional industry and capital applied to the land, will be such an additional motive for im-

provement and expenditure of capital as must cause general increase of wealth.

2nd. That the landholding class will be content and have the strongest inducement to royalty.

Lord Lawrence said (in 1862):—

"A perpetual settlement founded on a light and equable assessment of the land, would, it must be obvious, be very popular and advantageous to the great mass of the agriculturists. Against such a settlement of the land assessment, it has been urged that it is a suicidal policy to limit the amount of revenue derivable from the land, when we cannot limit our expenditure, and find much difficulty in devising any sources of taxation to which there are not great objections. Further, it is urged, with great force I admit, that India has made rapid strides in prosperity under the present system of long leases, which afford ample time for the accumulation of capital, the extension of cultivation, and the introduction of superior kinds of produce. Much weight is due to these arguments. Nevertheless I have no doubt but that a perpetual settlement of the land revenue has advantages superior to those which attach to long leases, provided that the measure be limited to those estates which are in a suitable condition for such arrangements. By these terms, for instance, I mean, that whenever three-fourths or even two-thirds of the land have been brought under cultivation, provided the proprietors are willing to accept equitable conditions, a perpetual settlement of the land revenue should be allowed. I recommend a perpetual settlement, because I am persuaded that however much the country has of late years improved, its resources will be more rapidly developed by the limitation of the Government demand. Such a measure will still further encourage the investment of money in the land, and will give still greater security to the land revenue itself, which in years of great calamity, occurring every now and then, has suffered largely, though the loss has been more or less of a temporary character. It is also very desirable that facilities should exist for the gradual growth of a middle class in India, connected with the land, without dispossessing the present yeomen and peasant proprietors. There are many men of much intelligence, spirit, and social influence among these classes, who are yet so poor that they find it difficult to maintain a decent appearance. It is no remedy for this state of things to confer great and exclusive benefits on a few individuals, especially when these very benefits are conferred at the expense of the rest of the community. What is really wanted is to give the intelligent, the thrifty, and the enterprising among them, the opportunity of improving their own condition by the exercise of such qualities, and this can be best done by limiting the public demand on the land. When such men acquire property and are in a thriving state, they are almost certain to be well affected to the Government, and will use their influence, which will generally be considerable, in its favour. Feelings of race and religion have great influence on the people of India; but love for their lands has still greater. Thousands, probably millions, of the people of northern India, the most warlike of its races, are descended from ancestors who gave up their religion to preserve their land. It is on the contentment of the agriculturists, who form the real physical power in the country, that the security of British rule to a large extent depends. If they are prosperous, the military force may be small, but not otherwise.

"No doubt if a permanent settlement be at once generally conceded, without reference to the condition of the country, the loss will be considerable. In such provinces, for instance, as the Punjab, Oude, Nagpoor, the Saugor and Nerbudda territories, the larger part of the country is quite unfit for such a settlement. . . . In the North-West Provinces fully five-sixths of the landed estates and townlands into which the country is divided would be found ripe for a perpetual settlement; indeed, whole districts are, no doubt, in this condition. In all such cases no present or prospective loss of revenue would arise from the measure. . . . Although it will always be wise to maintain the land revenue in its integrity as the mainstay of the State, there can be no valid reason why India should not yield a considerable revenue from indirect sources, though it cannot reasonably be hoped that such revenues will suffice to replace the land revenue, if once given up or largely reduced in amount. On the contrary, a moderate and fixed demand on land, by stimulating industry, will gradually, but certainly, enable capital to be accumulated, and give the agriculturists the means with which to purchase taxable articles. . . . By giving a perpetual settlement, the expense of future surveys and assessments is saved to the State. Such a work, though it comes round once only in 30 years, extends over several years, and occupies the time of many experienced civil officers, whose services can ill be spared, and under the very best arrangements is always more or less harassing, vexatious, and even oppressive. Moreover, as the period of enquiry approaches, the agriculturists, with a view of evading a true estimate of the qualities of their lands, throw much land out of cultivation; they cease to grow the most profitable kinds of crops; they allow wells and water-courses to deteriorate, and the like.

"It seems to be an impression, that one of the effects of a permanent settlement will certainly be, that the land in India will gradually change hands, and that the money lenders will supplant the people of the soil, and reduce them to the position of mere labourers on the lands of their ancestors. Did I believe that such was likely to be the case, I should be strongly opposed to such a measure. But I cannot myself perceive any danger of this coming to pass. Nearly all classes of the agriculturists of India of whom I have had any experience, have been careful and thrifty people. As a rule the smaller proprietors are more so than the larger ones, but all, and in particular those of Hindoo lineage, who form the great majority, are remarkable for these qualities."

Colonel Baird Smith, in reporting on the famine in the North-West Provinces, in 1860–61, wrote:—

"Foremost, then, among the means whereby society in Northern India has been so strengthened as thus to resist with far less suffering far heavier pressure from drought and famine in 1860-61 than in 1837-38, I place the creation, as it may almost literally be called, of a vast mass of readily convertible and easily transferable agricultural property, as the direct result of the limitation for long terms of the Government demand on the land . . . . . Land has obtained an increasing marketable value. . . . . Beneath the surface, there is a continual change of proprietorship in progress. Sales of land for arrears of public revenue have almost disappeared from the public records, while sales by voluntary action, or in satisfaction of debts, have vastly increased. These mutations almost uniformly indicate the healthy gravitation of capital to the land; and, though some may mourn over the gradual but certain displacement of an ancient proprietary, with all its traditional memories, the revolution will advance just as surely as, in the struggle of life, industry, thrift, intelligence, and wealth must displace indolence, extravagance, intellectual stagnation, and poverty. The general tendency of local influence is to check this progress; but the effort is idle, and may be mischievous. The action itself is, in so far as the stability of society is concerned, matter for congratulation rather than matter for regret, and it is determined by natural causes which can be no more interfered with arbitrarily without damage than can the natural laws regarding trade in any other form. Whether we wish it or no, however, the gradual growth of moneyed classes, and the progressive tendency of such classes to seek investments in land are sure to bring the

soil and the capital of the country more and more closely into an union, to be fruitful ultimately in the most beneficial results to all."

In illustration of the extent to which the proprietary rights of the agricultural classes have already been transferred to the commercial classes, he shows that out of 1,613 villages which constitute the district of Futtehpoor, 184 had within the last fifty years passed from the old agricultural proprietors to commercial proprietors. Out of 2,010 villages in the Cawnpore district, 153 had so passed.

After discussing the good results of thirty years settlement, he says:—

"The inference seems irresistible that to intensify and perpetuate those results, we must proceed still farther in the same healthy and fruitful direction. . . . It may be supposed that a great sacrifice of public revenue is involved in the conception of a perpetually fixed demand on the part of Government. . . . The recent tendency of the measures of Government has shown a different conviction and indicated its belief that its interests are best secured . . . by a general lightening of its demand on the land. . . . It is scarcely possible indeed that a tax on rent which, even at its minimum absorbs half that product, and presses exclusively on a single section of the community, can be permitted to increase. The tendency will, I believe, be quite in the opposite direction."

After describing the increase of commerce and general wealth in consequence, he adds that the intelligence of the Government would "direct it to the least offensive and most effective means of sharing in the general prosperity."

Such views prevailed at that time, and in October, 1861, the Government of India published a resolution regarding the sale of waste lands in perpetuity, and the redemption of the land revenue by payment of twenty years' purchase. The result was a dispatch from Sir Charles Wood, objecting to the redemption of the land revenue, but stating that "Her Majesty's Government have resolved to sanction a permanent settlement of the land revenue throughout India." But this general conclusion was immediately followed by a statement of the objections to an immediate introduction of it everywhere. It was to be altogether postponed in the Presidencies of Madras and Bombay, and in recently acquired territories, such as Oudh and Nagpoor, and in fact, Sir Charles Wood's dispatch only supposed that it might be introduced in "parts of the North-West Provinces, and probably of the Punjab," and there only "provided that the assessment is not only adequate in amount but also equally distributed."

The result was that no district was found to be suited for its introduction, and the question was more completely laid for the present by the permission to introduce a permanent settlement than it would have been by prohibition; more especially when one of its most experienced and ablest advocates, Sir William Muir, then Governor of the North-West Provinces, came to the conclusion that the time had not come for it, and concluded that revised settlements should continue to be confirmed for periods of not more than thirty years.

The question, however, is not formally closed, and if it were, it is always liable to spring up again.

The foregoing observations were, in fact, written last year. Since then the fall of the value of silver has happened, and I suppose the most ardent advocate of permanent settlement would think his cause hopeless for the present. Some would think it dead; but it is not so. It will revive again some day, and I, therefore, have not thought it worth while to omit the discussion of this part of the subject.

The arguments I have quoted are the strongest which I can find. Let us consider them. The main economic argument is, that the permanent settlement will give additional motives for the investment of money in the land, and so will give the land a greater marketable value, and cause more capital to be applied to agriculture. This is an opinion founded on supposed natural tendencies. On the other hand, it is a fact admitted by Sir William Muir, one of the very ablest men who ever advocated the permanent settlement, that a comparison of the permanently settled estates with those side by side under temporary settlement shows no difference as respects their improvement or prosperity. He looks to the future time, when more enlightened ideas will prevail, but he admits that there is at present little sign of the owners of land devoting capital to agricultural and economical improvements, and that this argument must be held as wanting in force at present. One can add little to the force of such facts, until some facts, and not opinions, are shown of an opposite character, and the general proposition above noted in support of a permanent settlement must be regarded as wholly unproven, whilst Baird Smith's intrinsically weak argument, that because a 30 years' settlement has done so much good, a perpetual settlement must be still more beneficial, *i.e.*, that because moderation is good, total abstinence must be better, loses any little force it might have had.

We must not pass over the semi-economic and semi-political argument of the advantage of raising up a middle class of wealthy proprietors of the land. The notion is a confused one, as one finds on attempting to analyse it. Every one will admit the advantage of a class of wealthy agriculturists. But how is the permanent fixing of the land revenue to produce them? It must be either because the wealth of the country will be increased on the whole thereby—a most disputable notion as we have already seen—or because the agriculturists will be thereby favoured at the cost of the rest of the community. But, to this last means, there is the double objection of the difficulties of every kind, financial and political, which would attend the increased taxation of other classes, and of the likelihood that the tendency to supplant the agriculturists by the mercantile class in the ownership of the land, will be stronger than the tendency to improve the condition of the agriculturists.

Lord Lawrence and Baird Smith are at variance as to this tendency to supplant the agriculturists by the mercantile, *i.e.*, the rich classes, in the ownership of the land. Baird Smith gives facts in support of his opinion that such supplanting takes place. Sir George Campbell bears testimony against Lord Lawrence in this respect as regards the question of fact, and against Baird Smith on the question of policy. He says that the economic gain of the definition of rights attending the settlement for thirty years in the North-West Provinces, was balanced by the political weakness

consequent on the old proprietors, the most martial class in the country, being reduced to the position of needy discontented cultivators; and that, especially, the too summary alienation of the rights of village proprietors was a source of political weakness in the rebellion of 1857-58. There is much other evidence to the same effect. The conviction that the free sales of all the proprietary rights had been a source of political weakness, led to special legislation in 1873. Sir William Muir in that year said:—

"He could regard nothing as more unfortunate and disastrous than the course which from the beginning of our administration had been taken with these ex-proprietors" (men whose proprietary rights in the land they cultivated, had been sold), "and the system by which they had been sold up by the application of a strange and uncongenial law, and reduced to the dead level of cultivators without rights of any kind. The results had been that the body to which we should have looked as the stay and backbone of our agricultural prosperity, had been reduced to a state in which they were liable to be ejected from their lands, and to have the last rupee demanded from them. They were then, on the one hand, ground down to be what he might call a depressed and emasculated tenantry; and, on the other, the body to which we might have been able to look as our stay in the time of trouble and danger, had too often proved itself a disloyal and dangerous yeomanry, a tenantry powerless for good, but strong for evil." (Debates in the Legislative Council of India.)

The Hon. W. Bayley, on the same occasion, affirming the observations of Sir William Muir, said:—

"Even in times of profound peace they (the ex-proprietors) were felt to be an embarrassment to the administration of the country. His own experience testified, and he believed that he could appeal with confidence on this point to other officers of similar experience, that if you met anywhere a notorious offender, a man who had made himself conspicuous in crime, and who had with him, as was very often the case, the sympathy of a large body of the community—and if you investigated the history of this man, you would find in the majority of instances that this man was an ousted proprietor. . . . . He believed he was scarcely exaggerating when he said that during the mutiny almost every person of this class re-possessed himself of his ancestral possession."

Apparently, Colonel Baird Smith is proved right as to the tendency of a permanent settlement to supplant the agricultural class; and if so, I suppose we may claim Lord Lawrence as opposed to the measure.

Some advocates of permanency have proposed a settlement which should be subject to alteration in proportion to the change of value of staple produce, and on no other ground. But, beside the many practical difficulties, the seemingly conclusive objection remains, that the assessment would still be paid in money liable to periodical alteration in amount; and this would not be felt by the cultivators to be a permanent settlement at all, and could not be expected to give the additional sense of security and additional inducement to industry which, as the assumed consequences of fixity, are the grounds on which alone a permanent settlement is advocated.

Baird Smith's remark about the inevitable action of natural laws in the healthy gravitation of capital to the land, is a good specimen of the fallacy of ambiguity. The investment of capital in land and the investment of capital in agriculture are perfectly different things. The first is the tendency of the moneyed classes to buy up the rights to rents, a tendency which undoubtedly exists, and is very commonly regarded as an evil. The other is the tendency of capitalists to employ their capital in agriculture, a tendency which every one would think healthy, but of which there is little sign.*

The argument touching the costliness and vexatiousness of a periodical settlement has really little force. The cost is in proportion to the work remaining to be done. All rights have not to be ascertained afresh at the periodical settlement; and we have the experience of the several settlements in Bombay to show that they can be made in such manner and on such ground of general increase of the value of agricultural produce, as leaves no motive for throwing land out of cultivation or other such means of diminishing the apparent productiveness and value of a particular estate.

The positive arguments against a permanent settlement are—

Firstly, that as permanence of tenure and permanence of rate of taxation are different things, and there is much reason to believe that none of the advantages of permanent tenure are appreciably hindered by the existing thirty years' settlements of the rate of taxation; the fixing the latter for ever is a wanton throwing away of a possible future resource, and, consequently, a wrong to posterity.

The injury to posterity is not only possible, but, according to our present economical knowledge, very probable; because

Secondly, and here I will read the words as I wrote them last year:—"There appears to be on the whole a continuous fall in the value of money; and in India, especially, considering the cheapening of silver by the substitution of gold elsewhere, and the cheapening of gold by its more abundant production, and the rise of prices which would attend the increased commercial prosperity, we hope, for her, it is likely that in the course of years the value of the present land revenue will be very greatly diminished." As it happens we have not had to wait years for that fall in value. But I hope that this present fall will not last.

Thirdly, it is admitted by all, that, irrespectively of extraordinary needs, some considerable and inevitable increase of the public expenditure is likely in future; and this must be provided for by other modes of taxation, if the gradual growth of the land revenue be stopped; and it is, to say the least, wholly unproven that such alternative taxation will be less burdensome either in its economic consequences or by its social and political influences, than an increase of the land revenue at long intervals.

This last question of alternative taxation is the real issue. No one pretends to be sure that the value of money will not fall, or that no increase of public expenditure will occur. What they say

* Sir Wm. Muir distinctly says that there is little sign of this in the North-Western Provinces. I find, however, that Sir George Campbell says that the mercantile and capitalist classes in Northern India have really done much to increase the number of ryots, and to improve landed properties which they have purchased.

is, that the economic or political effects, or both, of fixing the land revenue for ever, will outweigh everything. I cannot find any instance of the advocates of the permanent settlement facing this question of alternative taxation, by stating the other forms of taxation which are so certainly preferable, now and for ever, to an increase of the land revenue, that we may as well pledge ourselves to a perpetual abandonment of any increase. Nothing less can justify a permanent settlement. If it were a plausible opinion, or a strong likelihood, the existing rates might be made for a longer time; any change might be indefinitely postponed; but an absolute pledge that, so far as it is possible to bind posterity, there shall be no further taxation of the land for ever, is as unreasonable as a promise that for all time the custom duties shall never be increased. Surely this is a true statement of the economic part of the question, and if it be, the mere statement seems almost to dispense with further argument.

But so far from the preferableness of other modes of taxation being a certainty, or even a strong likelihood, there are abundant reasons to the contrary. Economic science tends strongly to the conclusion that appropriation of rent by the State is a mode of providing the State revenue, which interferes less than any other with general wealth, and the majority of economists at present, would declare the land revenue to be less likely to hinder production than an increase of custom and excise duties. The witness of Indian experience is against the hope of obtaining any large revenue by direct taxation (other than the land tax), whilst the witness of responsible opinion is extraordinarily unanimous as to the wide spread discontent which attends such direct taxation. It seems to me clear that a land revenue has singular economic advantages. So long as it is not heavy enough to rack-rent the land, there is no reason to suppose that it diminishes production or affects prices. If it be too heavy in that sense, it ought to be lowered for the present, not permanently fixed at what is too high. It is almost certain that in India the alternative of an increase of land revenue must be an increase of excise or custom duties. The circumstances of India make her foreign trade a necessity of her existence; one-fifth or one-sixth of her entire exports are not exchanges, but payments of debt. She needs to export yearly some twelve to fifteen millions worth of goods to pay the "home charges," as they are called, and several millions more to import silver, the mere means of exchange. To enable her to do this, she should be as free as possible to produce what she is best fitted to produce. The land revenue, unless it rack-rent the land, does not interfere with that freedom. All duties inevitably hinder it. I appeal to these economic doctrines, as at least affording a presumption which ought to preclude an irrevocable step in opposition thereto.

To free trade from all imposts, is not the only administrative principle; but, at least, we English, who have seen such beneficial results from every step in that direction, ought to regard as absurd a proposition to pledge India to a contrary policy for ever.

I have only indirectly noticed the political argument pure and simple, for a permanent settlement, as promoting the contentment of the agricultural class. But I have shown that one of its ablest advocates, Baird Smith, regards as an inevitable consequence that it will lead to the transfer of the proprietary rights from the agricultural to the commercial class. Experience confirms this expectation; and, if so, a permanent settlement is not likely to add to the eventual contentment of the dispossessed class. When we add to this the probable discontent attending other forms of taxation, we may confidently judge that the ultimate effects of a permanent settlement as respects the contentment of the people are very doubtful; and consequently that the irrevocable step of a settlement for ever is at present irrational.

I cannot use a weaker word than irrational, touching a policy of settlement in perpetuity. The newspapers mention that a deputation waited on Lord Salisbury a short time ago to ask for the total and immediate abolition of all the custom duties in India. The request did not indicate a very impartial view of the case. But I suppose that if some one had proposed to add a request for a pledge that no Government should reimpose them for ever, nobody could have been found to support it. Yet, if with respect to the produce of man's labour and of a kind which practically cannot be monopolised, a proposal to prohibit increased taxation thereof by our posterity for ever, is absurd, as I suppose every one present would admit; surely it is equally absurd to bind our posterity never to increase the taxation of the land which in its nature is national property, and by its nature becomes, as population increases, more and more a monopolised thing constantly increasing in value and proportionally more able to bear taxation.

Yet some of you must think, if this be so, if the one proposal be really as absurd as the other, how is it that we could hardly find a fool to father the one, and many men distinguished by general ability and experience to uphold the other. The question is fit and useful, for we can hardly be satisfied with the disproof of any opinion held by many, until we know why others hold what seems false to us.

The best explanation I can offer is that this subject is one specially liable to fallacies of ambiguity and association. There is frequent ambiguity between the permanent definition of the nature of the liabilities of tenure and the permanent definition of the measure of the liabilities. The two things are as distinct as the ownership of a thing and the liability of that thing to be taxed. Yet the arguments for the definition of the nature of the liability to pay land revenue, are constantly offered as reasons for fixing the measures of that liability for ever.

There is the fallacy I have already indicated of confusing the investment of capital in purchase of rent charges with the investment of capital in agriculture. But, above all, the fallacies of both ambiguity and association which cling to the notions of rent and taxation seem to have indestructible vitality. The claims of ownership implied in rent are met by saying that ownership has been surrendered, and that the land revenue is only a tax; whilst the absurdity of pledging posterity in respect of taxation is met by calling the revenue "rent."

By these means men impressed with the great need for political contentment of the agricultural

classes, can disregard the financial and economic consequences. Others, looking solely to the economic advantage of converting all privileges into well defined transferable rights, and so giving them the utmost exchange value, can shut out of sight all other economic and social tendencies and financial exigencies. Those who think that both political and social advantages will be secured by perpetuity, are enabled by these fallacies to hide "the sin against posterity." Yet, after all, the settlement of the land revenue for ever seems so unreasonable, that I always end the inquiry in some wonder.

There remain the two other general questions for brief notice. The first of which is, whether we should promote the growth of a more exclusive individual and transferable property in land.

On this it may be said that definition of rights may be assumed on general political and economical grounds to be needful, and, indeed, inevitable; and even if they be joint rights, we cannot define these without in some degree defining the individual share thereof. The open question rather concerns the transferableness of such rights. The solution of this question is only easy to those who regard a single tendeucy almost exclusively.

At first sight most Englishmen would solve it by an appeal to the principle of free trade. I am myself a professed economist and free trader, but I do not identify the mere increase of national wealth with social progress. Economic science is but a servant of civilisation, and in a lower grade than politics and ethics. If any one should argue for free trade in slaves, we should all agree that the question was not to be tried on economic grounds. A sale of the right of occupancy of land is a very different thing from a sale of commodities. So far as I know, there never was a time or a people, at which and among whom the principle of free trade in commodities would not have been beneficial; but I cannot say the same of free trade in land tenures. The cultivator's right of occupancy is a right to cultivate the land; and if he freely sell that right, to be exercised by some one else, betaking himself elsewhere, I know no social or economic objection thereto; but when, as under existing circumstances in India, the sale, ninety-nine times out of a hundred being made under the compulsion of debt, is attended by no change of occupancy, or of personal labour in cultivation, it is, in effect, the sale of the man's social and political status, and is, approximately, the sale of himself and his family, to become serfs, *adscripti glebæ*. This has been felt to be a political and social evil in the North-West Provinces, to such extent that, by the North-West Provinces Rent Act of 1873, the mere right of occupancy, though heritable, is not saleable or transferable, except between persons who by inheritance have become co-sharers in such right.

The solution of the question is easy to one who regards the purchase of rent-charges by the rich as "a healthy gravitation of capital to the land." The investment of capital which can be distinctively termed "healthy" must tend to increased production. It may be said that general economic experience warrants the expectation that freedom of sale of any means of wealth will tend, on the whole, to the most effective use of it, and consequently to the increase of wealth. This is true. But it is not the only economic tendency. It is equally certain that ownership of the profits of a man's own labour tends to industry and to effective use of that labour, and to wealth; and the sale of the right of occupancy tends to deprive the cultivator of that ownership. On the other hand, even this tendency is not without its direct counter-tendency; for it is no less certain that necessity stimulates industry; and it is not only conceivable, but likely, that a certain degree of pressure, by the necessity to pay rent, may increase production. Again, it is equally certain that poverty and indebtedness of the cultivator tend to the exhaustion of the land, and to a consequent diminution of production and of general wealth; and there is much evidence that the very saleableness of land, by facilitating borrowing, has increased the improvidence and indebtedness of the cultivator.

If there be these conflicting economic tendencies, much more does the question become complex when the political considerations of the degradation of the status of a large part of the people, and the enduring discontent of the dispossessed proprietors, are added.

The mode in which this question of transferableness is decided, carries with it a part of the answer to the last question stated above, viz., whether it be better that ownership of land be developed among aristocratic landlords, rich landlords, or peasant proprietors; whether, in fact, we should take advantage of any existing indefiniteness to define with a political or commercial bias, and consciously to create new rights, rather than merely to define existing rights as nearly as possible according to their historical nature.

Those who for economic reasons would favour landlordship by the rich, would make existing rights of occupancy freely saleable, and would allow the improvidence of the cultivating class free course. I have, however, indicated the grounds for doubt of even the economic and political tendencies of such a policy.

Those who would favour the creation of aristocratic landlords would do so on political grounds. The political advantages are commonly inferred from the disadvantages which have been felt when our measures have superseded or impoverished a previously existing aristocracy, as has happened more or less whenever our system has been first introduced into any native State.

I have no sympathy with the mere administrative sentiment which cannot bear imperfection in the machinery, or anomaly in the plan, of Government. No one can feel more strongly than myself the evil of large visible change among the influential people of any country or province. The tendency to regard the past as "the good old days" is always strong; and every other consequence of change is forgotten in the presence of living witnesses of a fall from comparatively high estate; who acquire thereby an influence greater than they had in their prosperity; whilst their motive to use that influence against the power and the system which has overborne them, is the strongest possible; and my sympathy has ever been with the maintenance of the system, the social relations, all the complicated growth of tradition, sentiment, experience, and even of mere

force, which we find established, so far as is consistent with order, public justice, and social progress. But it is the commonest fallacy to infer the intrinsic excellence of any state of things from the evil of disturbing it. Philosophy may see how inequalities of social status tend to harmonious action in the body politic. But the endeavour to artificially increase those inequalities for the sake of the incidental advantages, is as reasonable as to aim at artificially creating the inequalities of moral physical and intellectual force which are the roots of all seemingly accidental inequalities of position. It is the counterpart of the socialist's notion that perfect equality can be secured by administrative action.

Looking at an aristocracy of almost any kind which we find as an established fact, I sympathise with those who would utilise it by giving it, if possible, administrative duties, and at any rate would give it every chance to live and grow into some useful shape. But in any way to sacrifice the status or the proprietary rights of the agriculturist class in order to create an aristocracy who will support British authority for the sake of retaining their personal privileges, seems to me a conception inconsistent with the true idea of our responsibility to India.

The arguments in favour of developing peasant proprietorship wherever its actual existence affords the presumption that it is suited to the social and economic condition of the people, are weighty. It tends to industry, to political content, and to practical patriotism. Those who would favour peasant proprietorship, would reasonably sympathise with the recent legislation in the North-West Provinces; for there is reason to fear that, without such protection, the peasant proprietors would continually pass into the position of tenants-at-will on their own small farms.

If the tendency of the improvident agriculturists to become mere tenants-at-will, were balanced by a tendency of the more provident agriculturists to become large owners, this would indeed mean more capital to the land, and we might be well satisfied to let things take their course. But it really means, in most instances, not the aggregation of farms through the increasing wealth of some, but the subdivision of them all by poverty and by inheritance; not the attraction of capital to the land, but the expulsion of it in the shape of debts to money lenders, or rents to absentee non-cultivating landlords. We have recent evidence of this in the agrarian riots in the Deccan; and the case well shows the intimate connection of the land revenue and the land laws. The riots were all directed against the money lenders, and were, I believe, most prevalent in the Ahmednuggur district, in which there had been no revision and enhancement of the Government assessment. Yet the similar disturbances in other districts were attributed to the revision of assessment. Doubtlessly, the indebtedness of the cultivators would make an addition to the assessment a greater burden than it would otherwise be. But the addition is probably in most instances very small compared with the burden of loans borrowed at from 30 to 40 per cent. interest.

At some distant future day, the supply of food may be so increased, especially by irrigation; and capital may consequently be so much more abundant, and manufacturing industries and means of intercommunication may be so developed, that the population will not be tied to the soil in nearly the same measure as now; and capital may so seek employment in agriculture, that a sale of right of occupancy of land will ordinarily mean the transfer of the cultivation to more capable hands; and then any hindrance to such transfer would be harmful. But that is far from the present state of India.

Believing, to use Sir Henry Maine's words, that "the problem taxes to the utmost the statemanship of the most advanced, even when animated by the highest benevolence and informed by the widest knowledge," I do not pretend to declare the details of a true policy. My purpose has rather been to give some apprehension of the problem and its difficulties, than to solve them. But on some points I have no doubt. I have no doubt that the prosperity of a rent-receiving class, when obtained by the degradation and poverty of the cultivating class, is, on the whole, a national misfortune and loss under any circumstances; whilst in India it must cause grave financial difficulty, because the dependence of the State on the land for its principal revenue is inevitable, even if it were not, as I believe it to be, economically advantageous. It is highly probable, to say the least, that a rapid development of the nearly unconditional land-ownership with which we are familiar in England, would impoverish the cultivating class. I have no doubt of the political danger of any disregard of a people's established notions touching land tenure. We have large experience of the wide-spread and enduring evil therefrom arising. It was the root of the hatred of England which endured in Ireland for centuries. It was the cause of the New Zealand War. It spread, embodied, and vivified the spirit of rebellion in India in 1857–58 with more active force, probably, than any other cause.

Thus I arrive at the present conclusion that general policy concurs with abstract justice in defining existing rights according to traditional sense and sentiment, and not by any modern English analogies; and that if we only attend to the definitions of proprietary right as practical need for definition arises, the development of property in land is more likely to grow in a fruitful manner than if guided exclusively by any special economic bias.

Also, seeing that modern economic science, traditionary custom, and national sentiment, are all concurrent in favour of land rent as the principal source of State revenue, I have no doubt of the policy of obtaining the revenue therefrom, rather than from customs and excise duties, to the utmost extent which does not, by its pressure, diminish directly or indirectly the effective cultivation of the land.

Lastly, I have little doubt that a too doctrinary application of economic science is a likely source of future error. Economists are too apt to forget that their science is of human motives, which vary in relative force under varying circumstances, and that the resultant forces are proportionally uncertain and capable of indefinite modification. What suits England now is the outcome of a series of conditions, especially the growth and decay of

feudalism and the subsequent great predominance of manufacturing industry, which has not a parallel in India. Land tenure in India now is rather what it was in Europe some centuries ago, and European political and economic experience ought to give us some guidance in dealing with it. But the hope that India's peasantry may rise in well-being without first touching the bottom of social degradation and poverty which, for the most part, the peasantry of Europe reached before there was a reaction, is really the hope that economic science will only be the hand-maid of imaginative sympathy and insight in India's statesmen.

DISCUSSION.

The Chairman, in inviting discussion, said the paper was one of extreme value, though he thought the title was somewhat minifying, and many who read it might hardly have realised how great the subject was, and how completely it went home to the interests, rights, and well-being of the people of India. General Marriott had taken the broadest view of it, and had not confined himself to the mere question of revenue; and it would be of great importance to have it thoroughly discussed.

Mr. J. T. Wood said—British India contains something under one million square miles, exclusive of the lands belonging to native states. The area in the possession of Europeans is probably under 2,000 square miles. The 998,000 miles, waste lands excepted, are held under the native tenures, which have been described by General Marriott, and, according to some of such tenures, estates descend from father to son. On the occasion of the death of the holder of any such lands, held under native tenure, no kind of taxation is paid to the Government, beyond the burdens previously borne. Previously to the year 1865 the land in India which was held by Europeans was held (subject or not subject to a land-tax) either on long leases, or in fee simple. On the death of an owner in fee simple of such lands, the lands vested in his heir-at-law, or devisee, without any administration being necessary, according to the English law of primogeniture. In the year 1865 the Government of India passed the Indian Succession Act, which provides that all lands in India shall, in the first instance, vest in the administration, whether the owner died testate or intestate; and, in case of intestacy, shall be divided between his widow and children, or kindred, in the same way as personal estate; but the Act states that its provisions shall not be applicable to the wills or intestacies of "Hindoos, Mohammedans, and Buddhists;" and also that such races, sects, and tribes shall be exempted from its operations as the Governor-General in Council may from time to time direct. Another Indian Act provides that on taking out administration an *ad valorem* duty of two per cent. shall be payable to Government on the value of all the property comprised in the administration. It is also necessary to explain that an Indian executor is not allowed to take out administration in India unless he be resident in that country. Should he be resident abroad the will must be administered either by a public officer, called the Administrator-General, or by an administrator resident in the country, acting under a power of attorney from the executor. Both these alternatives involve a heavy commission to either the public officer or to the private administrator. A very large proportion of the 2,000 square miles which I have assumed to be in the occupation of Europeans must be in the occupation of public companies, such as tea companies, &c.; and, as public companies never die, moreover, should the companies be English companies, the property of any shareholders dying is not liable to Indian taxation. The lands held by these companies do not come within the operation of the Indian Succession Act. The Government now sell waste lands free of land-tax, to the highest bidder beyond the upset price, but it will depend on the race or creed of the buyer, whether at his death the waste lands purchased by him will or will not be liable to this special taxation. The operation, therefore, of the Indian Succession Act is limited to a very small proportion indeed of the landholders in India, and those almost entirely Europeans; and as imposing on those individuals a tax not borne by the remainder of the landed proprietors of the country, operates most unjustly. There may be reasons applicable to India, but not applicable to England or other countries, against the redemption of the land-tax in India; any information or arguments on the subject are appropriate to the discussion of the land tenures of India. Government are selling waste lands in lots, free of land-tax, as large as 1,500 acres at upset prices, varying from 5 to 10 rupees per acre, and the Government, doubtless, uses the purchase money in reduction of taxation, and the redemption of tho land-tax might, according to English ideas, be legitimately carried out, say thirty years' purchase, if the money obtained therefrom were used by the Government in the redemption of permanent national debt, or in renumerative public works.

Mr. Rowland Hamilton said the paper they had heard read was an example of how the principles of political economy might be employed without stretching them beyond the region to which they properly applied. He had often regretted that many economical theories had been stated and argued without a sufficient distinction being made between their purely material and their higher moral effects. Taking, for instance, the question of small and large culture. It might be true, as he would assume for the moment, that cultivation on a large scale, with better organisation of labour and greater command of capital, possessed great material advantages. But the true use of the theory would be to lay before the small cultivators the truth that this advantage was within the region of organisation if they could unite and work together. This would be an appeal to their intelligence and morals which in due time would bring forth good effects, but an appeal to legislation would only lead to the premature development of the one system rather than the other, and might very likely tend to disaster. If, for instance, no protection were now given to the ryots of India, if they were free to sell all their proprietary rights, there could be little doubt that we should have to contend with a pauper class. Given a ryot who wanted forethought, self-denial, and enterprise, he would remain in a state of poverty if he had not a landlord to take care of him, to advance him capital, and to assist him in the higher branches of his cultivation; he would inevitably fall into the hands of tho money lender. If you encouraged within reasonable limits the establishment of a capitalist landlord class, you might expect to find them taking an interest in the permanent prosperity of the land, which a mere money lender would not feel. It was a long and vexed question whether the land revenue of India was a tax or a rent, but he thought it might be elucidated by a consideration of the economical derivation of rent, as enunciated by Ricardo. If rent arose from the different degrees in which returns were yielded to the same amount of labour, you had rent which did not add to the cost of production, and was quite different in its origin from land-tax; because you might suppose the case of a country where there was such an abundance of land that no more natural premium would be required for one sort of land than another. But it would naturally be the case that the chief source of revenue must be a tax upon the land, and the remission of this tax would certainly be a stimulus to the cultivator, and an increased reward for his exertions. But if the land revenue arose from rent, the remission of it would not give any additional inducement to the cultivation of the land, because you must assume that the average reward to the cultivator was given before such a difference as that known as economic rent would arise.

Where a country was thickly peopled, a land-tax and rent may to a large extent be contemporaneous, because however grievous taxation might be, the cultivator must have the wherewithal to live, so that those who had the best land could be taxed to a much greater extent than those under less favourable circumstances. It appeared, therefore, that whereas remission of rent would not increase the inducement to the cultivator, remission of taxation would. He entirely agreed in the necessity for allowing largely for the difference in race, character, and position, in dealing with the land revenue in India. In Bengal there was a fertile soil and a large population, and there were many problems which involved the question of the ownership of the economic rent. Going though central India, where there was a large quantity of land cultivated almost in alternate patches, the cultivators having the power of taking what land they pleased, and then leaving it fallow, it was impossible that any such charge could have arisen, at any rate in such a form as to make it the basis of legislative action. One consideration seemed to follow from the security of tenure to the occupier in India; it acted in place of a Poor-law, because as long as the ryot had his hold on the land, however much he might be oppressed by the money lender or the rent owner, he could never become destitute. For the more energetic races in the north, whose instincts were warlike rather than economical, it was useless to legislate on purely economic principles. In such a case fixity of tenure acted something like entail, and if the money lender knew that the land could not be alienated, he simply lent less money, therefore, interference with freedom of contract was no doubt to that extent wise and just.

Mr. J. S. White said the land revenue of India had been properly called the backbone of Indian finance, for without it the fiscal position of the country would be simply one of insolvency. It amounted to about 20 millions, or a little more, out of a total revenue of from 40 to 50 millions. It had always appeared to him that the great problem to solve was how to make it most remunerative, to keep it at its existing point, and if possible to improve it, without pressing hardly upon the cultivator or interfering with the prosperity of the country, and the application of capital to the land. He thought the question of land tenures had been made too much of. It was not so important what the tenure was as the question with whom you could make the best arrangement for procuring an improved revenue. In deciding what mode of settlement should be made, and with whom, he thought the settlement officers should be governed, mainly, by what they found to be the existing state of things. Whether they found the ryot system, the village community system, which was a *quasi* corporation, or any other, they should treat with the persons they found occupying the land. One great objection to the revenue survey was that it appeared to define rights too much, and took too much pains to inquire into matters which were really not necessary for the object in view, namely, the collection of the revenue. If it were possible, the best plan would be to have nothing but numbers to each piece of land, register them, and say that the person who occupied each piece should pay the assessment upon it; that would get rid of the difficulty about titles. If they had a record of titles at all, there should be a regular registration, as in Australia, so as to dispense with private deeds, and let the land be transferred simply by means of the registry. In India there was the double system, and private deeds were required, notwithstanding the registry, because if any party to any suit relied on his registered title, he was told that was merely a register for revenue purposes. The difficulty the revenue officers found was, probably, to know who was the party on whom to levy the tax, but if the assessment were of moderate amount, there was no doubt there would be always plenty of people to come forward and cultivate the land. Let it be excessive, however, as it was in Madras—in some cases as much as 50 per cent.—and there would be great difficulty in keeping the lands in cultivation, for it was often found that the people threw them up and emigrated. In discussing the merits of the three principle systems of tenure, the permanent settlement, the ryot system, and the village community system, he quite agreed that the permanent settlement was a mistake financially. Many of the lands in Bengal were now paying not more than 6 or 8 annas per acre, and the result simply was, a gift of so much money to the first holders of the lands. In the first place it was a great question whether the right persons were settled with, but putting that aside, there was no doubt that Lord Cornwallis in 1793 put into the pockets of the zemindars the difference between what would be a proper and fair assessment, and what it was actually fixed at. He was not greatly in favour of the village system, though where it existed it was well to recognise it. He could not see that it was preferable to the ryot system, though it had come greatly into favour because it was found to be of historical antiquity. It did not seem, however, as civilisation advanced that was the best system for promoting the prosperity of the people. He believed it kept them back, and should doubt whether there would not be a great deal of squabbling amongst the members of the community, who should have the most desirable portions of land. It was a great pity that there was so much *doctrinaire* spirit in this matter, one upholding one system, and another another. On the whole he preferred the Bombay ryot system, which was a settlement made with the occupant, and when made it was a fixture for 30 years, during which time if the ryot paid his assessment he could not be ousted, though he could transfer his property by sale or gift, or will, just as any Englishman could. At the end of 30 years, if he were still in legal possession, he was treated with again, and a stipulation was made that the revision of the assessment should not be in respect of any individual piece of property arising from the proprietor having improved it, but must be based in a general rise in the value of the land in the whole neighbourhood, such as improved facilities of communication would create. That appeared in principle to be fair. He did not care whether a ryot was proprietor or freeholder or not, but he was substantially the owner. The preamble to the Act of 1865 stated that a moderate assessment was actually advantageous for the occupant and for the Government, but he did not know what guidance the revenue officers were furnished with to determine what was a moderate assessment. It varied enormously, and he thought some general rule should be laid down, and that in no case should it be greater than one-third of the gross produce. The Government had laid down in detail the principles on which the survey should proceed, and what their officers should do, but they had never committed themselves to the proportion which the assessment should bear to the gross produce, but in all cases where there was no limit imposed to the right of the Government to tax the land, the collector was to assess it at his discretion subject to the sanction of the Governor in Council. With regard to the revised settlement, the Government had had a discretion to limit any advancement of the rates in cases where the property had risen in value owing to circumstances applicable to the whole district, and that he thought was a proper course.

Col. Rathborne said there were two main systems of land tenure prevalent in India when the English went there, besides some minor and exceptional cases on the coast, the Hindoo and the Mohammedan. Under the former system every occupier of land was the actual owner, as fully as any English freeholder, but was subject to an assessment, which the Hindoo legislators had laid down was not to exceed one-sixth. Under the Mohammedan system the whole land became the property of the Sovereign; if occupied by Mohammedans it was subjected to a taxation, usually of one-tenth, whilst if held by infidels it was subject to another tax called the

karaj, which was not to exceed one-third, and was generally about one-fifth of the produce, but for certain crops, such as tobacco or vegetables, a money payment was fixed. If a person failed to cultivate his land it was held that the Sovereign had the right, if cultivation were not resumed within two years, of taking possession and disposing of it at his pleasure. Under both systems, therefore, the occupier was subject to a certain definite taxation, and no more. When the English came, they asserted the right which had never existed before, revising the assessment after a certain period, and the cultivator, no matter how ancient his rights, or how many centuries the land had been held by his predecessors, if he did not pay the money assessment fixed by the revenue officer, was liable to be ousted from his lands. At the same time the assessment was so badly managed that in Bombay a second, and he believed in some cases even a third revision had to be made. Some got off almost scot free, while others had to make up the deficiency. All the difficulty had arisen from the introduction of arbitrary rules, and ideas not natural to the country. Mr. White spoke of a moderate increase of the assessment after thirty years, but it had been in Bombay in some cases 180 per cent. to his certain knowledge. The Governor in Council passed a general rule that the increase was not ordinarily to exceed 50 per cent., and in no case 100 per cent; but he thought if a person in England rented land on a 30 years' lease, and then found his rent was doubled, without any excuse, except that a railway had come into the neighbourhood and given greater facilities, his ideas about his right to the land would be of a very vague description. Under such circumstances the value of the land to the occupier was really hardly anything at all, and if he could find a purchaser, it would be for a very low figure indeed. He had always been of the entirely opposite school to General Marriott, so far as the land revenue was concerned, and belonged to those who held that the position of a landlord had its duties as its rights, and that any one who undertook such a position, whether in England or India, must see that those duties were fulfilled. Now 379 millions of acres in India were in the hands of the British Government, and the idea of the Government undertaking to do all that a landlord ought to do, such as providing for watercourses, roads, &c., was absurd; in truth, not one million per annum was expended on what might be termed agricultural improvements over the whole of its large territory. The consequence was, that both in this room and at the East India Association they constantly had papers read complaining of the neglect of the Government to do that which was required to make the land valuable. But the same thing continued, and always would continue, because a Government had so many other matters to attend to, such as naval and military affairs, the administration of justice, education, and so on, that it could never properly fulfil the duties of a landlord. On that ground he thought the land ought to be allowed to fall into the hands of those who would be its natural proprietors, and without advocating any theory of setting up aristocracies, democracies, or any other system, leave the land free, as it was in other countries and in England, to fall into the hands of those most likely to cultivate it, and to fulfil the duties of landlords.

Mr. Conybeare, though he had not had the advantage of living in India, had been for a long time a student of land tenures both at home and abroad, and he begged leave to read an extract from Mrs. Fawcett's "Handbook of Political Economy," which bore directly on the subject under discussion. The passage referred to dealt with the constant increase in the value of land, arising from the constant rise in value of agricultural produce, and showed the advisability of the State retaining a share of this increased value instead of permitting it all to be appropriated by the few individuals who happened to be landed proprietors, thus saving a large amount of taxation, the case of India being adduced as an example of the benefits derived from this system. These words were even more important now than when they were written. India had to pay about 16,000,000 annually to England, though no doubt she received material advantages in return. But what would be the effect, especially with demonetised silver, if they abandoned this land revenue, which had been truly called the backbone of Indian finance. Sir Henry Maine's work on "Ancient Village Communities" had caused a complete revolution in men's ideas with regard to the tenure of land; it showed how much the Aryan races were akin, and there was little doubt that it was this social heredity which lay at the root of that universal love of land noticeable amongst Englishmen. It would have been well for England if these things had been known earlier, and probably it would have saved Lord Cornwallis from falling into what was now generally admitted to have been an economic mistake. It was our duty, however, not to fall into any further mistakes of the same sort, and to recollect how much our tenure of India depended on our popularity there. The tendency everywhere, with increased education, was to throw political power downwards, and though at some periods it might be desirable to encourage the ownership of land by a limited class, it became every day more necessary to give stability and character to the lower orders, and to make them comfortable and happy. There was, perhaps, no system of tenure which would be more consistent with the highest principles of political economy than a village community co-operating together to find the necessary capital, the want of which generally made a peasant proprietary an evil. No doubt England produced more per acre than any other country with the same natural advantages, owing to the application of capital to the land, but there was no reason why the same thing should not take with a well organised village community, whilst it would preclude the necessity for Poor-laws.

Dr. Burn said he had listened with very great pleasure to General Marriott's paper. So clear and able an exposition on so difficult a subject was rare. For the different systems of land revenue, or agriculture management in any district of India to be successful, a strict knowledge of the vicissitudes of climate was essential. Neglect of the fact of the periodic return of famines, through failure of the annual rains, and not to provide against such a contingency, was to live willingly as with the sword of Damocles always suspended over-head. The natives of some parts of India had discovered a very successful plan in the village communities, which had been discouraged, he never could understand why, by our revenue officers. In his opinion it afforded the only sure and safe mode of living protected from such dire calamity as attended those India periodic famines. The essence of the plan was simply this, each community had its water tank, its grain store, and its stacks of hay, in common, two years' supply always ready, sufficient for the people and their cattle, to enable them to tide over the period of want. This system enabled the people to have a safe investment in the land, and a large amount of produce and revenue, such as no others possess.

General Marriott, in reply to the observations which had been made, said that many of the points touched upon would be found dealt with in passages of the paper, which he had omitted to read from want of time. Some of Colonel Rathborne's remarks seemed to exemplify what he had said of the influence of the mere names "tax" and "rent"; for Colonel Rathborne's objections to the Government being the general landlord were founded on the reasoning, that the land-tax was a rent, that the receiver of rent is a landlord, therefore the Government is the landlord. In reply to Mr. White, he must say that he also did not particularly favour the village system, but would take things as he found them. Some of his remarks, as to the registration, raised a question with which Indian

officials were familiar, viz., the degree of authority which should be given to revenue courts; but the idea that whoever occupied the land should pay the assessment without raising any question of title, was practically impossible, because the mere acceptance of the revenue would be taken as *primâ facie* evidence of at least the right of occupation. He also said that the Government had never fixed the proportion to be taken, but in the North-West Provinces it had been fixed at one-third of the gross produce. It was not so in Bombay, in the provinces which had been lately re-assessed under Colonel Francis and others; but there the assessment was made so remarkably light more than thirty years ago under Lieutenant (now Sir George) Wingate, that in spite of the lowering of the assessment, the gross returns owing to the fresh lands taken into cultivation, more than paid the whole cost of the survey. That notoriously light assessment was taken as the basis of the new assessment, on the understanding that there was to be no increase in consequence of the ryots' own improvements, but only such as might be due to the general rise in value of produce. There might be differences of opinion as to how it was carried out in detail, but that was the principle laid down.

The **Chairman** said he felt very much in the position of the man who said that, after ten years' study of the land question in India, he felt farther from having come to a confident conclusion than when he began; and it would be quite impossible, in the few minutes at his disposal, to state his views on so extensive a subject. He could only repeat how much he felt indebted to General Marriott for the able manner in which he had brought this subject forward, and say that, for himself, he felt on this as on many political subjects, both a Radical and a Conservative. He was a Radical, he hoped, for the extirpation of wrongs, but a Conservative for the retention of many old rights, manners, and customs. Sir Henry Maine's writings had led many to think that some of the so-called Radical ideas of the people were founded in the very roots of the Aryan race; and, with regard to the tenure of land in India, he was much inclined to think that some of the evils of which complaint had been made simply arose from our going too fast. Some 800 years passed from the time of the Norman Conquest to the period when real free trade in land was established in England, and that long time barely sufficed to convert *status* rights in land into pure commercial rights. He was inclined to think, therefore, that they had gone much too fast in India when they tried at one blow to introduce the English system. The ownership of land there was a *status* right, and in trying to convert it into a commercial right, with all its incidents and inconveniences, they had gone too fast, and ran a great risk of inflicting a serious injury on the country, besides incurring political danger. He was much struck by General Marriott's remark that what was called the sale of land in India was not in truth a sale of commercial rights, but a sale of the status of the cultivators, by which a free cultivator or owner was turned into a serf, holding his land under a servile tenure from a money-lender, whom he looked upon as an oppressor and an unrighteous encumbrance imposed upon him by the Government. He believed the people would readily accept a fair and liberal administration of the system existing there when we took possession, and he agreed that was the principle by which we ought to be guided. At the same time he felt that that system was one under which the land was made the fund from which the expenses of the State were to be met; and it was a grave injustice to the people to sacrifice that fund in favour of certain people whom you chose to call landlords, and making it necessary to impose taxation on the mass of people. It would be doubly hard on the ryots to reduce them to a servile condition, and at the same time impose heavy taxation on their means in the shape of an enormous salt tax, because the land revenue had been sacrificed in favour of individuals. At the same time he was willing to admit that under the present management of India it would be necessary to a certain extent that systems consistent with English laws and ideas should gradually be introduced. Property in land, in the English sense, was to some extent established; and he could not avoid the conclusion that they must teach the natives to adapt themselves to that system, and gradually try to make both ends meet by moderation in the assessment on land on the one hand, and by such moderate taxes on the other as should not be oppressive to the people. In consideration he moved a hearty vote of thanks to General Marriott.

The vote of thanks having been passed unanimously,

The Rev. H. Solly asked leave to announce that General Marriott was endeavouring to disseminate and popularise the information he had gained during his residence in India, and from his general studies by delivering lectures on political economy to working men's clubs, and he ventured to suggest that other gentlemen having special information would be doing good service if they could follow his good example.

AFRICAN SECTION.

A meeting of this Section was held on Tuesday, March 28th, Lieut.-General Bissett, C.B., in the chair.

The paper read was—

THE INDUSTRIAL PROGRESS OF THE NATIVES OF SOUTH AFRICA.

By T. B. Glanville.

The subject I at first selected for this paper was the industries of South Africa. Finding subsequently that ostrich farming and diamond digging had been chosen as the topics for the two evenings immediately preceding my own, I felt that the most interesting and romantic South African industries had been taken away from me, and being unwilling to play Hamlet with the part of Hamlet left out, I declined upon a lower level, and have gathered together a few remarks on the progress of industry among the South African natives. Perhaps, however, I may be permitted to refer for a moment to a question on which, had I adhered to my first chosen subject, I should have had something to say at length.

The industrial temper and aptitudes of South African colonists have been much criticised of late. In a magazine article, published this month, Major Butler, recently returned from Natal, a master in the art of brilliant narrative, sums up a not very flattering review of South African industries in the following sentences:—

"Take the bill of lading of any steamer sailing away from South Africa. The cargo consists of wool, a few packages of ostrich feathers, and parcels of diamonds and gold. It is scarcely too much to say that, with the exception of wine, the manufactures of South Africa are confined to two articles, Cape carts and Cape waggons, both excellent in their way, but not enough to make even the semblance of an industry. We do not mean to assert that idleness is universal in South Africa. All professional and commercial life goes on there as elsewhere, but out in the country people do not till the land as they till it in America or in Australia, and it is but too evident that the occupations of husbandry are not congenial to the habits of the Dutch farmer in any shape or form."

So writes Major Butler in that excellent and widely-read periodical, *Good Words.* My purpose in quoting these remarks is not to contradict, but to soften down, to amplify or to explain. Major Butler's first count in the indictment is, that South African export cargoes consist only of wool, ostrich feathers, diamonds, and gold. Accepting this for the moment as a correct and sufficient statement, is it, I would ask, a just and reasonable cause of complaint? Are not simplicity and numerical scantiness the characteristics of the export list of almost all British colonies? The Dominion of Canada is now on the footing of a nation, but not many years back some of its provinces shipped wood and little else, and others fish and little more. Are not the exports of Australia now to be counted on five fingers? and are they not all simple things, like wool and gold, wheat and copper, hides and tallow? The ships from New Zealand are not freighted with more various articles than those from the Cape. Nor is the reason far to seek. The production of raw material falls to the hands of the scanty dwellers in new countries, as their accepted part in the general economy of labour and commerce. It is thought they are doing what they can do best, with the greatest advantage to themselves and others, when they raise and send away natural substances, roughly prepared, in as large quantities as possible, for older countries, rich in capital, force and machinery, to turn into manufactures. In the course of time the new world grows to be as the old, promotes itself from the elementary work of mere production, and becomes remarkable for its "notions." While it is new, however, it not unwisely limits itself to growing or grubbing up what the long established workshops demand.

But the South African exports are not limited to wool, ostrich feathers, gold and diamonds. The Customs lists of the Cape and Natal seldom show less than twelve or fourteen articles, and the annual value of the outward cargoes of South Africa is about £6,000,000, not including diamonds. Now £6,000,000 worth of export produce every year cannot be held in light esteem, and cannot have been grown or collected by a wholly idle people. There are about 300,000 colonists in South Africa, and the share per head of exported production is thus £20 a year. The similar rate for Great Britain and Ireland is £8—very far from half that of South Africa. Undoubtedly the colonists are not the only workers and producers in South Africa, as I hope to show this evening; but they certainly can claim to fill the first place in the ranks. But if the whole population, black as well as white, of all colonies and States in South Africa are brought into the calculation, and reckoned at 1,500,000, and the annual value of diamond exports is taken at only £1,000,000, the South African rate is £4 13s., a most remarkable result, seeing that it is mainly based upon a population, the mass of which is still barbarous.

Again, when it is said that it is "scarcely too much to say that, with the exception of wine, the manufactures of South Africa are confined to two articles—Cape carts and waggons," I must be allowed to reply that it certainly is not "too much," but, rather, too little, to say. Brandy might be mentioned as well as wine, and harness as well as carts. Sugar is made in Natal in quantities which are beyond the measure of samples. If fish-curing is not to be called a manufacture it is an important industry, as is also the preserving and drying of fruit. The copper-mining of Namaqualand and diamond-finding give employment to machinery and railways. It must be remembered that the preparation of wool for export is not a mere act of shearing and transport. It involves processes which are very generally carried on by organised and machine labour. Then, also, there are a hundred towns and villages in South Africa, all of which have been built; and in every town of size there are the usual craftsmen working in foundries, mills, smithies, tan-yards, and shops. I regret that I cannot add to this list a splendid array of cotton, woollen, and hardware manufactories, but probably it will be agreed that these cannot be expected of South Africa until it can get at its coal measures, and find iron as well as gold.

I have only one other remark to make on my quotation from *Good Words*, and that is not my own, but Mr. Froude's. Major Butler says:—"It is but too evident that the occupations of husbandry are not congenial to the habits of the Dutch farmer in any shape or form." In his lately published letter to Lord Carnarvon, Mr. Froude says, "The western province of the (Cape) colony has been much longer settled than any other part of South Africa. The population is principally Dutch. There alone in the colony are families who have lived for many generations on the same spot; there alone is any large breadth of land under the plough. There are the vineyards which produce the Cape wine, palatable and even excellent in the cellars of the growers. There also are to be seen the most splendid orange orchards in the world. There, too, has sprung up recently the new industry of ostrich farming, the profits of which rival the returns from the diamond-fields themselves."

Look on this picture and on that! The truth is that Mr. Froude travelled more widely and saw more than Major Butler. No doubt the Dutch farmers of the interior are content with a primitive simplicity which has but little sympathy with the commercial spirit; but then the singular story of the pioneer boer does much to explain this. His long northward wanderings, over a country often stricken with drought, amidst tribes that he could not make friendly, under a half-tropical sky, nursing all the while deep regrets for an allegiance he had lost, and ardent longings for independence, have made him regardless of those very things upon which western civilisation, with its numerous wants, subtle perceptions of the niceties of comfort and respectability, and restless spirit of competition, has set the highest value. The so-called, indolent, sluggish boer, satisfied with a rude plenty, has a reason for his peculiarities which should fairly be considered when the peculiarities are deplored.

Hoping to be pardoned for this brush with the gallant Major, I will now turn attention to the question of the South African natives and their progress and prospects in industry, and perhaps I may be allowed to say that this is a question which has large relations. It has an important bearing on the general conditions and prosperity of the colonies and States of South Africa, and it is

worthy of being considered in connection with the newly awakened curiosity and interest regarding the whole African continent.

To take the wider consideration first: travel, discovery, war, victory, trade, humanity, and high politics, have placed Africa, round about its coast and within to its very centre, under our eye. We long gave it our wonder; now it has been brought within our knowledge. River, lake, and lagoon, forest and swamp; valley and upland, snow-crowned mountain and sandy desert; bay, bight, creek, river mouth, and sand bar, are taking their place in our school geographies. But a greater fact than any of these has been unveiled, because we have learnt to give at least as great a consideration to newly discovered men as to newly discovered lands.

The English opinion and feeling about slavery, now an inheritance of three generations; the national habits formed by our rule in India, which, if based on conquest and maintained by force, is directed above all things to the welfare of the Indian peoples; and our colonial policy which has always in theory, if not invariably in practice, been mindful of aborigines; all these forces incline and oblige us, when a group of islands, like Fiji, falls into our hands, or a continent, like Africa, is opened out to our view, not only to exult in the fair prospect of more land for planting, pasture, mining, and production, but to be seriously conscious of a responsibility towards the flesh and blood, the kindred, suddenly brought to light. It would be a libel on Englishmen to say that they hunger for the rich lands of Central Africa, or that they are eager only to drain them of their barbaric wealth of tusk, and gold, and jewel, or that they are anxious merely to open shops near the sources of the Nile. Without being in the least too good for this world, Englishmen are ready to concern themselves with the well-being of the peoples whom Livingstone, Speke, Grant, Baker, Cameron, and Stanley have introduced to them. The settlement on the banks of Lake Nyassa, now happily being founded, is a practical proof of this. Mr. Young, Dr. Stewart, and their party have gone out in full accord with the national spirit, to discourage the slave trade, to represent our Western life, and by example to teach lessons in faith, morals, and industry, with the hope that Africans may be induced to play a part in that better use and enjoyment of the continent which must follow recent discoveries.

But to my mind the question of what is to be the future of our newly-found Africans finds its best answer in the industrial progress of our native fellow subjects in South Africa. The well established statements of facts which I shall presently make will show that the leaven of labour has spread, or is spreading, through hundreds of thousands of native Africans, occupying, partly by themselves and partly in neighbourhood with Europeans, a territory of half a million of square miles. This leaven will spread northward. It already approaches the Limpopo, and the Zambosi will not stop it. It will follow the track of Young upon the Shire, and will, in due time, meet the influences which are destined to flow southward from Egypt and westward from Zanzibar. A generation has been sufficient to give it its present rate of expansion, and in the next generation the work of any past ten years will be done in one, always providing that the native system of the Cape is allowed to prevail and is accepted by the other communities of South Africa.

The bearing of the question of industrial progress among the natives on the prosperity of the South African colonies and States is obvious. In and about the Cape, Natal, Griqualand West, the Free State, the Transvaal and Delagoa Bay, there are more than two millions of Africans. Let productive labour, or the use of some European garment, or European implement, or European article of furniture, become a fashion and the numerousness of the people tells at once. Production and consumption are multiplied by tens, hundreds, and thousands. The tribes adopt the novelty, and commerce finds itself advancing by "leaps and bounds." The recent growth of the South African trade has surprised colonists well acquainted with the general conditions of the country, because, while they have taken into account the obvious influence of the Diamond and Gold Fields, the increased expenditure on public works, the sudden success of domestic ostrich farming, and the rapid development of the Free State and the Transvaal, they have not considered the contributions to commerce made by the natives, especially of late years.

The facts and figures which I shall now proceed to state are drawn almost entirely from the Cape Blue Books on native affairs, and belong mainly to the Cape Colony and its neighbouring native dependencies. Within the old limits of the colony there are nearly 500,000 people of colour. On the eastern side of the Kei there are, under the care of the Cape Government, 200,000 Kaffirs, Fingoes, and Griquas, not including the Ama-Pondos, while in British Basutoland there are 140,000 Basutos; in all 840,000 people, having a steady annual increase. I shall make only this brief allusion to the place the Malays occupy in the industries of Capetown, Simon's Town, and Port Elizabeth, to the share the descendants of the old slave population and the Hottentots take in farm and domestic service throughout the colony, and to the fact that without the native herds, sheep farming, ostrich farming, and agriculture would be impossible or difficult; nor will I detain you with a list of the miscellaneous services the natives give in stores, on quays and public works, and in the transport of merchandise. My object is rather to present those facts which show that the African natives within the circle of their own proper life are for themselves adopting our ideas of work, methods of labour, notions of property, and spirit of accumulation and progress. And for this I go to the great Eastern locations and the tribal communities but lately brought under our rule, begging you to observe that over each location or tribe is placed a magistrate, agent, or resident, whose duty it is, not only to administer justice or represent authority, but also to encourage and provoko the industrial temper.

I shall begin with some notes on the growing adoption of the plough.

Tho magistrate of Victoria East, writing in 1874, said, "Ploughs and agricultural implements are greatly sought after. The native pick, except for clearing the growing crops, is seldom used. During the years 1872 and 1873, the Fingoes purchased in the village of Alice 188 American

ploughs, at an average cost of £5 each." In 1875, the same authority reports of the same people that "the desire to possess ploughs and other civilised appliances increases annually. During the year the natives bought 187 ploughs from dealers in Alice, the aggregate cost of which was £1,000." Thus, then, in 1872 and 1873, these people purchased ploughs at the rate of 94 a year, while in 1874 they bought twice that number. This indicates great rapidity of rate.

From Middledrift, the magistrate reports that in 1874, the natives of his district possessed 553 ploughs and says that the old native hoe has been entirely superseded by the plough. By 1875 these people had increased their ploughs to 608.

The natives of the Tembani district had 120 ploughs, in 1864; ten years afterwards they had 300; and last year they had 900.

In 1875, the Tamache district boasted 1·165 ploughs and the Herschel district 810. Keiskama in 1874 had 426, and in 1875, 500 ploughs.

The report from Wodehouse in 1874 contains a most significant remark. "The status of the women is better, owing to the almost universal use of the plough." That little sentence lets in a flood of light on the question of native progress in Africa. The plough is not only the sign of a better agriculture, larger production and quickened commerce, but also of actual human and social betterment. In the days of the hoe the woman was the field labourer; the plough comes in, and the man becomes the worker. That is, in fact, a revolution. It implies a greater change than one statement can express, A Kaffir at the plough-tail forgets the feel of the assegai. But, to return to my figures and facts. The magistrate of Queenstown writing in 1874, said, "I believe that where one plough was bought four years ago five are purchased now." Then he adds another light-giving sentence. "One consequence is that much more soil is brought under cultivation."

The magistrate at East London, confirming the observation of the magistrate of Wodehouse, says, "Ploughs are more generally used than before, and the labour of cultivating the land is being transferred from the women to the men"—a singular settlement of the great question of women's rights by the rule of contrary.

Crossing the Orange River, we enter Basutoland, a region full of interest to the student of native development under a wise system. The Governor's agent, writing in 1874, says, of tribes which in 1869, only five years before, were stripped by war bare of every possession,—"The production of grain has greatly increased, the plough having generally superseded the Kaffir pick." In 1875, these people had 2,000 ploughs valued at £10,000, and the agent again says, "Larger areas of land have been brought under cultivation during the year, and consequently the demand for ploughs continues unabated, and the production of grain is annually increasing."

Crossing the Kei, we enter Kaffir-land proper, quite as interesting a field as Basutoland, and meet Fingoeland upon the threshold. In 1874, the number of ploughs in that district was 1,935. In the Idutwya reserve there were 501, and the emigrant Tambookies had 896, while the agent reports that "the use of the plough appears to be on the increase."

The resident with Kreli says, in 1874, "There has during the past year been a most remarkable increase in the demand for ploughs. Kreli himself possesses three. This," he goes on to say, "I consider the most cheering sign I have observed. It will exert a more powerful civilising influence in the tribe than any other agency in operation. Already a marked increase in the quantity of land under cultivation is perceptible." In 1875, the same cheerful note is sounded, "There is, says the resident, "an increasing demand for ploughs."

The agent with Gangelizwe speaks of "the number of ploughs in use," in 1874, and in 1875, he says, "cultivation with ploughs is largely on the increase." The agent at Gatberg reports 177 ploughs from his outlandish quarter, and in 1875, he returns 947 from Adam Kok's land, 400 from another tribe, and says that, by the remote Pondomisi, "a considerable number of ploughs have been bought."

Here my ploughshare stops, not, however, I venture to submit, without having done its fair proportion of work. A furrow has been drawn straight and deep by African hands, through African soil, pointing and driving ever more and more northwards, preparing for generous seed and rich harvests, driving through idleness in men and cruel drudgery by women, stimulating production and increasing wealth. In 1875, the natives of the Eastern side of the Cape Colony alone had more than 13,000 ploughs at work, how many more I cannot say, but the returns from several of the larger locations do not give the numbers. Twenty years ago for a native to have a plough of his own was a wonder. Twenty years hence the 13,000 will be multiplied by ten within the same area, and in the regions beyond my story will find its counterpart. Speed the plough!

I now come to waggons. I do not, however, attach the peculiar significance to waggons that I do to ploughs. Still, if the plough is a producer and a civiliser, the waggon is a distributor and an evidence of wealth. But as this witness is comparatively unimportant, his testimony must be briefly stated. Suffice it to say that the natives of the locations and tribes already referred to own 1,700 waggons, valued at about £70,000. This return does not include the possessions of the colonial natives not grouped in locations, numbering at least a quarter of a million, many hundreds, perhaps thousands, of whom have waggons. I am selecting my facts from those bodies of natives only which retain the ancient character of the tribes, still barbarous, and yet undergoing change; because I wish to show that progress amongst Africans precedes, as well as accompanies, European colonisation. There are no white settlements—although there are white magistrates, missionaries, and traders—over the Kei and in Basutoland. But there are ploughs and waggons there. To give full force to the testimony from waggons, it must be remembered that they imply teams; now, in Africa, a waggon team ordinarily includes fourteen oxen, and a draught ox is ridiculously cheap at £5. At a very low calculation, the 1,678 waggons with their power represent a money value of £150,000.

I may stop a moment here to note that the ploughs and waggons are things that cannot be stolen. A colonial audience would understand the

meaning of this remark at once, because many colonists have a profound belief that the native is a thief, and that he has nothing which he has not stolen. Undoubtedly many natives steal cattle. But the waggon and the plough must be earned. They imply industry, saving, and property. They imply, also, property held by individuals, and not by the tribe. So taken, they are the signs of what is meant by the very long word civilisation—the beginning of it, at all events.

The next witnesses I shall call are legion; but the evidence from one class only will be insisted on by me. Were the natives of South Africa all honest men, it would tell very much in their favour to be able to say that a portion of them—the Basutos, Kaffirs, Fingoes and others clustering about the eastern borderland of the Cape—own more than two million head of domestic animals, valued at £3,500,000, comprising half a million of horned cattle, 1,000,000 sheep, 369,429 goats, 62,244 horses, and 16,000 pigs. Here is a vast body of property which would give great force to my argument, were it not tainted with the suspicion of being ill-gotten. If the two million head were undoubtedly a just inheritance or the fruit of labour I could press the whole into my service, and employ them as proofs of the industrial aptitude and force of the owners. But it is possible to say that theft has had nearly as much to do with the accumulation of these herds and flocks as industry, and the mere possibility of such a charge would discredit the testimony of my figures were I to force them into the box. This is not the time to discuss the vexed question of Kaffir depredations. It will be much more to the purpose to point to the beginnings of an important change in the preferences of the natives with respect to certain kinds of live stock.

The loug-inherited habit of the South African native is a delight in horned cattle. The habit has grown up from many motives. The natives are great milk drinkers. It is with cattle they buy their wives. And they have a gentlemanly liking for a fine animal, and especially for a swift racing ox. Then, again, a large herd is a sign of wealth and respectability. It has not been the custom of the native to take a commercial view of horned cattle, unless in relation to wife-buying. But within the last few years a preference for sheep has shown itself, and on the sole ground of the profitableness of wool. The Kaffir is actually beginning to barter away his beloved and cherished cattle for an animal which promises to be remunerative.

One magistrate says:—"Such is the value attached by the Kaffirs to the production of wool, that a few of them in the district have hired sheep from Europeans, and many have exchanged the largest oxen, usually kept for show or for ox races, for sheep." The magistrate of Queenstown says:—"The Tambookies also thoroughly understand the value of woolled sheep, which are gradually superseding their fancy for cattle. Very large quantities of wool are now produced in the location."

The Governor's agent in Basutoland reports that, in 1873, 2,000 bales of wool were exported from Basutoland. The magistrate with the Fingoes says, "sheep still increase in large numbers." The agent with Kreli reports, "Woolled sheep are much sought for, and cattle are readily given in exchange for them." The agent with Gangelizwe says, "The quantity of wool sent away by the traders shows the country to contain large numbers of sheep." The magistrate of King Williamstown says, "It is as significant as it is gratifying to record the fact that the natives are turning their attention more than ever to woolled sheep, exchanging oxen, which are now selling at a high price, for sheep. Large quantities of wool are now being raised by the natives, and in not a few instances creditable exertions have been made in the get-up of the article, so that gradually and by degrees they are entering into close competition with the regularly established sheep farmer." The resident with Kreli says, "Sheep are also eagerly sought after, and within the past week some farmers from the colony have bartered away a large flock for cattle. About 300 bales of wool have been produced and disposed of in this part."

These official statements, coupled with the fact that the natives about the eastern and north-eastern portions of the Cape Colony possesses a million sheep, may be taken to prove that the change I have referred to is not to be doubted. The natives of South Africa are becoming sheep owners. What does this mean? It certainly does not mean that the Kaffirs, Fingoes, and Basutos are beginning to prefer the sheep as a fancy animal to the ox, or to like mutton as an article of food better than beef. The simple but significant truth is that the natives, as I have already said, have learnt the commercial value of sheep and are ready to sacrifice old habits and long inherited tastes to a new-born idea of utility, and desire for profit. The change means more than this; for as the use of the plough and the disuse of the pick involves the labour of the men instead of the women in agriculture, extended cultivation, enlarged production, a surplus beyond personal wants for trade, and the growth of property; so the preference for sheep involves an additional demand on the labour of the men in shearing, cleaning, sorting, packing, and all the arts, however humble, of preparing wool for the buyer. It includes also the transactions of trade, weighing, reckoning, and bargaining. It directly leads to other results. The magistrate of King Williamstown poiuts out that sheep owning leads to a desire to own or lease land. The scope of this sheep-revolution has a yet wider sweep. All will, no doubt, remember the celebrated picture named "Peace," in which a meek, dull, well-rounded ewe looks with placid gaze into the mouth of a dismounted cannon, lying amongst a rich crop of grass and bramble. Well, this picture aptly represents one of the meanings of the sheep as a possession of South African natives. In this case "sheep" spells "peace," whatever Spelling Bees may say. A Kaffir who has a flock of sheep, who has learnt to look upon his wool-bearers in the magical light of property and profit, who has handled them in remunerative labour, counted up the value of their fleeces, and hired or bought land for their pasturage, has raised up and fortified himself round about with a little army of peace-keepers. I am, of course, only speaking of tendency, and the probable direction of things. Were the million sheep in the hands of the natives to become ten millions to-morrow, peace would not be absolutely assured. The very next mail steamer from Capetown may possibly bring news

which may put all my witnesses out of court. Even in civilised Europe war is not made impossible by the presence of wealth, habits of industry, and the gentle influence of art. All that can be said is that the more ploughs, waggons, and sheep the Kaffir has and values, the more he uses them and profits by them, and the more he occupies his thoughts, his ambitions, his hands and his time with them, the less likely is he to be a passionate and war-loving man.

It will not, I am sure, be considered trivial if I put in as evidence the wardrobe of the modernised African native. Sartor Resartus says, "Clothes give us individuality, distinctions, social polity; clothes have made men of us." Again he says, "Teufelsdröckh undertakes no less than to expound the moral, political, even religious influence of clothes; he undertakes to make manifest in its thousandfold bearings this grand proposition that man's earthly interests are all hooked and buttoned together, and held up by clothes. He says in so many words, 'Society is founded upon cloth'; and again, 'Society sails through the infinitude on cloth, as on a Faust's mantle, or rather, like the sheet of clean and unclean beasts in the apostle's dream, and without such sheet or mantle would sink to endless depths, or mount to inane limboes, and in either case be no more.'" Under shelter of these great words I may venture to rank a change in the costume of the natives among the more important proofs of improvement. It must be clearly understood that the quotations I shall make refer to the groups already particularised. Within the limits of the older districts of the Cape Colony European clothing is universally adopted by the blacks. The statements I shall now read show the spread of the practice into regions where Europeans themselves are few, or where settlement is a comparatively recent fact.

The magistrate of Victoria East says, "The Fingoes readily adopt European customs; civilised clothing is considered indispensable by most of them. They are large consumers of paper collars." The magistrate at King Williamstown, speaking of the natives in his district, refers to the "purchase of articles of clothing" as a satisfactory sign of progress. The magistrate of East London says, "Upon the high roads and in the villages natives are found more generally clothed than formerly." The magistrate of Queenstown says, "the use of European clothing is more common than formerly." The magistrate of Wodehouse numbers "the desire to obtain clothing" amongst the decided signs of improvement. The magistrate of Peddie speaks of the "increasing number of those who use articles of European clothing." The Basutoland authorities say that "clothes of European make are more worn by the men, that "the skin kaross has gradually given way to the blanket," and that "boots and gaiters are in considerable demand." The agent in the Idutwya Reserve says, "The people of the Reserve are gradually, but surely, improving in civilisation. When I took charge, four years ago, not one in fifty wore European clothing; now the proportion is one in four." The resident with Kreli says, "Cattle, wool, skins, and tobacco are bartered away for blankets, ploughs, and other articles of European manufacture." The resident with Gangelizwe speaks of the "increased quantity of European clothing purchased and worn."

The reports from which I have made these selections cover an area as large as England, and have regard to many tribes. To prevent wrong impressions, however, it is as well to say that the phrase "European clothing," so frequently used by our friends the magistrates and agents, must be understood to mean blankets and second-hand clothing. From an artistic point of view, the new habit is not agreeable. The blanket is not as graceful as the kaross, and a dingy suit from the Cape Monmouth-street gives to the native a look of squalor never suggested by the rich red hues of his own skin. But the day is coming when the Kaffir man, like the Kaffir woman, will discover the colours and the forms which will suit him best. Meanwhile the adoption of even the rags and tatters of civilised clothing means far more than meets and offends the eye. We Englishmen change our fashions, it is true, without changing our minds. But if, instead of going to Paris for a new bonnet or a new hat, we went to Cairo for a veil, or to Delhi for a turban, or to Canton for little slippers, we should be rightly suspected of being converts or perverts, or some other sort of verts. Well, the Kaffir or Fingo who puts himself into a paper collar submits himself to as marked a change as any we have indicated as possible to an Englishman who should go Eastward for his tailor. The new article of dress is more than a badge of submission. Although that it is that is something. For a gross, full-blooded, proud barbarian to prefer, or to adopt though he may not prefer, the costume and "cast-offs" of another race, to his own Prince Vortigern style of "painted vest," romantic robe of tiger skin, and plumed head dress, is evidence of that discipline of the spirit without which progress were a mere mechanical putting of one foot before another. But more than this is meant. The adoption of European clothing signifies the beginning—I speak only of beginnings—of a desire to be like Europeans. This may be ridiculed under the name of "apery." But it is good for the African to ape his betters, that is to say to be ambitious of imitating the European. That which begins in vanity ends in sympathy. The ape first—then the man. The importance of a fact is sometimes seen more clearly when it is, in statement and imagination, placed in association with conditions not contemporaneously belonging to it. India is before us at this moment prominently enough. We are accustomed to consider with attention the means by which Hindus may be brought into community of thought, feeling and life with ourselves. Our churches pray and work for conversion; our merchants desire a free use of Manchester cottons; our statesmen long to see our financial system, our enterprise in public works, our language and our rule universally accepted; our princes travel far and wide to attract and win by the charms of manner and the grace of royal sympathy with national, if barbaric, sport; and the historic crown of this realm submits to a new setting of its gems in the hope to win over an Eastern taste to Western sovereignty. But, for my part, I must say, that while undervaluing no source of English influence in India, I should begin to be very sanguine were it seen to be the case that the Hindus were receiving at our hands our swallow-

tail coats and our black silk hats, our spring novelties, furbelows, and flounces. We might then withdraw half our army, and arrange for parliamentary institutions in Calcutta. In South Africa the paper collar may not, at the moment, mean quite so much; but that it is a precedent which will, as time flows, broaden down to great sequences, is not to be doubted. The tailor abroad is as much a power as the schoolmaster. The putting on of the European garment is to the African savage the dawn of self-respect, decency, restraint, regard for others, and respect for the law. The coat adds to his commercial-mindedness, for he must buy it. It gives him a new occupation, for he must mend it. It occasions a new want, for he must have a box in which to keep it. It promotes religiousness, for he must on Sundays go to church to show it.

Having now set in array four witnesses to native progress in South Africa—the plough, the waggon, the wool-bearing sheep, and the wardrobe, I have but one other to produce—the house.

Two or three quotations from the reports must suffice here. One magistrate says, "The dwellings of the Fingoes are no longer the beehive huts of former years, some—not a large proportion—have square houses." The agent in Basutoland, says, "Stone cottages are beginning to supplant the rude native hut." Another says, "A good many stone and brick cottages have been built here and there during the year." Again, "during the past year many square cottages have been built in spite of the scarcity of materials for roofing."

The special points to be noted in these statements are the references to a change of material and shape. Stone and brick are beginning to be used instead of reed, rushes, grass, or mud; and squareness, with the inevitable angle, takes the place of the simpler form of the circle. The adoption of the more substantial material signifies new-born ideas of permanence, stability, fixity of the dwelling place, and marks the stage at which the nomad becomes the settler, with the accompanying sense of locality and home. The change in the form of construction indicates a new capacity for combination, the putting of things together, and relativeness; and marks the stage at which the savage begins dimly to understand harmony as well as melody. I am no freemason, but I fully recognise the importance of the square. In relation to my subject, the progress of the natives of South Africa in civilisation through industry and the arts, this conversion to the square has a place second to none. One of the surest marks of debased savage life is the inability to draw a straight line, and the therefore necessary inability to draw two straight lines so as to form a right angle. The other day the natives of South Africa could not do this. The circle they could accomplish, but not the square. Now they have begun to cross the *pons asinorum* of civilisation, are in the straight line of progress, and have made the nearest approach possible to squaring the circle.

Here my case is closed. There are other witnesses; but there is no time for them. Besides it will readily be understood that the peoples who have taken to the plough, the waggon, woolled sheep, European clothing, and square houses, have taken to other Western implements, industries, practices, and customs.

It may, then, be considered that the natives of South Africa are better than they were. The forces of growth are working within them as individuals and as communities. If the beginning is humble, it is a beginning, and day by day brings its advance and increase. As a matter of course, in the great mass of Kaffir, Fingo, and Basuto life, the distinguishing characteristics are still those which belong to the savage state. It is even possible for the passing observer to see in the changes in native conditions a decline from a noble simplicity to a state of disorder foreboding dissolution. This is not the interpretation I put upon facts which, whatever their true meaning, cannot be denied; and it should be recognised by all, that revolutions, whether in civilised or uncivilised peoples, are invariably ugly, in at least some of their presentations. Almost all beginnings are without form and void, and darkness is upon the face of them. By-and-by light and order appear, and the evil turns to good.

This dawn of improvement in South African native conditions is, as I ventured to say at the outset of these remarks, of much importance in relation to the prosperity of the South African colonies and the future of Africa. I return to this statement because after all it is very difficult to awaken any great interest in these native peoples on their own account. To give any attractiveness to the question of their progress it is necessary to associate it with some other subject, appealing either to some form of selfishness or idol of the imagination, such as the advance of European settlement, or the gradual opening out of a great and mysterious continent.

When I join together the idea of native progress in South Africa with the idea of colonial prosperity, I think of the colonists of the Cape, Natal, Griqualand West, the Free State, the Transvaal, and Delagoa Bay, and wish that they would clearly recognise the fact that the two millions of human beings they have in their neighbourhood can, by wise management, be made as fruitful contributories to the general welfare as a soil rich in grain or wine, precious stones or gold, or as flocks and herds. Were this the case, were the natives of South Africa considered by colonists to be as important economically in their way as sheep and ostriches are in another, the changes which I have noted would speedily repeat themselves and be accompanied by others.

For my part, I do not care to say that the South African colonists have a duty, or a responsibility, or a mission to the natives. I prefer to say that their own interests are concerned in the improvement of these peoples. In the human capacity and human force possessed by Kaffir and Fingo, Basuto and Zulu, there is a mine of wealth which simply awaits the patient and diligent use of reasonable means. As a matter of course the relations of colonist and native have for the most part been hostile. The native has seen in the colonist a displacer, and the colonist has seen in the native an encumbrance and a danger. Time has strengthened the settlements and has taught the native to fear, to obey, and to copy. In the Cape Colony there has come to be, almost without intent and plan, a method of managing natives which is working well, although it has still to take a settled form and organisation, and has yet to be recognised as

a system and department by the local government. What is needed is the recognition of a purpose in the method—a definite will and intent to bring the natives within the line of general and harmonious progress. With this purpose at its heart the Cape procedure would at once become a complete, organic, and living system, and the effect would be marvellous. The armed and mounted police would be augmented, in order to encourage industry by preventing vagrance, theft, and war; the number of carefully selected and well paid officers with the locations and tribes would be increased and formed into a service; roads and bridges would be given to Kaffirland and Basutoland; education would be stimulated, and missionaries would be favoured; and from the higher aims and more effective plans of Government the colonists would learn the way to that management and use of natives which is now the secret of a few.

Imperfect in some respects as the Cape native method may be, it is by far the best in South Africa, judged by the standards of improvement among the natives and advantage to the colonists; and it is this consideration which gives one of the most forceful arguments in favour of that large measure of confederation, concerning which so much has lately been said. In order that the great body of South African natives may be made to take their part in the economy of South African life, the wisest and best agencies should be in the van of European settlement. This cannot be the case while the most powerful and best equipped community, the Cape, operates only within the lines of its own boundary, and leaves the important work of dealing with the masses of interior barbarism to the feeble hands and perplexed judgments of scattered pioneers. The strength, experience, and hands of the Cape should, by the means of a federal union, be present on the Tugela as on the Kei, and on the Limpopo as on the Orange.

When I associate the improvement of the natives of the Cape, Natal, and the two Dutch republics, with the fortunes of that Central Africa which is now being unveiled, I do so in the hope that stay-at-home Englishmen will take an interest in races hitherto known only by the evil repute of war and the annoyance of complaint. As it seems likely that those new and splendid regions along the course of great rivers, and about the shores of lakes large enough to be called seas, will be reached by a young civilisation from the South, spreading northward by the sympathies of race, as well as by the vigour and push of colonial life, it is not unreasonable to expect from England something more for South African natives than disgust when they fight and an easy pity when they seem to be oppressed. Englishmen have 1,000,000 of fellow-subjects in South Africa, and 1,000,000 more ready to become so, and it is through these, as much as through Egypt or Zanzibar, that they can reach the middle lands of the continent. It may be said that in giving attention, however enlightened and earnest, to the affairs of South Africa, England can do but little in these days of colonial independence. But to say so would be a mistake. The opinion of England, when it is based on the knowledge of facts, is a guiding and encouraging light in every British colony. A true, just, wise, kind word spoken here, close by the current of the Thames, goes far and wide, to every shore of our empire, and becomes part of the law or of the opinion which governs our manifold dependencies and fashions the fortunes of a hundred races.

DISCUSSION.

Mr. Johnston Campbell said he had come that evening to learn, and he certainly had not come in vain, for a more able paper he had never heard. Mr. Glanville had made more of the industry and commerce of South Africa than he had thought possible, but at the same time he recognised all his statements as perfectly true, though he had not seen things in the same light before, probably because he had not resided in Africa as long as Mr. Glanville. He had, in fact, visited the colony rather as an amateur, but he had felt the advantage of making Mr. Glanville's acquaintance and obtaining his advice before he went.

Dr. Mann, though he had expected a good paper, had not looked for so interesting a one as they had been privileged to hear, although he knew how large was Mr. Glanville's acquaintance with the country, and how ardent his interest in all that related to its best fortunes. What he had said with regard to the influence which indicated the progress of the natives, enabled one to put one's finger on the leading points which showed the reality of that progress; though it was not until they were brought together in one view that the decided character of that advance was manifest. The great increase in the ownership of woolled sheep amongst the natives was new to him, and it was a most important fact, especially when it was remembered that while these natives already owned one million sheep, sixty millions was the number given for the Australian colonies, which were at present the great stand-by for wool production, and appeared likely to be so in future. The development of a taste for English clothes was also very important, and Mr. Glanville would doubtless remember when in the capital of Natal the Lieutenant-Governor had to issue an order that no natives, male or female, should enter the town without clothes, prior to which they were accustomed to wear nothing but the simplest girdle; and even for some time afterwards it was their habit when visiting the town to bring their clothes in a bundle under their arms and put them on whilst they walked about the streets, and remove them again as soon as they reached the outskirts, so that it was by no means an unusual sight within a quarter of a mile of the town to see them in their primitive condition. That state of things, however, was rapidly passing away, if it had not already passed. One point of some importance might be added to Mr. Glanville's paper, and that was this; in the colony of Natal the half-trained natives, in consequence of the introduction of the sugar manufacture, which was now an established industry, were not only becoming fair engineers, but were actually owners of machinery. Even in his own time, he remembered a very striking instance of this. A Kaffir, who could neither read nor write, having seen the sugar manufacture in a distant part of the colony, on his his return home, made an arrangement with another man who like himself had saved a few pounds, bought machinery upon trust, and worked it themselves. They were aided by the Government to the extent of £100, and purchased machinery at a cost of £500, and when he left the colony, some ten years ago, they had already paid off the amount borrowed—by far the greater portion of the purchase-money—all but £10, and that was, no doubt, soon afterwards liquidated. This was a remarkable instance of how these men felt the influence of civilisation; and showed what might be expected to take place in the future.

The Chairman, in proposing a vote of thanks to Mr. Glanville, said he felt it due to him and to the meeting

to say a word or two as an old resident in the colony. Mr. Glanville had very distinctly shown the progress which the natives were making, and he (the Chairman) attributed that progress in great measure to the assistance rendered by this country in furnishing them with ploughs. He considered that no money had ever been more judiciously expended by Parliament. When Kaffraria was taken possession of by the English Government, £40,000 was voted as a subsidy to the natives, and it was chiefly expended in agricultural implements, and in establishing industrial schools. Not only were the mission stations converted into industrial schools, but the chiefs themselves were brought under English influence by the placing of magistrates amongst them, and in this way civilisation had been gradually spread amongst them. It was most important that these influences should continue, because he had made a calculation of the numbers, and found that instead of there being, as was stated in the paper, two millions, there were about three millions of natives in the English provinces and the two Dutch states. The Europeans being 316,000, were only about 1 to 9, whilst in Natal the natives numbered 20 to 1 of the white population. Unless, therefore, civilisation progressed, they could hardly expect cordiality and good relations to continue between races living side by side in such great disproportion to each other.

The vote of thanks having been passed unanimously,

Vice-Admiral Erasmus Ommanney, C.B., F.R.S., proposed a similar compliment to the Chairman, who had materially added to their information from the results of his own observation, whilst discharging his duties as a military officer in South Africa.

This motion was also carried, and the proceedings terminated.

SEVENTEENTH ORDINARY MEETING.

Wednesday, March 29th; Lord Alfred S. Churchill, Chairman of Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Blashill, Thomas, 10, Old Jewry-chambers, E.C.
Dawson, James Thomas, F.S.S., 2, Royal Exchange-buildings, E.C.
Hirst, Charles, jun., Hungerford-house, Huddersfield.
Holtorp, Erasmus A. von, 21, Holland-villas-road, Kensington, W.
Lancaster, John, Vine-house, Canning-town, E.
Paterson, Edward James, 3, Bedford-court, Covent-garden, W.C.
Pattinson, John, 75, The Side, Newcastle-on-Tyne.
Samuel, Stuart M., 60, Old Broad-street.
Smith, Bridgman, 27, Lloyd-square, W.C.
Sykes, John Henry, West-field, Huddersfield.
Vaion, William, Andrew McIntosh, Ramsgate.
Warren, Samuel Hillyer, 38, High-town, Crewe.

The following candidates were balloted for and duly elected members of the Society:—

Bryan, E., Gas Works, Beverley.
Eastwood, Charles, Soothill-lane, Batley, Yorks.
Hogg, Dr. Robert, F.L.S., 99, St. George's-road, Pimlico, S.W.
Parlby, William, Aylesbury.
Whitehead, W. S., 11, Drewton-street, Bradford.

The paper read was—

MODEL DWELLINGS FOR THE RICH.

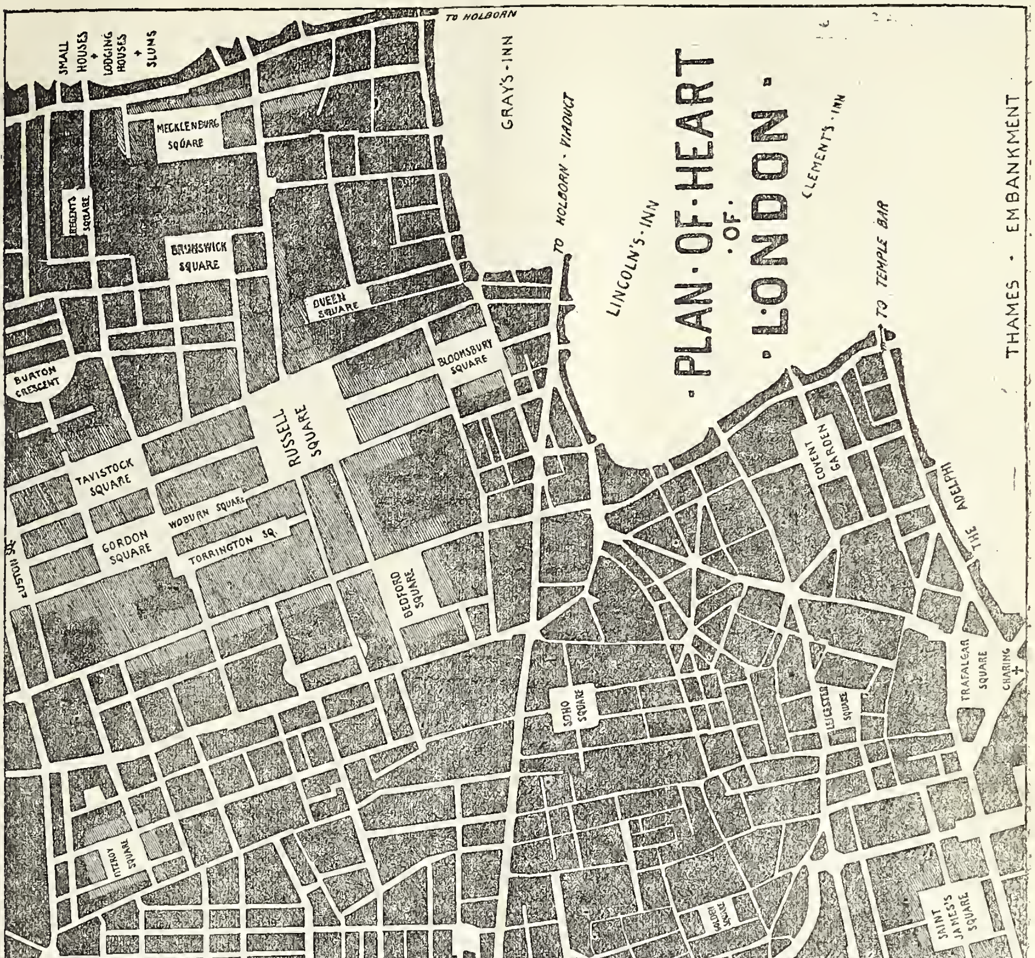
By T. Roger Smith and W. H. White.

If it be tacitly admitted by most Englishmen that whoever can make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, does more essential service to his country than the whole race of politicians put together,* perhaps he who can make two healthy houses to stand in this colossal city where a singly unhealthy one stood before, confers a greater benefit upon his fellow citizens than all the enterprising persons daily engaged in enlarging the area of inhabited London. At the present day when the custom has become all but universal for Londoners to live out of London—to regard town in fact as a place of probation through which men must pass daily before hoping to enjoy their lives elsewhere—it may seem quixotic to suggest a contrary procedure; yet to dwell within reach of the heart of London is almost a necessity for that increasing class whose mental activity is of most importance to the community in general. Parliament, the Courts of Law, the public offices, the various professions, the daily and weekly journals, make large demands upon the time of the more accomplished minority of Londoners; and, for these persons, the clubs, the learned societies, the places of public amusement, and congenial neighbours are more or less necessities of intellectual life. There are consequently, and there always will be, a large number of people to whom the neighbourhood of Westminster-hall, Pall-mall, Burlington-house, and the Strand, is not merely attractive but essential; and who, if they can reside in central London, will enjoy advantages for which no consideration, except that of health, can be accepted as an equivalent.

In point of fact such residences, both large and small, as can be obtained within a mile of Charing-cross, are eagerly sought, and are occupied at high rentals. To show what is obtainable under existing circumstances, we have prepared a rough map, comprising an area of between two and two and a half square miles, which represent the heart of London.†

On the map will be found marked with black those portions which are so laid out and constituted as not to be available for high-class occupation, while the portions which are so available are etched. It will be at once seen that the residential part forms but a fraction of the whole, and if we may judge by past analogy, there is more likelihood of the black encroaching still further on the grey, than of the grey regaining possession of the black. For instance, within three minutes' stroll from Charing-cross there is the Piazza of Covent-garden, which Hogarth painted while the houses were occupied by people of quality; further on, Soho-square, once a favourite haunt of fashion; Golden-square, inhabited in the last century by "lords and ministers of State;" St. James's-square and Jermyn-street, built "near the Court," for the accommodation of those who frequented it. The clubs, the joint-stock banks, the hotels, the private lodging-houses, and the professional chambers, are gradually, but surely, ousting peers, both spi-

* The King of Brobdingnag's speech to Gulliver.
† See map.



PLAN · OF · HEART · OF · LONDON
TO HOLBORN
GRAY'S-INN
TO HOLBORN · VIADUCT
LINCOLN'S · INN
CLEMENT'S · INN
TO TEMPLE BAR
THAMES · EMBANKMENT
SMALL HOUSES + LODGING HOUSES + SLUMS
MECKLENBURG SQUARE
REGENT'S SQUARE
BRUNSWICK SQUARE
QUEEN SQUARE
BLOOMSBURY SQUARE
BURTON CRESCENT
RUSSELL SQUARE
TAVISTOCK SQUARE
WOBURN SQUARE
GORDON SQUARE
TORRINGTON SQ.
EUSTON SQ.
BEDFORD SQUARE
COVENT GARDEN
THE ADELPHI
SOHO SQUARE
LEICESTER SQUARE
TRAFALGAR SQUARE
CHARING +
FITZROY SQUARE
GOLDEN SQUARE
SAINT JAMES'S SQUARE
REGENTS PARK
PARK CRESCENT
CAVENDISH SQUARE
HANOVER SQUARE
BERKELEY SQUARE
GREEN PARK
MANCHESTER SQUARE
GROSVENOR SQUARE
PORTMAN SQUARE
MONTAGU SQUARE
HYDE PARK
HYDE PARK CORNER

ritual and temporal, millionaires, and others who still cling to a spot near which "Norfolk, Ormond, Kent, and Pembroke, gave banquets and balls."* Shops and lodging-houses are creeping up to the very portals of Grosvenor and Berkeley-squares. Mayfair is already shaken by more than one unwelcome intrusion. Portman-square and its adjacent great thoroughfares is the quarter most affected by the large family of the "Harley-Bakers," whom Thackeray has immortalised; while the Portland and Bedford estates have been long besieged upon their eastern side with a pertinacity of mischance which has left many of their symmetrical streets in the "parlous" condition of lodgings, and the "upper-part-of-this-house-to-be-let" state.

All who know town well doubtless concur in our assumption that, unless some new system of construction and arrangement of residences be introduced, no enlargement of the area now devoted to first-class residences in the heart of London is likely to take place. The violent expedient of making certain new streets has done good to commerce, but to domestic households it has brought literally nothing—in fact, it has driven them further into the outskirts of this enormous city; and in London new streets are always a question of years, sometimes of a generation. On the other hand, two remarkable and suggestive modifications in town buildings have been made within the present century. They encourage us to believe that a similar one, such as we advocate, may be readily adopted. The huge blocks of offices for merchants and professional men now to be found in the City, and the model dwellings for operatives and others lately erected in parts of the metropolis, are comparative novelties; and model dwellings for a different class of the community are a natural sequel to them. Little more than fifty years ago a great many merchants resided east of Temple-bar, often over their counting-houses. Even at that time a few houses were let in separate floors, and used as offices; but buildings erected especially for offices were unknown; and one of the first houses planned and constructed for that purpose was a stack of offices in Clement's-lane, built about 1823.† During the last twenty years the growth of this class of building has been enormous. Several companies have been formed for the erection of such specially contrived blocks. The huge houses on either side of Queen Victoria-street—the latest buildings of this sort—are arranged on the horizontal system, by floors, in sets of offices, or even single rooms. The upper stories are often reached by a lift, and there are continuous rows of shops on the street level.

Let us now turn to the model dwellings, and to what they supersede. Visiting any district of London where operatives and some of the poorer class of the community reside—on penetrating behind the main thoroughfares—you will find large spaces covered by small, low, irregular, and ill-built houses of two stories, badly approached, and badly drained. The best of them are often in narrow lanes, the remainder in courts and alleys, and all suffer from a stagnation of air; yet they are let at exorbitant rents! Here and there, however, you may discern a group of solid, substantial buildings, lofty, well drained, well supplied with water, with a liberal provision of light, air, and comfort. These are the model dwellings. If you examine into the whole history of these buildings you will find that, where the management is economical and thorough, it is possible to obtain a fair return for the outlay expended on land, building, and maintenance. Owing to the fact that they contain four, five, or even six stories, as compared with the two by which the land was covered before, it has been possible to pay for a good site, to allow ample space around the buildings, to construct them with a solidity worthy of a public building, and yet to let them to families equal in number and extent to those which covered the ground on the old system, for rents favourable in comparison with those of the original tenements.

The subject of such model dwellings is already almost an old one, and the idea of extending their usefulness is not new. For half a century the propriety of adopting the mode of house accommodation practised in most of the European capitals has been discussed in London. Twenty-one years ago, one of our colleagues,* since dead, published a pamphlet on this subject, in which he declared that three-fourths of London houses were lodging-houses—that is to say, houses in which two or more families or groups extemporise residences in a building constructed for the accommodation of a single one. Our map bears out his assertion, for almost all the houses which help to compose the black portions of it are built for the express accommodation of a single family and are inhabited by two or more groups of people. Without, however, going into statistics, it is certain that a large lodger population exists in the metropolis; that it is composed of offshoots from all classes, even the upper classes of the community; and that the Legislature has recognised the fact. It is certain also that on the great patrician estates of central London there arise periodically new houses, built to accommodate one group of persons, which are immediately let to several groups. At this very moment, hard by, there stands a new street just presented to the public by the Metropolitan Board of Works—a street, of which even Paris might be proud—and in which, according to all probability, the same false economy and commercial waste will be suicidally rampant. Northumberland-avenue, from Charing-cross to the Embankment, is ninety feet wide, planted with trees and paved with wood. It may be lined with houses eighty or ninety feet high from pavement to cornice; and according to the London system the builders of these new houses will devote their skill and energies to the distribution of the ground and first stories alone, and leave the upper ones to take care of themselves—confident in the fact that in the neighbourhood of Charing-cross sets of rooms are so urgently required and diligently sought, that anything of the kind, however primitive, will let at an almost fancy price.

This time-honoured system of London house-building, both unscientific and inartistic, is due

* "State of England in 1685" (Macaulay).

† See papers by Mr. I'Anson, in the Transactions of the Royal Institute of British Architects.

* "Town Dwellings," by the late Mr. Arthur Ashpitel, in conjunction with his partner, Mr. Whichcord, the well-known architect.

partly to the tenure of land customary in the metropolis, almost the whole of which is leasehold—that is to say, consists of houses erected on land not sold, but let on what is known as a building lease. The nature of a building lease is that the possessor of a piece of freehold land lets it for a term of years to some one who undertakes to pay an annual rent for it; to build and maintain a house upon it; and at the end of the term to surrender the land and all that stands upon it back to the owner of the soil. The immediate result of this system is that it is to the lessee's or leaseholder's interest to build a house as cheaply and nastily as he can; and very little to the interest of the lessor or freeholder to prevent him from doing so. The lessee will lose the house he builds at the end of his term of sixty or seventy years, and the freeholder will not get it for that time. The one, therefore, desires to make as much of it as he can before it slips away from him—and at the same time to do nothing superfluous or from which the freeholder may ultimately profit—and the other, so long as the security for his ground-rent be sufficient, cares but little what is the nature of a property which will come into his or his heirs' possession at so distant a day; and when, if the lessee has displayed only common shrewdness, it will be worn out.

Our description, however, of this transaction represents it as far simpler than it really is, for we have omitted a chain of circumstances which often tends to burden the building of a London house with expenses to be ultimately defrayed by the unfortunate tenants. As a rule the land is not leased to the actual builder, but to a middle-man who gains a profit by re-letting it at a higher rate. The builder is usually a needy man who builds with borrowed money, and the high interest he has to pay, the expenses of solicitors and surveyors, and the profits on the original ground-rent must all come out of the house-rent. How enormous an evil this system has grown to be was described a few years ago by a writer in the *Quarterly Review*,* whose vigorous attacks created some little astonishment at the time of their publication. On the other side it has been urged that the control of the ground-landlord prevents irregularities of all kinds; and that this fact outweighs a few acknowledged disadvantages. That the ground-landlord exercises a control which renders it extremely difficult to improve a London dwelling-house is eminently true; and experience shows that that control is no safeguard against the fatal violation of sanitary laws. How can it be otherwise "while houses are built not primarily as a comfort for the occupant but as a security for the freeholder?" And such houses are not exceptional cases, to be found here and there, old, or soon to be pulled down. It has been computed that the buildings in London of one year alone would cover "an extent of frontage of something more than fifty miles;" and it may unhesitatingly be added, that both as regards solidity and sanitary provisions, half these leasehold houses are unsound.† But at least they are convenient, comfortable, private, and thoroughly English. They are and they are not. The traditional system of town residence, as carried on in London, makes the British capital socially inconvenient, in comparison with those of France and Austria. The chief advantage of living in Paris or Vienna consists in what Dr. Johnson was able to say of London, that there "a man is always so near his burrow." The French and Austrian capitals of our time are to the Parisians and the Viennese "what Athens was to the Athenians of the age of Pericles, what Florence was to the Florentines of the fifteenth century." But, it will be argued, London contains double the population of Paris. True; not only is it double, but it is increasing at an enormous, although perfectly calculable rate of progression. Streets after streets of houses, far beyond the four-miles' radius, have risen, and are still rising into existence.* These streets mean miles of roadway, which have to be paved, maintained, and scavenged; miles of gas and water pipes; of main and branch sewers; of police supervision; and of all those things which are known to Londoners under the comprehensive and disagreeable title of rates. Meanwhile, central London, where the great mind of the capital is daily and nightly at work, is more than partly covered by low, irregular, unhealthy, makeshift tenements—often the houses of the poorer classes of the population—traversed by narrow thoroughfares, into which flow, so to speak, alleys and courts as bad as the worst wynds of old Edinburgh.

Even admitting that the residential parts of central London please the well-to-do families who inhabit them, it cannot be difficult to convince the majority of those who believe in the London system, that metropolitan house accommodation is not so distributed as to suit the habits and wants of all classes of occupiers. A certain situation and a certain respectability of appearance being essential, the householder takes the best house he can find in the position he wants, and makes the best of it. But if his family be small, or if he be a bachelor or an unincumbered widower, the householder is saddled, for the sake of situation, with three times as many bedrooms, and a set of drawing-rooms twice as extensive as he requires. Indeed, a bachelor of fortune, ensconced in the only snug parlour of a fashionable London mansion, reminds his visitors more of a sailor on an abandoned ship, or of a "man in possession," than of an English gentleman enjoying the lettered ease and artistic refinements of modern home life.

* April, 1872.

† It is within Mr. T. Roger Smith's personal knowledge that on one of the best estates in London the main drains of a comparatively modern leasehold house were of inferior brick, and owing to their failure these had to be relaid in tubular tiles by the tenant. On another such estate a magnificent house was found to be literally built on a dunghill. All the walls had to be underpinned, and several hundred cubic feet of filth were removed. In a third instance, in one of the finest leasehold houses which London possesses, the arrangements for taking sewer gas into the proprietor's bedroom were fully as complete in their way as those for supplying combustible gas to the gaseliers. It turned out also that the flooring of what was built for a bedroom was so weak as to be actually in danger of breaking down under the weight of the people who would fill the room, irrespective of any dancing.

* Mr. Thomas Carlyle, writing in *Macmillan's Magazine*, August 1867, said:—"Truly the state of London houses and London house-building at this time who shall express how detestable it is, how frightful! 'Not a house this of mine,' said one indignant gentleman who had searched the London environs all around for any bit of villa, Alpha-cottage, or Omega, which were less inhuman, but found none. 'Not a built house, but a congeries of plastered bandboxes; shambling askew in all joints and corners of it; creaking, quaking under every step; filling you with disgust and despair.'"

The case, as far as we have yet gone, is that residential London covers a far smaller area than appears credible; that there is a demand for the re-arrangement of some of its dwellings; and that, if possible, an encroachment of its territory upon that of non-residential London is desirable.

The actual town residence is a vertical slip of comparatively tall building; and it consists, above the street pavement, of perhaps four or five stories and a low roof. The Londoner cooks underground, dines on the ground level, receives visitors on the first floor, sleeps on the second floor, lodges his children and guests on the third floor, and his servants in the roof. From bottom to top of this house is an open shaft, called the staircase, which is a complete conductor of smell, noise, and draught—an intolerable evil to old people, children, and invalids. The long weary flights of stairs render efficient attendance so difficult that many well-to-do persons give up the idea of being waited upon, and those who insist upon it have to pay for a large staff of servants, which, in some fashionable streets means filling up the passages and stairs. In many aristocratic London dwellings, a butler and his assistant will effectually block up the entrance passage, while in the majority of even very good houses, stairs exclusively devoted to the domestic service are unknown.

As a singular instance of custom engendered by the vertical system of house-building, the labours of a London dinner party may be cited. First, from the street door to the kerb-stone of the pavement, a strip of carpet is spread, and over this the guests are conducted, often under an umbrella, to the threshold. Having passed through a long narrow passage, they are made to climb two flights of stairs. The ceremony of reception over, they then descend to the street level, only, however, to scale, after dinner, the same two flights of stairs, and ultimately to be conducted down them again to their carriages—this process of climbing having to be renewed before they reach their own bedrooms.

Another evil of the narrow vertical slip of building is the slenderness of its constructive parts. The floor-joists, boards, and ceilings, are generally so slight as to admit the easy passage of sound, and to vibrate with the mere motion of the inmates, or the shifting of furniture. One wall of each room in the house is called a party-wall, and the Metropolitan Building Act is sometimes so cleverly evaded that there may be a thickness in parts of only 4½ inches between house and house —while a thickness of one brick is legal in many places. Of the other walls one or more is often a partition of lath and plaster. The stairs and the floors are of deal, and often concealed within the latter lie yards of leaky gas-pipes. The walls and partitions are covered with absorbent paper, and the floor boards are hidden by an equally absorbent carpet. Exactly in front of the windows which light the principal living-room is the sole entrance and exit for the household service; and the kitchen and household refuse of several days festers in a dust-bin, artfully placed in the area, just under the dining-room window.

We, by no means, assert that the Parisian is better off in his home—and many Frenchmen enjoy their homes quite as much as Englishmen do—than the Londoner; but we do assert that the ordinary Paris houses are more scientifically planned, more artistically rendered, and more solidly constructed than even the best London ones.* Half-a-dozen London houses turned on their sides and piled one over the other, may help to convey a rough notion of a Paris house; but for English brick and deal you must substitute French stone, iron, and oak. In Paris, Brussels, Vienna, St. Petersburg, Geneva, Hamburg, and Berlin; in Turin, Naples, and Rome; in Calcutta, Cairo, and other Eastern cities; in Edinburgh, Glasgow, and other Scotch towns, families inhabit what are called "Flats;" and which are slightly known to Londoners by certain examples in Westminster, Marylebone, and elsewhere. But a large number of these, planned upon the Continental and Scotch systems, possess the defects inevitable to a first attempt. They have dark, close, stuffy passages, with kitchens, bedrooms, and living-rooms all huddled together; and the majority are only reached after a fatiguing climb—faults which have given a bad name in England to the horizontal system of residence. They no more prove, however, that such defects are inherent to the system than the existence of a certain number of blind people is a proof that the human race cannot see! Indeed the study of actual buildings of this description, both at home and abroad, will be of little avail, unless it convince the British architect that a primary canon of the horizontal dwelling excludes from all parts of it, either a dark or an ill-ventilated corner. Not only must the corridors be spacious and light, but the three sections of a house—the living-rooms, the service-rooms, and the sleeping-rooms—must be entirely distinct. At the present moment the Parisian principle of plan governs the architects of these special buildings in European capitals; but some of our insular habits are opposed to its adoption in this country. One important difference, for example, is that Englishmen often pass the day in their dining-rooms, and only sleep in their bedrooms; whereas a Frenchman lives in his bedroom and only eats in his dining-room. In London more space is required for the household service than in Paris, where kitchen economy is pushed to an extent almost incomprehensible to English housewives. In Scotland, Rome, and the London Inns of Court, the public staircase is synonymous with the street, and often equally dirty, since there is no one to look after it and no external door. In Paris it is protected by a *concierge*, his wife and family, who are responsible for its cleanliness and safety. Still even this staircase and this social incumbrance, the married porter must be improved upon if we are ever successfully to turn six vertical English houses on their sides and convert them into twelve horizontal residences—that is to say, if a dozen self-contained healthy houses are to be provided for the dozen different groups of people who previously dwelt in the six unhealthy ones.

We will now, with your approval, describe a block of horizontal dwellings suitable, as we humbly think, to the wants and associations of English families of position and means.

The site must be in the heart of London—in a wide street or a square, facing a park, or on the

* See Papers on "Paris Houses," in the *Builder*, December 11th, 18th, and 25th of last year.

new Embankment. At present, it would be unwise to erect a building of the kind except in an open, and therefore expensive situation. Were it not almost impossible to buy land in London, the site ought to be freehold. A corner or triangular plot of ground lends itself extremely well to the kind of building contemplated, but it must be open enough to admit of lofty *facades*, containing, in cases where the basement and ground stories can be devoted to mercantile and professional offices, as many as eight stories. Above the business offices there would be six stories, that is, twelve residences, each containing fourteen or sixteen rooms. We may be told that to reach the top story some 150 steps or more would have to be scaled, and in an ordinary London house there are rarely more than 50 steps from the pavement to the level of the bedroom floor. But now that people cheerfully cross a street, say, the Edgware-road to the Great Western Hotel, by steam, we propose that the inhabitants of our model dwellings shall similarly travel from the street pavement to the particular story in which they reside. The tenants and their families shall go up first class, their servants and tradesmen second class; and to this carriage a goods-van shall be coupled. We propose, in fact, without absolutely abolishing the traditional staircase, to construct a brick shaft, in which shall be placed an "elevator," fitted up like railway compartments; and that a guard shall be always in attendance to accompany passengers in their ascent and descent.

As we have previously hinted, each residence would be divided into three distinct sections, each served by its own corridor. That in the service section would communicate by a special passage with the dining-room, and in this passage a small tramway might be laid down, for the conveyance of dishes and similar articles. The section containing the living-rooms would comprise a large hall, a dining-room, a library, a drawing-room, and sometimes a gentlemen's smoking room, as well as a ladies' boudoir. The sleeping-section would consist of a sufficient number of bed, dressing, and bath rooms, with a fire-place in each room. In the service-section would be placed a butler's pantry and a servants' hall, in addition to the kitchen, scullery, and stores, as well as bedrooms for the female servants; but all the men-servants would be lodged in separate rooms in the roof. Each section would communicate with the others by means of swing folding-doors without locks. In all the rooms of the sleeping-section water would be laid on, and a means of exit for it provided.

The *facades* of our building would receive attention of a utilitarian, as well as of an ornamental nature. We propose to face the external walls, both towards the street and towards the quadrangle, with hard impervious substances, such as glazed bricks, relieved by Majolica ware and a little polished granite, in fact, to use externally only those materials that will "wash."*

In a building of such a character and such dimensions, many sanitary precautions could be taken in the construction of the foundations and lower floors, which, to say the least, are not taken in even the best London houses. A layer of concrete would be spread over the whole surface of the site, between the foundation walls; and damp-courses of brick laid in asphalte upon the walls themselves. Cellars vaulted with brick arches would be arranged under the basement floor, and these cellars would be allotted to the different tenants, and be let with each residence. There would also be in each service-section small cellars for coal and wine, which would be replenished from the stores kept in the larger cellars, situated in the sub-basement.

All the chimney flues would not only ascend to above the roof, but also descend perpendicularly to the cellar level, whence they could be swept, so that no sweep need enter any of the residences or business offices.

A special external feature of the building would be the street entrance to the residences, and it would be so arranged that the tenants and their guests could alight under cover from their carriages. None but those residing in the house, and their visitors, would use this special entrance. The entrance to the business offices—where they were admissible—would be in an opposite part of the building, and the servants' and tradesmen's entrance would be distinct from both that of the residences and that of the offices.

Our model dwellings would form so extensive a block, that the external and party-walls would perforce be of more than ordinary dimensions; most of the partitions would be of brick; the floors would be equivalent to horizontal party-walls, fire and sound resisting, and composed of rolled iron entirely enveloped in concrete. The staircase would be absolutely fire-proof. The outer doors of each residence would be of solid oak, and not only folding, but double, like the outer doors of chambers in the London Inns of Court. The floors of the corridors would be covered with marble mosaics, and those of the principal rooms with oak parquetry. From top to bottom of the building, the kitchens, sculleries, &c., of each residence would be over one another, and the danger of fire or explosion from range or boiler thus concentrated in one spot.

The landlord or manager of such a building should have a certain share in its internal economy, because it offers, we venture to think, an easy opportunity for the practical application of co-operative advantages. In several modern buildings, both public and private, it is quite an ordinary thing to find in the basement a steam-engine at work for purposes of ventilation. We propose to place one under the central courtyard of our building, for a threefold purpose—to ventilate and to warm, as well as to work the elevator. Not only the public entrance-hall, public stairs, and passages, but the private vestibules, ante-chambers, and corridors of each residence would be warmed and ventilated by means of this same steam-engine.

The management would have to provide certain general servants, each with special functions, to do part of the domestic work of all the families residing on the six stories, and of the business offices on the lower floors. For instance, a hall porter to open and shut the external door, to direct visitors, to receive, distribute, and post letters; an attend-

* A great deal of the dirt which enters a London residence is due to the fact that the house-fronts are begrimed with soot and dust—formed by moisture into a paste—which, in fine weather, dries, disintegrates, and is then blown into the rooms through the open windows.

ant at the elevator; a man to perform window-cleaning, and maintain bright and clean all the portions of the house common to the families residing in it, and also to remove dust regularly night and morning. Our proposition aims at getting the dirty, and therefore menial, work of each household done by outsiders, exactly as such work is now done by the time-honoured "laundress" of the London Inns of Court. By previous arrangement with the landlord much general assistance might be thus rendered by the servants of the house to the tenants, without prejudicing the internal domestic privacy of each family. They might, for example, clean boots and brush clothes; they might polish the oak and mosaic floors of the different residences, and, indeed, do any similar work specified by landlord and tenant.

There are, of course, objections to such a scheme. In the first place our suggestion tends indirectly to mix up in one block of buildings professional and mercantile offices with family residences. But one of the causes of the present unwieldy condition of London is, that the different classes of the community are always trying to fly away from each other, and, as a direct consequence, they are always invading each other's territory. Those who desire to live in the heart of a great city must accept the logic of circumstances; and we would so arrange the houses that some of the upper and middle classes should inhabit the same streets without incommoding or, so to speak, compromising each other.

The insular objection to live on the upper stories of a tall house is perfectly natural so long as people are compelled to climb up to their residences. It should cease when they can be carried up to them easily, and without exertion, in less time than would be required to reach their bedrooms on the old system. For several families to live under one roof, and to be partly "helped" by the landlord's servants, is also startling in an English point of view. But it is less startling when the present condition of London life is calmly considered. More than one recent satire, treating of popular social questions, seems to foreshadow change in the thought and custom of society. One book, called "The Coming Race," sketched a subterrestrial region in which men and women were lifted from one floor to another of their houses by invisible machinery, and were waited upon by automata.* Another book, called "Erewhon," on the contrary, described a beautiful race of beings who regarded machines with loathing; who held picnics in the ivied ruins of a railway station, and who placed in their museums fragments of ancient watches and steam engines, just as we now-a-days collect the bones of a dodo or a mammoth. The one hinted that science, having gone so far, must go yet further; the other suggested what might happen if it went too far. For the present, however, we may safely assert that steam is still youthful; and, with very little thought, an ascending chamber could be made to supersede a staircase as effectually as the railway has superseded the stage coach. Of course a steam or hydraulic elevator implies a certain amount of risk, but so do railways, and yet people seldom hesitate to travel upon them. An elevator would make some ladies ill, and ladies are sometimes affected by sitting with their backs to horses or to engines; but the number of persons liable to this inconvenience is happily very small. On the other hand, there are real human distresses in both men and women, which are aggravated by the enforced climbing of a London staircase-ladder.

We hold it of great importance to arrange London dwellings in such a way as to lighten domestic labour of every description.* The relations of master and servant in England never were so strained as they are at present. The old type of domestic servant is now very rarely found; the new type is seldom worth the having. Men and women are no longer for hire. They will do a certain amount of definite work and sell that work to their superiors; but they aspire to the right, at least the men do, of disposing of themselves as they choose when their work is done and the contract with their masters is thus fulfilled. The patrician, the historical family, a few people of exceptional position and winning manners may gather around them domestics who identify themselves with those they serve, but old-fashioned service cannot be exacted by the mere payment of wages. Under a system such as we propose the number of domestic servants would be considerably reduced, and the ordinary household labour diminished. A professional housekeeper would become an incumbrance; and, in these days when ladies and gentlemen carry home their own stores from the various co-operative shops, the place of housekeeper ought not to be worth many years' purchase.

To sum up: a building planned upon the principle of which we have given an outline description, a principle which we have worked out upon paper, and which applies equally to a square, an oblong, or a triangular site, combines internal economy and constructive strength—economy in the kitchen and domestic arrangements, extra comforts in the dressing-rooms, and a set of sitting-rooms, not *en suite*, but on the same level and entered from the same corridor. It divides the three sections of a house so that the foul air generated in each may pass away naturally without rising, as in our actual houses, from one section through the others. All our living-rooms, both of day and night occupation, would face the public street, only the corridors and the service-sections being lighted from the back of the house or the courtyard. The tenants need not mount a single stair from one year's end to another. The members of each family would be as privately located as if they inhabited a vertical slip of building in which the various rooms are connected by the usual staircase-

* The late Lord Lytton wrote:—"Some words in a low tone passed between the beings present; one of the group touched an automaton which started forward and glided from the room. .... My guide again took me by the hand, and re-entering the gallery, touched a metallic plate inscribed with strange figures, and which I rightly conjectured to be of the nature of our telegraphs. A platform descended, but this time we mounted to a much greater height than in the former building, and found ourselves in a room of moderate dimensions.... .. Four automata (mechanical contrivances which answer the ordinary purposes of domestic service) stood, phantom-like, at each angle in the wall."

* The late Cardinal Wiseman, lecturing in April, 1864, said:—"The French word *grenier*, originally the granary, now means an attic, because the provision of grain and other stores was first and for once carried to the dry top of the strong well-built house, whence the domestics had the lighter toil of bringing them down in detail. Was not this a wise economy? Now we send our coals, for instance, a story lower than the ground, to have them carried up to a third or fourth floor above it."

ladder; but, instead of climbing, they would walk from room to room. By the horizontal system of residence, families desirous of living in the heart of London can be agreeably lodged, and at comparatively reasonable cost. House-rent would rise, but household expenses and household annoyances would diminish. The character of London housebuilding would be raised. Bad neighbourhoods could thereby perhaps be redeemed, and good neighbourhoods undoubtedly guaranteed from deterioration. Such buildings as our Model Dwellings for the Rich would, we are confident, "pay" all those concerned in their erection. We are equally certain that when the upper classes have set an example by inhabiting them, the insular prejudice against such residences will disappear; and the middle classes, who most require a reform in the London system, will soon follow in the steps of their more fortunate brethren.

DISCUSSION.

The following letter was read from Mr. Edwin Chadwick, C.B.:—

I consider that the paper of Mr. White and his colleague, on "Model Dwellings for the Rich," opens up important sanitary and economical improvements for the benefit of the large class of the very moderately rich, and for professional persons, who cannot individually help themselves, and who need collective aid and service from sanitary science and architectural art.

Dr. Richardson's paper on the construction of an ideal city, under sanitary science, a "Hygeia," has, I am glad to learn, given rise to suggestions from various quarters, that the idea should not be postponed to an indefinite future, and that steps should be taken for its early practical realisation. Constructions on the principle advocated in the paper would enter into prominent consideration for such a city.

In my observation, however, most of the existing buildings on the "flat" principle have sanitary defects which will require careful attention for their prevention in new buildings. During the cholera visitations these classes of houses, in Edinburgh, Paris, and elsewhere, were marked by the excessive severity of the attacks upon the occupiers of the basements and the upper floors of these dwellings, or the attics, whilst the occupiers of the intermediate dwellings or apartments had an almost complete immunity from the pestilence. Much of such differences of sickness and death-rates between the upper, the lower, and the intermediate classes of occupiers is manifest in ordinary times. The comparative severity of attacks upon the occupiers of the basement tenements is attributable to the obvious inferior sanitary conditions belonging to them. The comparatively lower health of the occupiers of the highest tenements to the intermediate occupiers is ascribable to defects of ventilation, by which the attics are made inverted receivers, as it were, for the detention and accumulation of the vitiated warmed air ascending from the basement, as well as from the intermediate tenements opening into the common staircase. In tall town houses of the well-to-do classes, servants working in the lower rooms and sleeping in close attics suffer in their health proportionately to the greater amount of aerial impurities to which they are exposed.

The remedy to be applied is that the rooms of each stage shall be provided with distinct means of ventilation from the out-door air, entirely independent of any supply from what I call the aërial common sewer—the common staircase.

With these precautions, the higher flats may have a superior supply of out-door air, above the lower stratum of air commonly polluted by street dust, and be placed in the best sanitary condition as to aëration. Each living room should have its separate warming as well as ventilating apparatus for protection against rushes of cold air from the staircase.

There is now in course of construction some houses on a plan of hollow concrete walls and floors by Mr. Pope, the architect—of which I hope we may shortly have an account—that serve for the leading of warmed air to warm floors, also to warm walls, and effect a restoration of the Roman warmed floor and warmed wall, with great economy of fuel, specially applicable to this class of residences, and to the construction of a Hygeia, in providing a greatly improved quality of construction at a reduced cost.

Blocks of these tall houses should be laid out, with sanitary precautions for the avoidance of the enclosure of deep reservoirs of stagnant and vitiated air, such as may be pointed out at the West-end of the metropolis, and for ensuring the free sweep of the wind, and external ventilation.

The economical construction, and the economical working of the lift for application to this species of dwellings, would be an object of great importance, and I should desire some particulars from the authors on these points.

The general advantages to be derived from the principle of construction propounded by them, appear to be in giving to three or fourfold populations economically, the advantage of the finest sites and aspects, a great economy of servant power, and attendance of a good trustworthy quality, now getting more scarce and expensive; in giving parties facilities to leave their homes and enjoy vacations with greater comfort and security than at present. The reports of the occupiers of flats, in new West-end edifices, even as they are at present constructed and conducted, are in accordance with the representations of Mr. White and his colleague, and with what I have heard of the experience in Paris and Vienna, and are highly favourable.

The deplorably distressed capitalist, who, at this time, by lending a thousand pounds of his capital for a day, cannot get more than two shillings for its use—actually not more than half the day's pay of a journeyman bricklayer—may have the assurance, that by its application to the construction of a Hygeia, or in the minor way proposed, he may obtain safe and more satisfactory remuneration for his labour and thrift. The distressed and bewildered capitalists of Liverpool and Manchester, who do not know where to get remunerative employment for their money, may with profit obtain, by the means opened to them, better health for themselves, and a prolongation of their working ability, with better health for their families in new suburban sites, than they can ever hope to have by continued residence in those pre-eminently heavily death-rated cities. Of this we may give them assurance.—I am, &c.,

Edwin Chadwick.

East Sheen, Surrey, March 29, 1876.

Mr. Lawrence said there was no doubt this system of building in flats would succeed to a certain extent in London, following the example of Paris and Vienna, but he did not think the time would ever come when the ordinary Englishman would adopt such a system, which simply meant the total absence of home life. It did very well for professional men, but was quite unsuited for families with children. A Frenchman's house was the last place he looked upon as his home, and you could not take up a child's book in French without seeing allusions to old gentlemen below complaining of the noise of children above. No doubt lifts would be a great accommodation such as were in use in the Grand Hotel in Paris, which had sleeping room for more than a thousand persons. On the whole, while there must be a certain demand for this class of buildings, he did not think leading noblemen would ever occupy them, or that they would come back to live in the heart of

London as in former days, or as they did now in Paris, and for that reason he feared London would never be so handsome a city as Paris.

Mr. Tilghman said this system had been to some extent adopted in New York, and as far as he knew had succeeded very well. The lifts had been found a great advantage, and he understood that in business houses the upper floors were preferred, even at the same rents, on account of the greater amount of light and air which reached them. Some years ago a portion of Boston was burned down, and it had been partly rebuilt in large blocks, where lifts were almost universal; not only in business premises, but in hotels and boarding-houses. There was this great advantage in connection with this plan, that where there was a lift there must be a steam-engine, and you could consequently warm the house by steam pipes to the great comfort of the inhabitants and the great economy of fuel.

Professor Kerr desired to guard against the supposition that the authors of the paper had exaggerated their case, because one could not quite go all the way with them in all that they had advanced, any more than Dr. Richardson had in his "Hygeia," because he had gone further than many people could follow him. Custom was held to be binding in England until it was forcibly overthrown, and therefore all reformers had to state their case as strongly as possible in order to get a hearing. He recognised the maxim more perhaps in building than in anything else—"Whatever is, is right," and if London was found to be built on one plan, it must be taken that that was on the whole the best plan. All that could be said against it was that in certain exceptional cases it would be advisable to build upon another system. Although it was complained that the working classes lived two or three families together in houses arranged for one family only, still a further examination would show that this was the right plan, and that the bulk of model lodging houses had departed too much from it. It was in vain to contend that any better plan could be provided for London than that adopted at the West-end. Every family man who could afford it would have his own front door, and would not like having any one else either under him or above him. It was easy to laugh at this as insular prejudice or John Bullism, but there was common sense at the bottom of it, and at any rate it could be got over. At the same time there was no doubt a large class in London who would be glad of the accommodation of chambers or apartments in flats, but the extent of this kind of accommodation required must be considered, and also how it was to be provided. These questions had been discussed many times, but he did not know that up to the present moment any completely successful solution of the problem had been given. The authors had not gone much into detail, no doubt feeling it preferable to confine the discussion as much as possible to the general principle. Efforts had been made to provide these kind of apartments in Victoria-street, and elsewhere, and he believed they had answered fairly well, but he was not sure whether they were not occupied almost exclusively by bachelors. At all events ladies had a decided objection to going up a common stair, and this difficulty must be fairly met. Then if two staircases were provided there would be a difficulty in drawing the line who should go up the one and who should go up the other. Again there was the question who was to live in the attics. People would never live in London as they did in Paris, a shoemaker or seamstress at the top of the house, and a nobleman at the bottom. He did not see, however, why large houses should not be built in such a way that they could be divided into two, with two separate entrances, one for the lower half and the other the upper, the advantage of which would be that all the family rooms must be on one floor, which would render them much more convenient for occupation.

Mr. Grueneisen was inclined to take a broader view of the question than had been adopted by the previous speaker, especially considering the enormous and constantly increasing population of London. There had been a strong tendency for some years past for people to live out of town, and the suburbs had grown to such an extent as quite to belie their name. Many also had taken to live at longer distances, such as Brighton, but of late medical men had discountenanced this as being injurious to health. It would not do to take as a standard the spirit of exclusiveness which formerly prevailed amongst Englishmen. No doubt there were some who liked to surround themselves with high walls until their houses looked like lunatic asylums or prisons, but there was also a numerous class who would be very strongly disposed to live in flats. He had lived for five years in Paris *au troisième*, and was never more comfortable or independent. By having a *concièrge* you to a great extent got rid of the nuisance of domestic servants, and of course in London, with lifts, the Paris system might be greatly improved upon. He believed if the plan could be carried out it would prove a great success.

Mr. Hale did not think the aristocracy and upper classes would approve much of the proposed system.

Mr. Strong wished to know how light and ventilation would be provided for in these large blocks if they were erected in a street so as to open at the back and front, but enclosed at the two sides. He had lived some time abroad, and had always found a great annoyance from the shafts leading to the larders, &c. There was but one shaft all the way up, which conveyed the smell from the scullery below. The only remedy would be to have separate shafts, which would require a great deal more room. Another objection was that whenever you entered a flat you could tell what the occupants were going to have for dinner. The top floor was generally used as store rooms, and for fuel, and the roof being flat afforded a means of escape from fire. After all an Englishman's house was his castle, and he did not think men with families would like to live in a flat, and to have to carry the perambulator up and down two or three flights of stairs.

Dr. Wylde said some gentlemen thought there would be a great demand for this class of buildings, and others doubted it, but the question had been to a great extent answered already. When model lodgings for the poor were built they were occupied almost immediately, and there had recently been erected near Regent's-park some better class buildings called Cornwallis-mansions, six stories high, on the same principle, and they were all taken long before they were completed. He knew ladies who resided in them, and who were highly pleased with the accommodation. Rich men who lived in the squares would not take these flats, but there were many people, to whom economy was an object, who would be glad to do so. Domestic service would be greatly economised, because in such cases ladies and gentlemen would not mind opening their own door to visitors, and the kitchens being small, and well fitted with kitcheners or gas apparatus, ladies could do a great deal of their own cooking.

Mr. Hyde Clarke was glad that one or two of the speakers had come out of the realm of fancy into that of fact. It was all very well to talk about an Englishman's castle, but the question was, what kind of castle could he have? In such a population as London there were people having different requirements, and they all ought to be provided for. There were a great number constantly living in lodgings or chambers, and many who only came to town for a few months in the year. One great cause of the present taste for living in what were called in the North "self-contained" houses, was the window duty, which altered the whole construction of London during the last century. Previously to that the English had been a clubbable people; for though they were independent, they also liked association. At the

dissolution of the monasteries they were all occupied by families, and in the sixteenth century a large portion of the population lived in flats, exclusive of the inhabitants of the Inns of Court and Chancery. The circumstances of London were not those of the whole country, and there would always be in the metropolis a large number who must live in apartments of some kind. At one time every peer had a residence in London, but that had been greatly altered by the railway system; and many only came up for a month or two, and had no permanent residence here. With regard to the annoyance which had been spoken of from children, and so on, it must be remembered that at present there was a constant annoyance from noises next door, and that under an improved system of construction they would be greatly modified, if not altogether removed. Possibly, if one person in a house gave a party, it might be an annoyance to his neighbours, but not more so than was the case at present from the same event next door. None of these considerations were sufficient to detract from the value of a suggestion which was practicable architecturally, and would, no doubt, be economically advantageous. It was after all a question, whether those who were compelled to live in apartments, should do so in houses constructed for the purpose. The residential portion of London was continually being encroached upon, and if any one would walk about Bloomsbury and the surrounding district, he could not help being convinced of the value of the suggestion which had now been made.

Mr. R. Manuel said the paper opened out a new vein of thought with regard to the construction of houses, but he feared the ideas contained in it were somewhat in advance of public opinion and insular prejudices. He hoped Mr. Smith, in his reply, would state how he proposed to ensure builders carrying out his plan, supposing it commended itself to the public. The defects of modern house-building were notorious, and he thought the Legislature might well pay moro attention to the subject.

Mr. Robert Rawlinson, C.B., had listened to the paper with very great pleasure, but he knew his friends the authors were not so sanguine as to imagine they were going to subvert the existing order of things. They only proposed to introduce an improvement. Many persons came to London for short periods only, and if they rented a residence it must greatly deteriorate while unoccupied. These block-buildings, properly arranged on sanitary principles, would offer great facilities to such persons, and there was plenty of room for them. He had been actually alarmed at the progress of building at the West-end during the last ten years, and had been for a long time expecting some catastrophe to put a stop to it. But still it went on year by year, though it must come to an end some day in all human probability. The class of buildings run up in the suburbs was of the worst possible description, and he could not understand what the surveyors were about. Only last week two large houses, partly built, came down like a pack of cards; and not more than two years ago three or four houses, of rentals varying from £200 to £300, suddenly collapsed in the same way. These proposed buildings would be thoroughly well built from foundation to attics, solid in construction, fireproof, and giving easy access to the upper floors by means of a lift. Probably the objection with regard to children was a valid one, but there would always be plenty of ordinary house accommodation for families with young children, and there were numbers of others who would appreciate the superior comfort of a superior class of buildings.

Mr. Baruchson said there were numerous lifts in constant use in London, as well as at the Grand Hotel in Paris, where they were now constructing a second one. He had lived a long time in Paris, and thought the annoyance from children and other causes was quite imaginary. Concerts and balls were constantly givon without causing any inconvenience to those living underneath or above, and the same system of building was followed all over the Continent. At Naples he had seen a duke living on the ground floor and a shoemaker at the top. The great objection was the staircase, and that would bo overcome by the lift; but he did not know whether the grand folks on the first floor would like to go up in the same lift with the shoemaker who lived at the top. He believed this plan had been successful in Victoria-street, and it had long been followed in Edinburgh and Glasgow.

Mr. White said the common notion in England that in Paris houses the ground floor was occupied by a tradesman, the first by a duke, the second by a marquis, the third by a baron, the fourth by ordinary people, and the fifth by labourers, was quite mistaken. As a rule, all the inhabitants of a house belonged to the same class in society, and if there were poor people at the top they went up by a separate staircase. He had lived ten years in Paris, and nobody ever complained of his making a noise, nor had he complained of his neighbours; neither had he been assaulted on the staircase, or assaulted anyone else. Since he had lived in London, however, he had been constantly annoyed by an abominable piano on one side of him, and by worse singing on the other.

The Chairman, in moving a vote of thanks to the authors of the paper, said he believed there was a great need for such buildings as they had described, and there was a large class who would gladly take advantage of them. They must be well built, and many domestic annoyances would be obviated. When in New York two years ago, he found a lift in the hotel in which he stopped, which was only an ordinary sized one; it was fitted up like a drawing-room, and was a great convenience. He saw no reason why there should not be a second-class lift for the servants and goods, and a first-class for the family and visitors. The suggestion to put ornamental glazed tiles on the outside of the walls he thought a very good one, and had seen very handsome effects produced by it in Lisbon, where it was quite common. He doubted, however, whether this style of building would accommodate more persons on the same area than at present.

The vote of thanks having been passed unanimously,

Mr. Roger Smith, in responding, said it was not necessary to notice all that had been said, as many of the objections advanced had been already met. Practically the case had been admitted, which they had brought forward. They did not propose to alter the habits of all London, or even of a great portion, but there were large numbers to whom it was important to live in a certain locality, and to make the question definite they had dealt especially with one district; but he believed an equally strong case could be made out for the dwellings in many other quarters. In reply to the question put by Mr. Manuel, he thought the only way of insuring good building was that the persons engaged in it should build for investment and not for speculation. The circumstances under which the houses were built should be such that the builders should have an interest in the wholesome and satisfactory investment of their money, and then buildings would be put up substantially and with judgment. At present, the conditions under which most London houses were built were inimical to anything like solidity of construction. With regard to the number of persons to be accommodated on a given area, he believed that generally speaking it would be about double those under the present system. Of course there would not be so many bedrooms, nor such large offices in the basement; but taking it for granted that the tenants would be satisfied in convenient and comfortable sitting-rooms, and with as many bedrooms as were necessary for a moderate family, it would be possible for very nearly, if not quite, twice as many families to occupy a given site as at present. It was on that footing they rested the economy of the proposition, because both the erection

and maintenance of the buildings, working the lifts, &c., would necessarily be more expensive. By having rent from a greater number, however, these expenses would be met, and greater comfort would be obtainable for the same outlay.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

April 5.—"The Cultivation in India of Caoutchouc-yielding Trees," by Clements R. Markham, Esq., C.B. The chair will be taken by Vice-Admiral Erasmus Ommanney, C.B., F.R.S.

April 12.—*No Meeting.*

April 19.—"The So-called Deposits of Onyx near Mexico, and their Value as a Decorative Material in this Country," by W. Eassie, Esq., C.E., F.L.S., F.G.S.

April 26.—"Sericiculture in Australia," by Mrs. Bladen Neill.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

April 21.—"The Sanitary Progress of India," by Captain Douglas Galton, C.B.

May 5.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

May 26.—"Thaumatodendra, or the Wonders of Trees in India," by William Tayler, Esq., late Commissioner of Patna.

Chemical Section.

Friday evenings at 8 o'clock. The following arrangements have been made:—

March 31.—"The Methods of Estimating the Illuminating Power and Purity of Coal Gas." By A. Vernon Harcourt, Esq., M.A., F.R.S. The Right Hon. Lord Aberdare will preside.

April 28.—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne.

Cantor Lectures.

Monday evenings at 8 o'clock. Third Course, "On Wool Dyeing," by George Jarmain, Esq.

Lecture IV.—April 3rd.

Logwood and other woods, and their application to the dyeing of wool and woollen fabrics.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. George Jarmain, "Wool Dyeing." (Lecture IV.)
Farmers' Club, Salisbury-square, E.C., 5½ p.m. Mr. J. Trask, "Local Taxation."
Royal Institution, Albemarle-street, W., 2 p.m. General Monthly Meeting.
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. James Steel, "Air Compression."
Royal United Service Institution, Whitehall-yard, 8½ p.m. Capt W. de W. Abney, "Magneto-Electric Lights."
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Resumed Discussion on "The New Valuation Bill."
Medical, 11, Chandos-street, W., 8 p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Mr. J. E. Howard, "Egypt and the Bible."
London Institution, Finsbury-circus, E.C., 5 p.m. Dr. Tidy, "Poisoned Air."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. Garrod, "Classification of Vertebrated Animals." (Lecture XII.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on "The Treatment of Sewage."
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.
Photographic, 5, Pall-mall East, S.W., 8 p.m.
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Mr. A. H. Garrod, "Notes on the Anatomy of *Plotus anhinga*." 2. Mr. Edward R. Alston, "The Genus Dasyprocta. With Description of a New Species." 3. Messrs. Sclater and Salain, "New Bolivian Birds."

Wed. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. Clements R. Markham, "The Cultivation in India of Caoutchouc-yielding Trees."
Geological, Burlington House, W., 8 p.m. 1. Rev. J. Magens Mello, "The Bone-caves of Creswell Crags." 2. Prof. W. Boyd Dawkins, "The Mammalia and Traces of Man found in the Robin Hood Cave." 3. Mr. Horace B. Woodward, "Notes on the Gravels, Sands, and other Superficial Deposits in the neighbourhood of Newton-Abbot." 4. Mr. R. N. Worth, "Certain Alluvial Deposits associated with the Plymouth Limestone."
Microscopical, King's College, W.C., 8 p.m.
Pharmaceutical, 17, Bloomsbury-square, W.C., 8 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m.
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.
Entomological, 11, Chandos-street, W., 7 p.m.

Thurs...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Mr. G. J. Romanes, "Peculiar Varieties of Medusæ." 2. Dr. Francis Day, "Fishes of the Deccan." 3. Mr. C. H. Wade, "Venous System of Birds." 4. Dr. J. D. McDonald, "New Trematodæ and Hirudinei."
Chemical, Burlington House, W., 8 p.m. 1. Mr. Groves and Dr. Stenhouse, "Note on the Action of Sulphuric Acid on Napthalene." 2. Prof. Thorpe, "Notes from the Laboratory of the Yorkshire College of Science." 3. Dr. Armstrong, "Systematic Nomenclature." 4. Dr. Messel and Mr. Squire, "The Manufacture of Sulphuric Acid on a Large Scale, Experimentally Illustrated." 5. Mr. Watson Smith, "The Action of Certain Metallic Chlorides on Benzene, Toluene, and Napthalene, at High Temperatures."
London Institution, Finsbury-circus, E.C., 7 p.m. Mr. E. Dannreuther, "Richard Wagner and the Nibelungen Ring." (Lecture II.)
Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Spottiswoode, "Polarised Light." (Lecture IV.)
Institution of Naval Architects (at the House of the Society of Arts). Morning Meeting at 12 o'clock. Opening Address by the President (Lord Hampton). Papers and Discussions on "Ships of War." Evening Meeting at 7 o'clock. Papers and Discussions on "Merchant Shipping."
Royal Society's Club, Willis's Rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.

Fri.......Institution of Naval Architects (at the House of the Society of Arts.) Morning Meeting, at 12 o'clock. Papers and Discussions on "Material and Designs for Naval Construction." Evening Meeting at 7 o'clock. Papers and Discussions on "Screw Propulsion and Marine Engineering."
Royal United Service Institution, Whitehall-yard, 3 p.m. Rev. Edmond Warre, "Ancient Naval Tactics."
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Mr. E. W. Taylor, "Ordeals and Oaths."
Geologists' Association, University College, W.C., 8. p.m.
Philological, University College, W.C., 8 p.m.
Archæological Institution, 16, New Burlington-street, W., 4 p.m.

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Mr. E. Dannreuther, "Wagner and his Trilogy."
Physical Science Schools, South Kensington, S.W., 3 p.m.
Institution of Naval Architects (at the House of the Society of Arts). 12 a.m. Concluding Meeting.
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, APRIL 7, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

HEALTH AND SEWAGE OF TOWNS.

The Conference on this subject will take place, as already announced, on May 9th and 10th. The Executive Committee have received a large number of answers to the queries issued, and these are now being digested, so that the information may be presented in a form suited for easy comparison. There yet remain some towns from which no replies have been received, and it is hoped these omissions will be repaired as soon as possible. A Sanitary Conference will also be held by the British Medical and the Social Science Associations on May 11th and 12th, in the Rooms of the Society of Arts.

The following circular of questions has been issued to the Mayors, Town Clerks, Chairmen of Boards of Health, Medical Officers and others engaged in sanitary work in England and Wales. The circular was issued the beginning of last month.

Questions to which replies are requested by the Executive Committee for the use of the Conference, to be held on the 9th of May next, at 11 o'clock. It is requested that answers may be sent before 31st March instant. (By Order)

P. Le Neve Foster, *Secretary.*

1. Name of city, town, or other locality.
2. Population of last Census.
3. Death-rate in 1875.
4. State how the water-carried sewage is dealt with.
5. How many water-closets used?
6. When water-closets are used, what treatment does the sewage undergo or has it undergone by filtration, precipitation, or farming? State if not under any treatment as at Manchester, &c. Also how many years has the treatment been in action? If abandoned please state when.
7. What has been the total cost of construction to the locality for sewers up to the end of 1874?
8. What has been the annual outlay for maintenance?
9. What was the net annual cost of dealing with the sewage in 1875?
10. What method in water sewage has been found successful as respects preventing the pollution of rivers, commercially and otherwise?

Does your sewage contain any manufacturing refuse?

11. State how night soil is dealt with.
12. Are the ashes mixed with the night soil?
13. How many middens, ash-pits, pails, tubs, and the like, known as "dry methods?"
14. When by the dry method, what processes are adopted to get rid of the products?
15. What has been the gross cost of disposing of the night soil in 1875?
16. What have been the roceipts in 1875?
17. State the cost of the scavenging distinct.
18. What has been fonnd in your locality to be the best method of disposing of the night soil in respect of cleanliness and profit?
19. Are there any obstacles, either social or legislative, which impede the progress of improvement in the sanitary condition of your locality, and if so what are they?
20. Can you offer suggestions for the removal of them?
21. What has been the cost of legal proceedings in respect of sewage in any form, and how many injunctions have been obtained against your locality?
22. State any additional facts which you consider desirable to be discussed.
23. Please forward copy of your last report.

ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal for 1876, early in May next. This medal was struck to reward "distinguished merit in promoting Arts, Manufactures, or Commerce," and has been awarded as follows:—

In 1864, to Sir Rowland Hill, K.C.B., "for his great service to Arts, Manufactures, and Commerce, in the creation of the penny postage, and for his other reforms in the postal system of this country, the benefits of which have, however, not been confined to this country, but have extended over the civilised world."

In 1865, to his Imperial Majesty, Napoleon III., "for distinguished merit in promoting, in many ways, by his personal exertions, the international progress of Arts, Manufactures, and Commerce, the proofs of which are afforded by his judicious patronage of Art, his enlightened commercial policy, and especially by the abolition of passports in favour of British subjects."

In 1866, to Professor Faraday, D.C.L., F.R.S., for "discoveries in electricity, magnetism, and chemistry, which, in their relation to the industries of the world, have so largely promoted Arts, Manufactures, and Commerce."

In 1867, to Mr. (now Sir) W. Fothergill Cooke and Professor (afterwards Sir) Charles Wheatstone, F.R.S., in "recognition of their joint labours in establishing the first electric telegraph."

In 1868, to Mr. (now Sir) Joseph Whitworth, F.R.S., LL.D., "for the invention and manufacture of instruments of measurement and uniform standards, by which the production of machinery has been brought to a state of perfection hitherto unapproached, to the great advancement of Arts, Manufactures, and Commerce."

In 1869, to Baron Justus von Liebig, Associate of the Institute of France, Foreign Member of the Royal Society, Chevalier of the Legion of Honour, &c., "for his numerous valuable researches and writings, which have contributed most importantly to the development of food-economy and agriculture, to the advancement of chemical science, and to the benefits derived from that science by Arts, Manufactures, and Commerce."

In 1870, to M. Ferdinand de Lesseps, "for services rendered to Arts, Manufactures, and Commerce, by the realisation of the Suez Canal."

In 1871, to Mr. (now Sir) Henry Cole, C.B., "for his important services in promoting Arts, Manufactures, and Commerce, especially in aiding the establishment and development of International Exhibitions, the development of Science and Art, and the South Kensington Museum."

In 1872, to Mr. Henry Bessemer, "for the eminent

services rendered by him to Arts, Manufactures, and Commerce, in developing the manufacture of steel."

In 1873, to M. Michel Eugène Chevreul, "for his chemical researches, especially in reference to saponification, dyeing, agriculture, and natural history, which for more than half a century have exercised a wide influence on the industrial arts of the world."

In 1874, to Mr. C. W. Siemens, D.C.L., F.R.S., "for his researches in connection with the laws of heat, and the practical applications of them to furnaces used in the Arts; and for his improvements in the manufacture of iron; and generally for the services rendered by him in connection with economisation of fuel in its various applications to the Manufactures and the Arts."

In 1875, to M. Michel Chevalier, the distinguished French statesman, "who, by his writings and persistent exertions, extending over many years, has rendered essential service in promoting Arts, Manufactures, and Commerce."

The Council invite members of the Society to forward to the Secretary, on or before the 16th inst., the names of such men of high distinction as they may think worthy of this honour.

PROTECTION OF SHIPS FROM FIRE.

A meeting of this Committee was held on the 31st instant. Present—Vice-Admiral Erasmus Ommanney, C.B., F.R.S. (in the chair), Lord Alfred S. Churchill, Donald Currie, and F. Davison, with P. Le Neve Foster (Secretary).

CHEMICAL SECTION.

A meeting of this Section was held on Friday, March 31st, Dr. Odling, F.R.S., in the chair.

The paper read was—

SOME METHODS OF ESTIMATING THE ILLUMINATING POWER AND PURITY OF COAL GAS.

By A. Vernon Harcourt, M.A., F.R.S.

Reader in Chemistry at Christ Church, Oxford, and one of the Metropolitan Gas Referees.

It is well known that coal gas which has been purified from sulphuretted hydrogen is not free from sulphur, but retains, chiefly in combination with carbon, a quantity of this element, varying from ten to forty grains in 100 cubic feet. It is commonly believed that the small quantities of sulphurous and sulphuric acid produced by the burning of coal gas distinguish it unfavourably from other illuminants, and hence there is a general wish among both the consumers and producers of gas to remove as far as possible the last traces of sulphur.

Sulphuretted hydrogen is one of the few substances for whose presence, even in very small quantity, we have a test which anyone can apply, which is quick and conclusive. The existence of such a test has no doubt contributed greatly to the development of a system of purification, by which coal gas, at least in London, is always and absolutely freed from sulphuretted hydrogen. In his endeavour to purify gas from other sulphur compounds the manufacturer has no test so handy as the strip of lead-paper, to bear witness at once when the purifying material needs renewal. Increased facility of testing might lead, in this case also, to the discovery of better methods of purification or to a better management of existing methods.

While endeavouring to turn to account for the purification of gas the effect of heat upon it, which converts the bi-sulphide of carbon in gas into sulphuretted hydrogen, it occurred to me that a test might be based on the same principle.

I have here a glass tube filled for two inches with a plug of platinum wire and foil. I am passing gas through it, but as the gas is pure from sulphuretted hydrogen it does not affect the paper moistened with solution of acetate of lead upon which the gas is blowing. Now I heat the tube, and you will soon have evidence of the presence of sulphur in the gas.

This, however, is only a qualitative test, or, at most, the rate at which the paper darkens furnishes a very rough indication of the amount of sulphur in the gas. In the case of an impurity such as sulphuretted hydrogen, which is to be wholly removed, a qualitative test of this kind is all that is required. But, as no means are known of arresting completely the other compounds of sulphur, and all that can be done is to reduce their proportion as low as possible, a qualitative test is insufficient. What is required, as a guide in managing the process of purification, is a rapid quantitative test.

To fulfil this requirement, I propose to substitute, for the lead-paper with the gas blowing upon it, a solution of lead, through which the gas shall pass in small bubbles. All the sulphuretted hydrogen in the portion of gas operated on is thus arrested; and, through the mixing of the liquid, an uniform colour is obtained, whose shade the eye can compare with that of a similar portion of a standard coloured liquid. If the passage of the gas is continued until the tint, which grows continually darker, matches that of the standard liquid, a definite and ascertainable quantity of lead sulphide must have been formed, containing a known quantity of sulphur, and that derived from a known volume of gas. The larger the volume of gas that must be passed before this tint is attained, the smaller, in exact inverse ratio, is the proportion of bi-sulphide of carbon in the gas.

To prepare a lead solution which gives a clear tint instead of becoming turbid when acted on by sulphuretted hydrogen, I dissolve litharge in caustic soda, and add a relatively large quantity of solution of sugar. For each testing, a little of the solution thus prepared is mixed with twenty or thirty times its volume of water.

For a standard of comparison, I have tried various colouring matters. Any red, yellow, and blue seem to give a brown. Cochineal, caramel, and indigo, rightly proportioned, matched the tint of the coloured lead solution very satisfactorily; and the appearance of the liquid did not change perceptibly from day to day; but, after some weeks, I found that my result had varied, and that the gradual fading of the standard colour was the cause. Since then I have used a mixture of the three sulphates of copper, cobalt and iron, substances which are perfectly stable. To imitate a dark shade which the coloured lead solution has, probably owing to the sulphide of

lead not being really dissolved, but rather suspended in a state of minute division, I add a trace of lamp-black to the standard liquid.

Unfortunately, the coloured lead solution and the standard look differently by daylight and by gaslight, and, through the change of light, they become extremely different one from another. I have, therefore, prepared another standard for use by gaslight, and it happens conveniently that a mixture of the sulphate of cobalt and copper serves the purpose.

The volume of gas which has been operated upon is known with sufficient accuracy by reading off the volume of water which has run from the aspirator into the measuring vessel placed beneath. The standard has been made such, that to impart the same tint to the same volume of lead solution, there is required 0·0025 grain of sulphur. From this datum, and the capacity of the measuring cylinder, I have calculated a table giving the number of grains of sulphur in one hundred feet of gas corresponding to each graduation.

The apparatus in the form in which I have it here is probably familiar to some who are present, as I brought it before the meeting of the British Association of Gas Managers at Leeds last summer, and my account of it was published in the *Journal of Gas Lighting*. But quite recently a suggestion made to me by Mr. Wills has led to an improvement in the apparatus, which may, I hope, help to justify me in giving this further account of it.

Mr. Wills suggested to me to use platinum as the heated material over which the gas should pass, he having observed that the development of sulphuretted hydrogen occurred at a lower temperature when the gas was in contact with platinum, than when it is heated otherwise.

Such an action of platinum upon mixtures of gases is familiar to chemists by many examples, and I can only plead in defence of the comparatively bulky and inconvenient form which my test has assumed hitherto, that I designed it, in the first place, not for laboratory use, but to illustrate a chemical fact, which I hoped to turn to account on a large scale for the purification of gas. Those who have used it must, I think, have convinced themselves that when gas is passed through a layer of heated pebbles, the sulphur contained in it, with the exception of 8 or 9 grains in 100 cubic feet, is converted into sulphuretted hydrogen, and can, therefore, be easily removed.

If any others have had this test in operation, as I have, continuously for several months, they will also have convinced themselves that the action of the heated surface upon the gas may be continued for an indefinite time, if the temperature is not allowed to rise too high, and if, at intervals of one or two months, air is drawn through the apparatus.

Experimenting with this larger object in view, I made trial only of common materials which it was practicable to use on a large scale. Perhaps it is impossible that so costly a metal as platinum should be used in gas manufacture, especially where the object in view is only a slight improvement in the quality of the article manufactured. But it is possible to employ costly materials for common uses where, as in the use of gold on paper-hangings, a little goes a long way. Substances which can be dissolved, may be spread over an indefinitely large surface, by wetting the surface with their solution. Mr. Deacon has thus applied copper to the manufacture of chlorine. Whether or not the action of heated platinum on gas may hereafter find any more extended application, it serves exceedingly well the purpose of this test. It may be used by leading gas through either a piece of glass tube packed with platinum wire, or a bulb filled with pumice which has been steeped in chloride of platinum and ignited.

I have now in the second place to direct your attention to certain methods of estimating the illuminating power of coal gas. Such methods divide themselves into two kinds; those in which the amount of light obtainable from a given volume of gas is, by some means, directly estimated, and those in which it is inferred from some other property of the gas.

Of the latter, which I may call indirect methods, one of the best, but the most troublesome, is the complete analysis of the gas. This demands a special and somewhat complicated and fragile apparatus, and considerable manipulative skill on the part of the operator. Improvements in the methods of gas analysis have considerably reduced the length of the operation, but it can hardly occupy less than three or four hours.

Some information, but of rather uncertain value, is to be derived from the determination of the specific gravity of the sample of gas.

Absorption by bromine of the olefines, to which chiefly the illuminating power of gas is due, is an operation which can be easily and quickly performed, and which should give trustworthy, though not very exact, indications of the relative value of different samples of coal gas.

The simplest and most trustworthy of the indirect methods are those which depend upon the relation between the quality of different samples of gas burning under the same conditions, and the size of the flame which they produce. The size of the flame is most easily observed by giving it the form of a long, narrow column as in Lowe's jet photometer. The samples of gas to be compared may be burnt when issuing either at the same pressure, or at the same rate. Or else the length of flame may be kept constant and the required pressures or rates of consumption compared. The last-named modes of operation are those employed in Messrs. Kirkham and Sugg's form of the jet photometer, and in the "duration" test. Still another mode of making the same comparison has recently been proposed by Mr. Sugg, who has been kind enough to lend me his illuminating power meter to show here this evening. In this instrument the gas is set to burn from an Argand burner with a flame three inches in height. It can be made either to pass through the meter or not; and in the upper part of the meter case is a minute clock. The index of the meter having been stopped at the top of the scale, gas is sent through the meter for one minute by the clock, and then turned off again, the flame being constantly maintained at the height of three inches. According as the gas is richer or poorer, the index of the meter will have travelled a less or greater distance; and the dial-plate is so graduated and numbered, that from the place at which the index has stopped, the illuminating power of the gas may be read off.

Direct observations of the illuminating power of different samples of gas have hitherto been made by a judgment of the eye, comparing under conditions favourable to exact observation the relative brightness of the flame produced by the sample of gas and of a standard light.

Within the last year, however, two substitutes for the direct judgment of the eye have been suggested, founded upon the observation of two physical properties of light. The facts which have been observed in both cases are of transcendent scientific interest; but I must here confine myself to the proposed practical applications of them to photometry.

The element selenium is a substance so incapable of conducting electricity that it has been used as an insulator in telegraphy. Three years ago Mr. Willoughby Smith observed that its power of insulation was impaired by exposure to sunlight. Since then this effect of light has been examined by Dr. Werner Siemens and Professor Adams.

Unfortunately the effect of light upon the electric conductivity of selenium varies according to the temperature to which the selenium has been exposed, and the mode of cooling; moreover the effect of light gradually diminishes, and after prolonged exposure the selenium needs to rest in darkness for a length of time before its sensibility is fully restored. The most comparable results are obtained by observing the maximum effect produced when a piece of selenium, inserted in a galvanic circuit, comprising a battery and a galvanometer, is exposed to various sources of light for a few moments. Professor Adams employs a piece of crystalline selenium which is exposed to different sources of light successively, for ten seconds, and observes the maximum deflection of the needle of the galvanometer. Dr. Siemens arranges the ends of two fine wires in a spiral or zigzag form, so that within a small space each may be close to the other, without touching, for a considerable length. By covering the interlacing spirals or zigzags with a drop of molten selenium, pressed into a thin sheet between two leaves of talc, the wires are connected throughout this length by a surface of selenium.

The sensitiveness of the selenium element thus prepared is admirably shown by an apparatus designed by Dr. C. W. Siemens, which he has kindly lent me for this evening. In it the selenium element plays the part of the retina of the eye; in front of it is a lens to bring the rays of light to a focus upon it, and beyond this a pair of metal eyelids closing by a spring, which preserve the selenium retina from the fatigue it would experience if constantly exposed to light.

Dr. Werner Siemens compares the light from two sources by so adjusting their distance from the selenium disc that, when it is exposed to each in rapid succession, the deflection of the galvanometer remains unchanged.

Selenium thus employed is said to be unaffected by the obscure heat rays, but to be affected by the red end of the spectrum in a greater degree than corresponds to the impression produced by that part of the spectrum upon the human eye. This defect may be remediable, as Dr. Siemens suggests, by interposing a sheet of glass with a green tinge. But a difficulty which must be overcome before any physical effect of light is accepted as a substitute for its impression upon the eye, is that of proving an exact correspondence between the physical and optical effects.

This vacuous globe containing the finely poised discs, which revolve rapidly when brought near a lamp, has already become familiar. It is called by its inventor, who is also the discoverer of the repulsive force exercised by radiant heat and light, a radiometer. Mr. Crookes has ascertained that the difference between the repulsive effect exerted upon the black and white surfaces of the discs, respectively, as measured by the rate of rotation, varies directly with the amount of light or radiant force falling upon them. Two candles, for example, at any given distance produce twice the rate of rotation which is due to one, and the effect upon the instrument of a given light varies inversely as the square of its distance.

But in this case, much more than as affecting the electric conductivity of selenium, radiant light needs to be separated from radiant heat, before the motion due to its repulsive force can be employed as a measure of illuminating power. Through the kindness of Mr. Crookes, I am able to show you the instrument which he has devised for comparing the amounts of light, separated from the rays of greater and less refrangibility, issuing from two or more sources. A pith beam, suspended horizontally in a vacuous globe by a single fibre of silk, is blackened on both sides, for half its length. When light falls upon one side of this beam, the blackened half recedes, and in the absence of other forces, the beam would set itself with its white end pointing towards the light. To the centre of the beam are attached, in a transverse direction, a small magnet and mirror. The former serves, when a magnet is placed beneath the apparatus, to make the beam assume a particular position, from which it can be displaced more or less, by the incidence of a stronger or weaker light on one side, but to which it returns when no longer solicited by other forces. The latter serves, by reflecting a pencil of light on to a scale some distance off, to render evident a small displacement of the beam. If two sources of light are placed on each side of the beam, such and at such distances that no displacement occurs, the amounts of radiant force emanating from each and acting on the two sides of the beam are equal. In order that the forces thus compared may be due to radiant light only, two glass cells with parallel sides are filled with solutions of sulphate of quinine and of alum, to cut off the invisible rays at each end of the spectrum.

Errors of observation in judging of the relative brightness of the two sides of a partially translucent disc may hereafter be got rid of by the adoption of one or other of the methods which I have attempted to describe. But two problems remain, a satisfactory solution of each of which is more necessary to the establishment of a trustworthy system of photometry than the substitution for the disc of some more absolute criterion of illuminating power.

The first problem is, what standard shall be used for the measurement of artificial light; the second, what burner shall be used in testing the illuminating power of coal gas.

The present unit, as defined by Act of Parliament, is a sperm candle of six to the lb., burning 120 grains an hour. This is convenient as an unit, since the light given by different lamps and gas-

burners may be described, without the use of high numbers or of decimals, as a light of 10, or 15, or 20 candles. But without further definition it is by no means satisfactory as a standard, since the light which a candle gives depends not only upon the material of which it is made and the rate at which it burns, but also upon the construction of the wick. Some differences of opinion exist among those experienced in candle photometry as to the extent of fluctuation to which the results thus obtained are liable. According to my own experience, sets of observations made one after the other with the same sample of gas, and with candles from the same packet, often agree very closely, and seldom differ to the extent of one candle. Occasionally, however, without any apparent cause, the results are more divergent; and I have found a considerable difference in the results and in the degree of uniformity with different packets of candles obtained from different dealers. What the burner is to gas, its wick is to a candle; and just as the definition of the illuminating power of gas has been unsettled by improvements in the burner used for testing, so it may also be altered by the application of similar attention and skill, on the part of the candle maker, to the conditions under which the maximum illuminating power can be developed from the combustion of 120 grains of sperm per hour.

If it be possible, as I hope to show that it is, to furnish a more constant standard of comparison for artificial lights than the sperm candle, the term candle might still be retained as the name of an unit otherwise defined, just as "foot" has come to be the name of an exact measure.

In Paris the photometric standard is the Carcel lamp, burning colza oil at a given rate. Some years ago Mr. Keates proposed the use of sperm oil, and I understand that such a lamp has recently been constructed on an improved principle by him and Mr. Sugg. I have not personally made trial of any of these lamps, but probably they give a light more constant and more comparable with that of a gas flame than is the light given by a pair of candles. At the same time, the very fact that an improved form of lamp has recently been constructed—if, as I believe, the improvement relates not only to the constancy but to the illuminating power of the lamp—suggests the likelihood that one standard lamp might differ in some degree from another, and that further improvements might gradually creep in. With a lamp, as with a candle, the wick is a most important element, and one which it is exceedingly hard to fix or define.

It was to meet the uncertainty as to the construction of the wick—and also that as to the composition or purity of the liquid fuel—that Mr. Crookes devised this little lamp which he has kindly lent me. Its wick consists of a certain number of platinum wires of a certain size. The liquid which burns is a mixture of two pure substances, alcohol and benzol. The light is said to be much more constant than that of a candle; but the flame in its present form is too small to be conveniently compared with that obtained from gas burning at the rate of five cubic feet an hour.

At present, I think it must be admitted that the problem of devising a satisfactory photometric standard, which can easily be obtained at different places, and is easily applied, and is such that when prepared with due care, absolute confidence may be placed in its uniformity, has still to be solved.

Upon this problem I have been working at intervals during the last two or three years, and though I am still occupied with the work and have not yet completed it, I may be permitted to lay before you the results at which I have arrived, and to show what would be the operations required for testing the illuminating power of coal gas under the system which I propose.

In place of candles or lamps I propose to use a standard gas. As no single gas exists which is suitable, a mixture of gases must be employed; and that which I believe to be most suitable is a mixture of hydrogen with pentane or with pentane and hexane. The two substances last named constitute the most volatile portion of American petroleum. Under a pressure of one atmosphere pentane is a liquid at temperatures below 30° C., and hexane at temperatures below 68° C.; but under a pressure of one-tenth of an atmosphere, and probably under somewhat greater pressures, both these substances are gases. To reduce the pressure upon them, and also to reduce their illuminating power to that of ordinary coal gas, they must be mixed with another gas. I have tried both air and hydrogen for this purpose, and I prefer hydrogen for the following reasons. A smaller quantity of petroleum, in about the proportion of two to three, is needed with hydrogen than with air for the same illuminating power, and thus the petroleum gas is under a less pressure, and further from its point of condensation. The gas prepared with hydrogen has about the same specific gravity as coal gas, and therefore, presumably, the same burner is suitable for both, whereas the gas prepared with air is, of course, heavier than air. In preparing the standard gas with air, a meter must be used to measure its volume, and corrections applied for the variations of barometer and thermometer, whereas by acting on an excess of zinc with a known weight of sulphuric acid, a quantity of hydrogen is obtained, which is accurately known without the need of either measurement or correction.

The following, according to Cahours, are the constituents of petroleum boiling below 100° C.:—

Pentane, $C_5 H_{12}$, sp. gr. at 17° C., 0·628, boiling point, 30°.

Hexane, $C_6 H_{14}$ sp. gr. at 16° C., 0·669, boiling point, 68°.

Heptane, $C_7 H_{16}$, sp. gr. at 16° C., 0·6995, boiling point, 92° to 94°.

Starting with the lightest petroleum which is obtainable commercially, I have rectified it with the following results. The composition of the samples is calculated on the supposition, which is probably nearly correct, that by rectification below 65° heptane may be excluded.

Petroleum	rectified	below 45°	sp. gr. at 15°,	0·635
„	„	45°—55°	sp. gr. „	0·647
„	„	55°—65°	sp. gr. „	0·664
„	„	below 65°	sp. gr. „	0·646

		Below 45°	45°-55°	55°-65°	Below 65°
Composition of samples	Pentane	82·9	53·7	12·2	56·1
	Hexane	17·1	46·3	87·8	43·9

The proportion of hydrogen, which must be added to the hydrocarbons to produce gas of con-

stant illuminating power, will vary slightly according to the composition, or specific gravity, of the sample of petroleum employed. It is on this point chiefly, a point of capital importance, that I need still to make further experiments. I have worked chiefly with the sample whose specific gravity is 0·646.

To prepare standard gas I employ the following apparatus:—A flask of from 3 to 4 litres capacity, into the mouth of which a thistle-funnel and elbow-tube pass through a plug of india-rubber; a wash-bottle of about a litre capacity; a gas-holder capable of containing 7 or 8 cubic feet; one or more graduated vessels for measuring out the required quantity of dilute sulphuric acid; a Winchester quart, fitted with pinchcock and inlet-tube for air, to hold the measured quantity of acid and deliver it by degrees into the generating flask; a pipette of 70 or 100 cubic centimeters capacity, to measure the required dose of petroleum, and deliver it into the wash-bottle.

The operation of preparing standard gas is as follows:—The flask is filled one-third with granulated zinc, and connected with the wash-bottle, two-thirds of which is filled with water. About 100 cubic centimetres of dilute acid is first poured upon the zinc, which generates sufficient hydrogen to sweep out air from the flask. When the evolution of hydrogen has ceased, which requires about half an hour, the wash-bottle is opened and the pipetteful of petroleum discharged into it, after which the wash-bottle is at once closed and connected with the gasholder. The Winchester quart, holding the measured volume of dilute acid, is supported in an inverted position, and its pinchcock is so adjusted that the acid may flow in a rapid succession of drops into the generating flask. Hydrogen passes in a rapid stream through the water in the wash-bottle and through the layer of petroleum which floats upon the surface of the water, and the mixed gases pass on into the holder. From this point the operation needs no further attention. When all the acid has run in, the evolution of hydrogen gradually diminishes, and almost ceases by the time that the liquid, heated by the action, has become cold. The gasholder then contains the whole of the petroleum which was taken, and a quantity of hydrogen which is also exactly known, since the sulphuric acid has saturated itself with zinc and consequently has yielded 1-49th its weight of hydrogen.

The water in the wash-bottle serves to prevent any acid spray passing to the holder, to provide a level floor for the evaporation of the petroleum, and to furnish the heat which the petroleum needs to pass from the liquid to the gaseous state. The absorption of heat, as the petroleum volatilises, reduces the temperature of the contents of the wash-bottle considerably below that of the surrounding air. Consequently the standard gas is formed at a temperature below that to which it is afterwards subjected. In spite of this reduction of temperature, the whole of the petroleum has generally disappeared when two-thirds of the hydrogen has passed over. Consequently the standard gas is formed under a pressure exceeding by at least ¼th that to which it is afterwards subjected. It is therefore a permanent gas under any conditions to which it is likely to be exposed.

I have here two similar tubes, standing vertically in a vessel of water, which have been filled to the same level, one with air, the other with standard gas. When ice is placed round them, so that their temperature falls to 0°, the contraction is the same in both cases, showing that the standard gas behaves like a permanent gas, and that no liquid petroleum is condensed out of it.

The dilute sulphuric acid which I have employed has the specific gravity 1·217, and contains 0·352 grains of pure sulphuric acid in 1 cubic centimeter. It may be made, approximately, by mixing 26·5 volumes of oil of vitriol with 100 volumes of water. The strength of the dilute acid is unimportant, provided it be exactly known, and provided it is not such that sulphate of zinc crystallises out and hinders the action of the acid.

It will be seen that the adjustment of the illuminating power of the gas is thus practically brought, with an acid of known strength and a particular sample of petroleum, to a question of rightly proportioning the volume of acid to the volume of petroleum. The following are some of the results I have obtained with acid of the above-mentioned strength and petroleum distilled below 65° and having the specific gravity 0·646. The numbers given under the head of illuminating power are in most cases the mean of four or five different sets of observations made with different samples of standard gas prepared according to the same recipe.

Vol. of Dilute Acid. Sp. Gr. 1·217.	Weight of pure Sulphuric Acid	Weight of Hydrogen.	Weight of Petroleum.	Ratio of Petroleum to Hydrogen by weight.	Illuminating power (candles).
c c.	Grams	Grams.	Grams.		
1680	593	12·07	45·22	3·75	14·5
1640	579	11·78	,,	3·84	15·2
1615	570	11·6	,,	3 9	15·9
1610	568	11·57	,,	3·91	15·97
1605	567	11·53	,,	3·92	16·1
1580	558	11·35	,,	3·98	16·6

Hence it appears that a mixture of one part by weight of hydrogen and 3·91 parts by weight of light petroleum, form a gas of 16 candles' illuminating power. I propose the use of this gas as a photometric standard. It consists of 90·9 volumes of hydrogen and 9·1 volumes of gaseous petroleum. It contains in one litre 0·265 grain of carbon. It is easily prepared of constant composition, and in any required quantity.

I have still to determine what modification needs to be made in the proportion of hydrogen, that is, of dilute acid employed, with samples of petroleum of different specific gravities. Probably it will be possible to connect by a simple formula the specific gravity of any sample of light petroleum with the proportion of sulphuric acid which must be used with that sample, in order to furnish 16-candle standard gas.

It remains for me to describe briefly the form of photometer which Mr. F. W. Hartley has arranged for me, in which to compare the sample of gas to be tested with the standard gas. It corresponds to the ordinary open photometer, with a 60-inch bar, except in the following particulars.

Both ends are furnished with similar "London"

argand burners, with the usual appliances for measuring and regulating the current of gas, all in duplicate. By a suitable arrangement of cocks either sample of gas may be sent into either meter, and thus to either burner. The centre line of the bar is numbered 16, and two scales having this line in common are drawn out, one beneath the other, so that the position of the pointer which travels with the disc can be read upon each.

One scale is to be used when the standard gas is burning on the right, and indicates the value in candles of the gas compared with it; the second scale is the reversed image of the first (corresponding to it as the image of an object in a mirror does to the object), and is to be used when the standard gas is burning on the left. When a reading has been made on one scale, the samples of gas are to be reversed and a second reading made on the other scale. The geometric mean of these two readings is the true illuminating power of the sample of gas tested, depending for its accuracy upon the quality of the standard gas, but independent of variations of temperature and pressure, and of all inequalities in burners, meters, or disc.

Comparing thus directly one gas with another it is likely that the nature of the burners employed will make little, if any, difference, at least where the gas tested has nearly the same illuminating power as the standard gas. If so, an indirect but important advantage that would accrue from the adoption of this method is, that a question which has been hotly debated, as to what kind of burners ought to be employed in testing the illuminating power of gas, would disappear altogether.

DISCUSSION.

The Chairman, before inviting discussion on the paper, desired to pay a brief tribute to the memory of the late Dr. Letheby, who was one of the pioneers in this branch of applied chemistry, and the first by whom any continuous series of examinations was made on behalf of any public body. In fact, the greater part of the development which the subject had since received was due to Dr. Letheby's early exertions. He was known familiarly to many present, and he (Dr. Odling) having been associated with him in many ways, could safely say that no interest entrusted to him was ever neglected, whilst he always acted with the utmost loyalty to all those associated with him. He wished particularly to call the attention of practical men to the great utility and availability of the sulphur test proposed by Mr. Harcourt, which could be used to determine the proportion of sulphur compounds in any gas by an experiment lasting from ten to twenty minutes. The various artificial modes of measuring light, by the means proposed by Dr. Siemens and Professor Adams on the one hand, or by Mr. Crookes on the other, were also very interesting and important, while the method now proposed by Mr. Harcourt for determining the illuminating power by means of a standard gas appeared very promising.

Mr. Livesey said the sulphur test, devised by Mr. Harcourt, had been in use at the South Metropolitan Works for the last six or seven months, and he had found it very useful, though it might not be quite so accurate as the ordinary official test. He had generally found it give higher results; for instance, in a number of testings by Mr. Harcourt's process the results were, highest 20, lowest 17, average 18 grains per 100 cubic feet, whilst with the official test the figures were, highest 17, lowest 15, average 16 grains. He could not refer to the sulphur test without expressing his conviction that no injurious effects were produced by any quantity of sulphur compounds ever found in gas, and it had been demonstrated that in the worst possible case the proportion of sulphurous acid gas present in the air of a room would be about one part in 500,000, which reduced the matter to an absurdity, and it had, in fact, been found that whenever public authorities carried on gas works themselves they were by no means anxious to introduce clauses into their Act, providing for a high standard of purity in this respect. The use of lime did not entirely remove the sulphur compounds, while it created a great nuisance in the neighbourhood, and often produced blindness in the men working the lime purifiers. The question of the illuminating power of gas was of far greater importance, though he feared the public did not regard the testing of gas with very much respect, and still less would they depend on the very delicate processes of Dr. Siemens and Mr. Crookes which had been proposed. Probably Mr. Sugg's standard flame would be most satisfactory, or Mr. Harcourt's standard gas, testing one gas with another. With regard to burners, the Act of 1868 said the companies would have the benefit of any improvements introduced into burners, but he did not think that was quite fair to the public, any more than it would be for an oilman to lower the quality of his oil in proportion to the improvements in lamps. They were all much indebted to Mr. Harcourt for the useful work he had been doing, and having conducted some experiments for him on a large scale, he had much pleasure in saying that Mr. Harcourt did not only give his orders, but came to the works and took part in carrying them out himself.

Mr. Trewby bore testimony to the great discrepancies which were found in candles, so that any means which could be devised for getting rid of this source of error would be a great boon both to gas companies and the public.

Mr. C. Woodall desired to confirm Mr. Livesey's statement as to the great value of Mr. Harcourt's sulphur test. The official test extended over twenty-four hours, and within that time the whole condition of affairs at a gas works must undergo a total change. By this charming little apparatus, however, they could watch the operations going on within the purifiers from hour to hour. He could hardly feel much confidence in the proposition made to test gas by means of another gas prepared in the way described. Similar attempts hitherto had not been successful in producing a gas likely to maintain its quality for a length of time, and the preparation of it continually would be very troublesome. Mr. Harcourt said the gas was permanent, and of course his statement had great weight, but it would be well to have the matter further investigated. He had looked for the last month or two with the greatest interest to the possible result of Mr. Crookes' discovery, and thought there was a considerable probability that a photometer might be constructed on that principle which would be satisfactory both to manufacturers and consumers. The advantages were similar to that in Mr. Sugg's illuminating power meter without the difficulties as to registering the exact height of the flame; and it would save the two elements of error most conspicuous in the present system—the variation in the observing power of different persons' eyes, and also the extreme variety in the quality of the candles. A short time ago he had experimented with a candle sent from Russia, which Mr. Wills pronounced to be pure sperm, and found that it gave, from 105 grains of sperm, exactly the same light as that obtained by 120 grains of ordinary standard sperm candles. If such candles were introduced into testing offices, it was evident they would have a very injurious effect on the gas company

Mr. Wills said his suggestion to Mr. Harcourt to substitute platinum for the pebbles in the sulphur test, was made in consequence of a few experiments he had made with Mr. Harcourt's first apparatus, which he found liable to crack with heat and get out of order. He naturally thought of platinum, on the account of its well-known catalytic action in bringing about the combination, and in some cases the decomposition of gases. It answered admirably, the desired result being obtained at a much lower temperature. He would further suggest that an air-bath should be substituted for the gas flame, by which a constant temperature would be maintained. 300° was quite high enough to bring about the decomposition of the bisulphide of carbon in the gas and convert it into sulphuretted hydrogen, and if the temperature could be kept constant, and the gas passed at a fixed rate, very accurate results might be obtained. From some little experience in gas-testing, he could endorse all that had been said about the varying character of candles, and some experiments he had made went to show that when the candles were burning less than 120 grains per hour they gave proportionately more light than when burning at a greater rate. Thus, he found that testing gas by two candles which burned a little over 41 grains in ten minutes, and by a pair which burned only 38 grains, he found a difference of more than one candle in the quality of the gas. Thus, it might happen that if a gas company were supplying gas very near the minimum quality, and it were tested by a pair of candles burning at less than the proper rate, it would be returned as below the standard; whereas, if it were tested with a pair of candles burning above the normal amount, it would be returned as over the standard. Testing the candle received from Russia against an ordinary gas-testing candle, he found that if the two were burning about the same amount of sperm in the same time, the Russian candle gave more light proportionately; but if the common candle were burning from 1 to 1½ grains less per ten minutes, the difference was imperceptible. It had occurred to him, and he had previously suggested to Mr. Harcourt, that the illuminating power of gas might be estimated by determining the amount of carbon which it contained. The colourless flame of an ordinary Bunsen burner could be converted into a luminous flame by shutting off the supply of air, and it struck him that, by determining the amount of air required to obtain a non-luminous flame with a certain volume of gas, you would obtain a true measure of its illuminating power, and that if an apparatus could be constructed so as to give this with accuracy, a very fair standard would be obtained.

Mr. Fewtrell had been rather surprised that the name of the Rev. W. Bowditch had not been mentioned in connection with the decomposition of bisulphide of carbon, and the formation of sulphuretted hydrogen at a temperature of 300°, though he used clay instead of pebbles. With regard to the composition of a standard gas, he should like to know a little more about it, and should doubt the value of any comparative test unless pure olefiant gas were employed as the standard, for he did not believe in mixtures of petroleum and hydrogen. That process, however, would be very expensive, and in the meantime he should stick to candles, which he did not think could be surpassed for regularity. He had had 40 candles burning at a time, and had never found a great difference between them. It was a curious point in reference to Mr. Crookes' radiometer, that he found two candles gave exactly double the effect of one, and this seemed to show that candles were more to be relied on than some were disposed to think. He desired to express his opinion that Mr. Harcourt's sulphur test was a most convenient and useful one for gas managers.

Mr. Hartley, while he did not believe that any serious injury could arise from the presence of sulphur in gas in any proportion in which it was likely to be found, was also aware that the public demanded that it should be as free from it as possible, and therefore practical men were much indebted to scientific men who furnished them, in the first place with the means of determining the quantity of sulphur, and secondly, with the means of removing it. Though he had not had an opportunity of using Mr. Harcourt's sulphur test, he had seen it used, and it was certainly a very valuable apparatus to the gas maker. In the course of his practice in photometry, he had not found such great discrepancies as other gentlemen had stated; in fact, he would not allow them to occur. If he found a candle burning indifferently he rejected it, and selected another. He had on many occasions obtained similar results within a grain of a candle, at two places more than a mile apart; and on one occasion at West Ham, he found that at a distance of four or five miles from the works, there was practically no loss of illuminating power. Granting you could obtain a standard gas, no doubt it would have its advantages, but there were difficulties in the way. Having had a great deal of experience with petroleum, he found that with water gas—a compound of hydrogen with carbonic acid and a little carbonic oxide—its permanent character was very great, and it might be sent an enormous distance. In one experiment he sent it through one mile of main, and found no appreciable loss, though the main was laid in an open field, and was exposed to a temperature of about 38°. At the same time there was a possibility that some deposit might take place in the gasholder in which it was stored, and though infinitesimal at the time it might be cumulative, and under a change of barometric conditions, some portion that had been thrown down must be given off from the surface of water, and render the gas more rich than usual. He did not mean to suggest that Mr. Harcourt had carried out his experiments so imperfectly as not to have arrived at satisfactory conclusions on these points, but it would be well to have them stated more clearly.

Mr. Methven thought if this permanent standard gas were manufactured in the operating room, whilst that which had to be tested travelled some distance through the mains, there would be a difference of temperature which would affect the results.

Mr. Harcourt, in reply, said he did not apprehend that any difficulty would be found in manufacturing the standard gas, and the simplicity of the operation could be seen in the apparatus at work. From the moment when the tap was turned, so that sulphuric acid began to flow into the bottle containing the zinc, nothing further needed to be done until the gas was wanted for use. If the process ever came into use, he should propose that the gas examiner should be furnished with two small holders, and that shortly before making the testings he should charge the bottle with a certain quantity of standard acid, put in a measured quantity of petroleum, open the cock, and leave it to next day. Whether it furnished an exact result or not, he did not think there could be any difficulty in it. The distinction between the object aimed at in this method and in Mr. Crookes' torsion apparatus, was very plain. Mr. Crookes proposed a substitute for the screen of the photometer, but what he proposed might be used either with the screen, or with Mr. Crookes' pith bar, being simply a substitute for the candles as a standard. Mr. Wills had referred to a point on which he had made a number of experiments, viz., the possibility of judging the illuminating power of gas by mixing it with air, but though he had had a very complete apparatus made for the purpose, he did not find it answer. He passed the air and gas through two meters, mixed them thoroughly, and was able to read off exactly the quantity of each, but he found that this proportion was not independent of the absolute quantities which were being used. At first he thought, with Mr. Wills, that a certain kind of gas mixed in a certain quantity of air would give a non-luminous flame but this did not prove to be the case,

the reason being that gas burning in a Bunsen burner had not only the oxygen of the air mixed with it to assist in the combustion, but also a certain quantity derived from the external air, and the amount of this would vary with the size and shape of the flame. When at a previous time he had gone more fully into the question of sulphur compounds than he had had time for on the present occasion, he had mentioned the experiments of Mr. Bowditch, but he thought that gentleman had been under a little misapprehension, in insisting too much on the action of the lime which he used, because any other heating material would have produced the same effect. One gentleman thought olefiant gas was the only proper gas to use as a standard, but in this he could not agree. Olefiant gas was to a considerable extent soluble in water, and the solubility differed according to the temperature, and therefore a mixture containing olefiant gas, if stored in an ordinary gasholder over water, would vary with the temperature of the room. It was also much more troublesome to make, while he could not see that it had any advantage over the mixture he had employed; which at the reduced pressure was thoroughly permanent. The mixture contained about 91 parts of hydrogen to 9 of petroleum vapour, so that the latter was under a pressure of only about one tenth of an atmosphere. He had not tried directly the effect of any considerable alteration of pressure, but it would be very easy to do so, and no doubt advisable. He felt little doubt, however, that with a liquid with so low a boiling point, which showed no perceptible variation when reduced to the freezing point, its volume might be reduced to a much greater degree than ever happened in ordinary atmospheric fluctuations without any of it being converted into liquid. At the same time he agreed that this point ought to be definitely ascertained before such a method was accepted. He felt little doubt, however, that you might increase the pressure upon the gas from 30 inches of quicksilver up to 32 or 33, without producing any greater variation in volume than would be seen in an equal volume of hydrogen or air. With regard to the temperature, it was ordinarily assumed that the temperature of gas was measured by that of the meter through which it passed; there was no reason to suppose that it brought with it the temperature of the works from whence it came. Besides, any variations due to temperature which no doubt did affect the light of candles would be entirely eliminated, because the temperature of two meters close together would be the same, as would also the barometric pressure under which the two flames were burning.

The Chairman proposed a cordial vote of thanks to Mr. Harcourt, both for the labour he had devoted to these important problems, and for the pains he had taken to bring the results clearly before them. The sulphur testing apparatus was no doubt familiar to them all, though not in so simple and compact a form as it was now presented, nor had they before seen so simple an apparatus for making a gas of constant composition. There could be little doubt that the hydrogen being saturated to only a very limited extent with petroleum vapour, so that the latter was only under a pressure of 1-10th of an atmosphere, the gas would be permanent under ordinary changes of temperature and pressure. He had no doubt that if Mr. Livesey would undertake to bring forward the public policy of the gas Acts, the Society would afford him an opportunity of doing so, though he had felt that it did not come within the scope of that evening's discussion. He could not agree with some of the speakers as to the high merits of candles as a standard, for his own experience led him to the conviction that all improvements in gas testing short of the introduction of a new standard would be almost labour thrown away. He did not dispute the results obtained by Mr. Hartley, but he thought a candle standard was very much like a yard measure of india-rubber, those who were very skilful in its use might manage to stretch it pretty evenly, but it might easily be made to measure less in one place and more in another.

The vote of thanks having been passed unanimously,

Mr. Silber proposed a similar vote to Dr. Odling for his kindness in taking the chair.

Mr. William Woodall seconded the motion, which was also carried unanimously, and the proceedings terminated.

EIGHTEENTH ORDINARY MEETING.

Wednesday, April 5th; Vice-Admiral Erasmus Ommanney, C.B., F.R.G.S., F.R.S., Vice-President of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Baldock, John Henry, F.L.S., F.C.S., South Norwood, S.E.
Jettes, J. F. L., 4, Amyand-road, Twickenham.
Luck, Thomas F., 24, Walbrook, E.C.
Macnie, John, Gas Works, Londonderry.
Payne, Alfred, Ettingshall, Wolverhampton.
Phipps, Richard, Spencer-parade, Northampton.
Tidman, Edward, Middlesborough, Yorkshire.
Wadeson, James, Goswell-house, Windsor.
Woodall, William, Burslem.

The following candidates were balloted for and duly elected members of the Society:—

Arteaga, Alberto de, 9, Austin Friars, E.C.
Brown, Samuel Stanley, 19 and 20, Cornhill, E.C.
Dougall, Archibald, Kidderminster.
Hille, Fritz, Chiswick.
Jevons, William Stanley, Withington, Manchester.
Kimber, Henry, 79, Lombard-street, E.C.
Marston, John, 24, Bradford-street, Birmingham.
Montefiore, Sir Moses, Bart., F.R.S., F.R.G.S., F.R.A.S., 35, Park-lane, and East Cliffe-lodge, Ramsgate.
Moon, J. F., 39, King Henry's-road, N.W.
Moon, Robert, M.A., 45, Cleveland-square, Hyde-park, W.
Salaman, Nathan, 41, Gordon-square, W.C.
Sanford, Henry Ayshford, 29, Chester-street, Belgrave-square, S.W.
Swain, Thomas Septimus, 5, Addison-crescent, Kensington, W.

The paper read was—

THE CULTIVATION OF CAOUTCHOUC-YIELDING TREES IN BRITISH INDIA.

By Clements R. Markham, C.B., F.R.S.

The necessity for cultivating any vegetable product, for which there is a great and increasing demand, is sufficiently obvious in itself, and has been proved in several instances. When such a demand arises, permanent reliance cannot be placed on the supplies to be obtained from trees growing in a wild state. Under such circumstances there is reckless destruction without an attempt at reproduction, and, literally, the supply becomes more precarious exactly in proportion as the demand increases.

The conversion of such products from a wild to a cultivated state is, therefore, one of the most important operations in connection with the advancement of commerce.

One such operation, which was undertaken just seventeen years ago this very day, has been completely successful. On the 5th of April, 1859, I submitted my scheme for the collection of plants

and seeds of the various species of the febrifuge chinchona plants in South America, and their introduction into India. At that time chinchona plants were uncultivated, the bark was collected in the South American forests, and the trees were rapidly disappearing over wide areas, owing to reckless felling. Now there are extensive chinchona plantations, yielding larger percentages of febrifuge alkaloids than the trees ever did in their wild state, and extending over the Nilgiri hills, the lower slopes of the Sikkim Himalaya, and the higher ridges of Ceylon. From these plantations, some belonging to Government, others to private companies, about 140,000 lbs. of bark are annually imported into this country, and the yield is rapidly increasing. The results of the measure are very satisfactory. The permanent supply of an indispensable medicine has been secured, it has been brought within the reach of millions who formerly could never procure it, thousands of lives will be saved, and the material wealth of India and Ceylon will be increased by the addition of a valuable product to their list of exports.

I had the honour of reading a paper before the Society of Arts, on the subject of chinchona cultivation in India, on the 25th of March, 1863, at a time when the undertaking had just been fairly launched. Now we see it crowned with complete success; and we may derive, from the excellent results of the enterprise undertaken to convert the chinchona trees from a wild to a cultivated state, the conclusions that, under like circumstances, the necessity for a similar measure will exist, and that, by benefiting from former experience, equally successful results may be secured.

There is another vegetable product which is in the same position as the chinchona bark: the demand rapidly increasing, while the only source of supply is from trees growing wild in the forests. In 1870, I came to the conclusion that it was necessary to do for the india-rubber or caoutchouc-yielding trees, what had already been done with such happy results for the chinchona trees. The area of yield of caoutchouc is far more extensive than that of febrifuge bark. While the trees yielding quinine and the febrifuge alkaloids only grow wild on the slopes of the Andes, and all belong to one genus, the caoutchouc yielding trees are of several genera, and are found in the forests of India, the eastern Archipelago, Africa, Madagascar, Mexico, and Nicaragua, as well as in South America. But the same danger threatens the one product as had threatened the other. Owing to the enormous demand for caoutchouc, the most reckless felling is now going on in all the tropical forests which yield this valuable product. The time has come when plantations must be formed of caoutchouc-yielding trees, in order to prevent their eventual destruction, and to provide for a permanent supply.

The increase in the demand for india-rubber is very remarkable, and the enormous number of uses to which this product is now put renders the consideration of measures for its cultivation, and for securing the permanency of an adequate supply, a question of great moment. In 1830 only 464 cwts. of india-rubber were imported into this country. In 1840 the quantity had increased to 6,640 cwts.; and in 1846 the duty on india-rubber of 1s. per cwt. was repealed. In 1857 the quantity had further increased to 22,000 cwts.; and in 1874 there were 129,163 cwts. imported into this country, worth £1,326,605. Caoutchouc is now used for an infinite number of purposes. Wherever steam-power is employed, either on shore or afloat, it is impossible to do without india-rubber. It is required as packing for the piston-rods and glands of the engines, valves for the pumps, washers for making joints, belting for driving the shafting, hose and tubing for conveying steam and water, buffer-springs for railway carriages, and many other such purposes too numerous to mention. When it is considered that every steam vessel afloat, every railway train, and every factory on shore employing steam power, must of necessity use india-rubber, it is hardly possible to over-rate the importance of securing a permanent supply, in connection with the industry of the world.

For purposes connected with telegraphy this product is also now extensively used. It is employed as the insulating material for submarine, subterranean, and aerial cables. In the hard form of ebonite it is employed for insulators to carry the iron wire along the posts, as well as for battery cells, for the electro-magnetic coils, and in many parts of telegraphic instruments in place of the more expensive article, ivory. India-rubber is also used for waterproof clothing, carriage aprons, fishing stockings, diving dresses, water and air beds and cushions, door mats, ground sheets in camping out, and tubing. India-rubber elastic thread is largely used in the form of webbing, by the Leicester, Derby, and Nottingham manufacturers. India-rubber is necessary, too, for life-saving apparatus, for surgical instruments and appliances, and for hose, gas-tubing, and innumerable domestic purposes, including door-springs, and, just now, a great many rings for the rinking skates. Ebonite—which is the form of india-rubber vulcanised hard by the addition of extra sulphur, so that it can be turned in a lathe and made into articles of any form or shape—is used very extensively for combs, photographic baths and trays, syringes, taps and tubing for aquaria, and in chemical works.

Such being the infinity of purposes which give rise to the demand, it will easily be understood how bravely the work of destruction is being carried on. In British India there is an indigenous caoutchouc-yielding tree, which should be brought under cultivation on the spot. But there are other kinds in other parts of the world, and it became necessary, in the first place, to ascertain whether they are superior to the caoutchouc in British India; for, if so, their introduction would needs be an essential part of any scheme for initiating the cultivation.

The caoutchouc-yielding trees grow in a zone on each side of the equator, encircling the globe, but by far the richest and best source of supply is in South America. It was M. de la Condamine, the leader of the expedition to measure an arc of the meridian near Quito, who first gave an accurate description of caoutchouc, and of the tree from which it is procured. The tree is the *Siphonia* or *Hevea*, which grows in all parts of the basin of the Amazon, and yields the Brazilian caout-

chouc. This is the best and most abundant, and is known as Pará india-rubber. The *Hevea* is a euphorbiaceous tree.

On the western side of the equatorial region of South America, in Ecuador and Colombia, on the isthmus of Panama, Central America, and Mexico, the india-rubber tree belongs to the *Castilloa* genus, so named after Don Juan del Castillo, a Spanish botanist, who died in Mexico in 1793. The native name of the tree in Mexico is *ulé*. The *Castilloas* belong to the family of *Artocarpaceæ*, of which the bread fruit and jack tree, and the *angelli* of India are members. It is worthy of note that the *Artocarpaceæ* are closely allied to the *moraceæ*, the fig tribe, to which the caoutchouc trees of India belong. The *Heveas* and *Castilloas* are the india-rubber trees of the New World.

In India the *Ficus elastica*, a tree so named by Dr. Roxburgh in 1810, which yields caoutchouc, is found in the forests which border the valley of the Brahmaputra, in the province of Assam. The family of *Apocynaceæ* includes the other caoutchouc-yielding trees of Asia and the eastern islands—the *Chavannesia* of British Burma, the *Urceola* of Borneo, and the *Vahea* of Madagascar, as well as the *Landolphias*, which produce the caoutchouc of Africa.

In commencing caoutchouc cultivation in India, it was in the first place necessary to take stock of all existing knowledge on the subject, and in the second place to ascertain whether any of the other kinds were intrinsically superior to the *Ficus elastica*, because if this proved to be the case, their cultivation in India would also be desirable.

With these objects in view, the duty of making the necessary researches and investigations was entrusted to Mr. J. Collins, formerly curator of the Museum of the Pharmaceutical Society, who drew up a very able and exhaustive report on the subject in 1872. The conclusions then arrived at were that the establishment of plantations of *Ficus elastica* should at once be undertaken in Assam; but that the caoutchouc from the *Heveas* and *Castilloas* of South America was superior to that of the *Ficus*, and that consequently those trees, as well as the *Vahea* of Madagascar, should be introduced into British India.

The first step, therefore, was to commence the cultivation of the native Indian caoutchouc tree, which is found in the forests along the northern and eastern boundaries of Assam, as well as in the low valleys of the Naga and Jynteah hills to the south. The *Ficus elastica*, like the banyan and other trees of the same genus, has aerial roots, and is of an epiphytical habit. When wild in the forests it often commences its growth in the fork of another tree, which it eventually overshadows and destroys. It grows to a great size, and one tree planted at Tezpur in Assam, 32 years ago, is 112 feet high, the diameter of the crown measures 140 feet, the circumference of the central mass of aerial roots surrounding the stem is 70 feet, and it has over a hundred aerial roots, the largest of which measures six feet in girth. The forests containing *Ficus elastica* are excessively moist in the rainy season, and they remain moist all through the dry season with a temperature of about 98° in the shade. The trees thrive best under conditions of excessive moisture and great heat, but with good drainage.

Hitherto the caoutchouc has been collected in Assam by men of the wild tribes, who cut every part of the tree they can get at, and allow the milk to flow into holes made in the ground. The collectors are encouraged to obtain the largest possible quantity during the shortest possible time, without any regard to future supplies. This has led to the most outrageous wholesale destruction of these valuable trees, by felling them so as to render the operation of tapping more convenient. Messrs. Martin and Richie, who had a lease of the caoutchouc yield at Tezpur, are said to have given it up before their time expired, because the supply had diminished so much that their business was no longer remunerative.

So that no improvement of the yield can be expected from private enterprise, except at the risk of exhausting the remaining sources of supply; and it is consequently necessary to place the collection of caoutchouc in Assam under the control of public officers who have an interest in the protection and improvement of the forests; and to commence the formation of plantations of *Ficus elastica* on a large scale, and in accordance with a well considered plan. Dr. Brandis, Inspector-General of Forests in India, strongly urged the necessity of these measures in 1872; and good progress has since been made, under the superintendence of Mr. Gustav Mann, the Conservator of Forests in Assam.

The first attempts, which were started in July, 1873, in the Darjíling Terai and in the Goalpara district of Assam, were failures, but in July, 1874, Mr. Gustav Mann took charge of the experiment with very satisfactory results. Two plantations were formed, one on the right bank of the river Kulsi, in the Kamrúp district of Assam, which is eventually to consist of 100 acres; and the other at Charduar, at the foot of tho Himalaya, 18 miles north of Tezpur, in the Durrung district of Assam, which now covers 180, and is eventually to cover 400 acres. In 1875 there were 1,790 live cuttings at the Kulsi, and 16,401 at the Charduar plantation. The first attempt failed owing to the seedlings and cuttings having been placed under shade, where the drip of the trees caused excessive wet about the roots. No artificial shade is now given, and the young trees are healthy and vigorous. Experiments are in course of trial, to plant the *Ficus elastica* in strongly made baskets placed in the forks of trees, and on grass lands, as well as in the regularly prepared beds. The trees may be tapped at the age of 25 years. After 50 years they will yield 40 lbs. of caoutchouc every third year, worth £3 4s. At present the quantity of caoutchouc annually exported from India is 16,000 cwts., valued at about £110,000, or £6 14s. 9d. per cwt. Of this quantity 12,000 cwt. goes to England and the rest to the United States.* Besides extending the cultivation of the trees, the officers in charge of the plantations will carefully investigate all such questions as the most favourable time of the year for tapping, and the

* Caoutchouc exported from British India during the last six years:—

1870— 6,584	cwts.,	valued at	
1871— 9,006	,,	,,	
1872—15,638	,,	,,	
1873—21,571	,,	,,	
1874—16,837	,,	,,	£117,775
1875—15,893	,,	,,	£108,618

best methods of collecting and preparing the caoutchouc. The experimental cultivation of *Ficus elastica* has thus been satisfactorily commenced in India, and, under the able superintendence of Mr. Gustav Mann, there can be no doubt of its success.

Another caoutchouc-yielding plant belonging to the *apocynaceæ*, has recently been discovered in British Burma, and reported upon by Mr. Strettell of the Forest Department. It is the *Chavannesia esculenta*, one of those creepers which it has hitherto been the object of foresters to extirpate, as injuring the growth of the teak trees. Some of these creepers, growing near Rangoon, have a girth of 18 inches round the stem, while the crown covers an area of 200 square feet, at a supposed age of five years. It may be propagated either from seeds or cuttings; and instructions for its cultivation have recently been published in the *Indian Agriculturist.* The estimated result of cultivating trees, thirty feet apart over an area of 400 acres, or in all 19,200 creepers, is that there will be an annual yield of 19,200 *viss*,* which, at 200 Rs. per 100 *viss*, will give 38,400 Rs. a year. After the first year, the cost of cultivation will be very slight, and the profits will begin to come in after seven years.

As regards the cultivation of indigenous kinds of caoutchouc-yielding trees in British India, it will thus be seen that the initiatory steps have already been taken. The second, and not the least important part of the undertaking, is the introduction of plants yielding a better kind of caoutchouc from other parts of the world, but especially from South America.

The most valuable trees, and those which now yield by far the largest quantity of india-rubber, are the *Heveas* of the Amazon valley, called Pará, from the port of shipment. We learn from Keller, that, during the last few years, both the quantity and the value of india-rubber exported from Pará has been steadily increasing. In 1874, England received 56,580 cwts. of Brazilian caoutchouc, worth £720,000; the average price being 2s. 10d. to 3s. a lb. Next to the Pará rubber in value and yield, comes that obtained from the *Castilloa* trees, which grow over a much wider area of South and Central America. The quantity of *ulé*, or *Castilloa* caoutchouc, imported into England in 1874, was 24,286 cwts., worth £287,413, at 2s. a lb. Thus out of the whole import of 129,163 cwts., 70,866 come from South America.

The remaining 38,755 cwts. is divided among British India, Borneo (1s. 9d. a lb.), Africa (1s. 5d. a lb.), and Madagascar (2s. 3d. a lb.).† But the South American source of supply is, beyond comparison, the most important, and the cultivation of *Castilloa* and *Hevea* trees into India is a most important part of the undertaking.

Several reasons led me to the decision that a collection of the *Castilloa* seeds should first be obtained. As the *Castilloas* grow over a much more extensive area than the *Heveas*, where there is a greater variety of soil and climate, it is more certain that suitable sites for their cultivation will readily be found in India and Burmah. They belong, too, to the *artocarpaceæ*, which are so well represented in India, especially on the Malabar and Travancore coasts, by the jack trees and the *angelli*, of which wood all the canoes are built.

The *Castilloa* trees flourish in all the equatorial forests on the west coast of South America, and in 1873 the quantity of india-rubber exported from Guayaquil was 10,690 cwts., worth £42,760. The trees also abound all over the Isthmus of Darien, where they are being destroyed most recklessly, in Central America, and in the southern states of Mexico. In Ecuador the india-rubber is called *heve*, in Mexico and Central America the Aztec word, *ulé*, is used.

The trees, which are the giants of equatorial American forests, belong to two species, the *Castilloa elastica*, and that which Mr. Collins has named *C. Markhamiana*. They thrive in dense, steaming, and warm forests, and are particularly abundant in the valley of the San Juan de Nicaragua, where it rains for nine months in the year. In Nicaragua the yield is said, by Mr. Collins, to be about 10,000 cwts., giving employment to 600 *huleros*, or collectors. From Carthagena, Guayaquil, Panama, and Vera Cruz are exported supplies of *ulé* india-rubber, the greater part of which goes to the United States; but it has been seen that as many as 24,286 cwts. arrive in this country.

The collection of *Castilloa* plants for introduction into India was a very difficult service, for the trees grow in wild and unhealthy forests, with no means of transit, and no facilities of any kind. In Mr. Robert Cross we have a man who has all the requisite qualifications for undertaking it. He is an excellent gardener, possessed of great energy and determination, combined with great judgment, is well acquainted with the language, and has had great experience in South American travelling. I first employed him in 1859, to assist Mr. Spruce in the collection of chinchona plants of the red-bark species in the forests of Ecuador. In 1862 I again employed him to go to Ecuador, and he made an invaluable collection of crown-bark chinchona plants in the forests of Loxa. I have since twice engaged his services to obtain plants of the chinchona species in the forests of New Granada, in which he succeeded, after encountering most formidable difficulties. In conveying the plants in a healthy state from their almost inaccessible native forests to this country, he has invariably been successful. No better man could have been found to execute the difficult task of obtaining a supply of *Castilloa* plants, and conveying them in a healthy state from their native forests to the gardens at Kew.

Mr. Robert Cross left England on the 2nd of May, 1875, and reached Panama on the 26th of the same month, my instructions to him being to endeavour to make the collection on the isthmus. He found that great destruction was going on among the *ulé* trees in all parts of the Darien isthmus, as the native collectors cut down the trees in order to tap them more easily, as is the case in the Assam forests. After collecting all the information that could be procured in Panama, Mr. Cross determined to select the forests on the banks of one of the large tributaries of the river Chagres as the base of his operations.

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* A *viss* is about 3½ lbs.

† Imports of caoutchouc into England, in 1874, from

South America	70,866 cwts.
India	9,341 ,,
Borneo, &c.	7,101 ,,
Africa	6,380 ,,
Madagascar	5,984 ,,

He ascended the Chagres river in a canoe, and then made a journey on foot through the dense forest, into the heart of the *ulé* district. He found the *Castilloa* saplings growing on the banks of streams, with their roots often running down to the edge of the water. They abound in rich soil along the base of the hills, and are also met with on the summits of ridges; everywhere, except in swampy ground. The trees, which proved to be of the species named by Mr. Collins *Castilloa Markhamiana*, are from 160 to 180 feet high, with a diameter of 5 feet, and a yield of 100 lbs. of india-rubber. The wood is spongy and soft, and decays rapidly when bruised or injured. Many of the leaves measure 14 inches in length, and 7 inches in breadth. The temperature of the forests ranges from 75° to 88° Fahr., and they are excessively damp. The range of the *Castilloas* is so wide that, in some places, the trees must flourish in climates which at one time of the year are dry. It is probable, however, that the species with the best and largest yield of caoutchouc flourish best in a hot and very damp and steaming atmosphere, like that of the forests of the isthmus.

Mr. Cross collected 600 plants, and also drew a quantity of milk, in order to prepare a specimen of the rubber. The sample he brought home has been examined and reported upon, and it is pronounced to have much less impurity than is usual for this kind of rubber, and thus proved Mr. Cross's plants to be of the best species. He left the isthmus with the plants on the 6th of September, 1875, on board the mail steamer *Shannon*, but in the morning of the 8th, when going 13 knots an hour, the vessel ran on the Pedro reef of rocks, off the coast of Jamaica, and her bows were immoveably fixed upon them, while the stern continued to bump heavily for many hours. The rest of the passengers left the ship in boats, but Mr. Cross stuck manfully by his plants and was eventually taken on board H.M.S. *Dryad*. He came home in the mail steamer *Nile*, reaching Southampton on the 2nd of October. Considering all the extraordinary difficulties of the undertaking, it reflects great credit on Mr. Cross that he should, for a fifth time, have been completely successful, and thus have performed an important public service with ability and success. There are now 134 of Mr. Cross's *Castilloa* plants in a most flourishing condition at Kew Gardens, and in the course of the spring a good supply of *Castilloas* will be forwarded to India, where they will form the nucleus of a series of extensive plantations.

Thus the introduction of one out of the two valuable South America species has been provided for.

It remains to take measures for obtaining plants of the most valuable kind of all, from the valley of the Amazon—the *Hevea* yielding the famous Pará india-rubber of commerce.

The *Heveas* are of several species, and like the *Castilloas*, they are large trees growing in humid tropical forests. Mr. Spruce, who is the highest authority on this genus, considers that the cordillera of the Andes separate the *Castilloas* from the *Heveas*, and that the caoutchouc-yielding trees to the eastward of the Andes are of the latter genus. They extend up to the very foot of the mountains, and I have myself passed some time among *heveros*, collecting for local use in the *montanas* of Paucartambo and Laris. While in Peru and Ecuador the india-rubber is called *heve*, in Brazil the name is *seringa*, and the collectors are *seringueiros*. Eight species are enumerated by Collins, namely:—

Hevea	*Brasiliensis*	(Müll.)
,,	*Spruceana*	(Müll.)
,,	*Discolor*	(Müll.)
,,	*Pauciflora*	(Müll.)
,,	*Rigidifolia*	(Müll.)
,,	*Benthamiana*	(Müll.)
,,	*Lutea*	(Müll.)
,,	*Guyanensis*	(Aube.)

The *Hevea Brasiliensis* is the species which prevails round Pará, and the forests of the lower Amazon; *H. Spruceana* is met with round the mouth of the Tapajos, and the other species occur on the banks of the Rio Negro and Casiquiari; but the genus is far from having yet been thoroughly studied.

In the Pará district of the lower Amazon, very little rain falls from August to February, the heaviest rains being in May and June; and the temperature varies between 74° and 95° Fahr; the mean of a year being 81°. The Amazon valley is remarkable for uniformity of temperature, and for regular supply of moisture; the dry season extending from June to December, and the wet from January to May. In the upper Amazon the atmosphere is densely vaporous.

Our latest authorities on the Pará caoutchouc are Mr. Wickham and Mr. Franz Keller. The latter traveller, writing in 1874, says that the *Hevea* trees on the shores of the Amazon have nearly disappeared, owing to the destruction and death of trees, the places of which have never been filled up. But the forests of caoutchouc trees on the banks of the Madeira, Purus, and other tributaries yield over 1,600,000 lbs.; while the yield of the whole of this colossal river basin amounts to 12,800,000.* Keller laments the fact that no attempt is made, in the Amazon district, to cultivate these useful trees; which, owing to frequent tapping and rough treatment, suffer much and die soon. The *seringueiros* have to go further and further into the interior, to seek fresh trees in undiscovered valleys. It is to be feared that, owing to the indolence of the mestizo population, and the short-sightedness of the Brazilian Government, measures of conservancy will not be adopted until too late.

The *Castilloa*, like the *Ficus elastica*, though requiring a very humid climate, will only thrive when there is drainage at the roots. But Keller says that the *Hevea* yields the largest supply of milk when, during the annual inundation, its stem is at least five feet under water.

The scene presented by an encampment of caoutchouc collectors is extremely picturesque. Their huts are lightly built among the trees, and round them tower the majestic *mosqueteiro* palms, and the lofty *bertholletia*,† while in front is the gleaming river with its sunny sandbanks. From the huts narrow paths lead through the dense

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* Keller gives the following statement of the export of caoutchouc from Pará:—

1865 —	256,967	arrobas.	
1866 —	291,091	,,	
1867 —	301,170	,,	
1868 —	334,975	,,	
1869 —	365,354	,,	(4,568 tons.)

† *Bertholletia excelsa* yields the Brazilian nuts.

undergrowth, cut by the axe of the *seringueiro*, to the lonely caoutchouc trees. The collector makes small holes in the bark, to which tubes of clay are fixed, which lead the milk into bamboo receptacles; going from tree to tree he collects these bamboos, and on his return to the hut the contents are poured into the carapace of a large tortoise; the milk is then subjected to the process of smoking without delay, for if left standing too long the resin separates. In this process the milk is exposed to the smoke of the *urucury*, or nuts of the *Attalea excelsa** palm, which alone, it is said, possess the power of liquifying. An iron pot, without a bottom, and with a narrow neck like a bottle, is placed so as to form a chimney over a heap of these burning nuts, and the white steam rises in masses through the narrow openings. The *serinqueiro* pours a small quantity of the white fluid, of the consistency of thick milk, from a calabash over a light wooden shovel, as evenly as possible, and then rapidly thrusts it into the white steam. The milk soon takes a greyish-yellow colour, and becomes firm. Thus they add layer upon layer, until the caoutchouc on each side of the shovel is about 8 inches thick. The *plancha* or slab is then finished, taken off the shovel by cutting down one side, and hung up in the sun to dry, as there is a good deal of water between the layers. The colour of the *planchas* is at first a light silver grey, but by degrees becomes yellower and yellower, until it turns the dark colour known in commerce; a practised hand can, in this way, manufacture 5 or 6 lbs. in an hour. The thicker and freer from bubbles the better the quality, and the higher the price. The cheapest is called *surnamby*, or *cabeca de negro* (negro head), and is made from drops found at the foot of the tree, and from the refuse in the vessels.

Great improvements might no doubt be introduced, in the method of preparing caoutchouc, by consolidating with alum instead of the tedious process of smoking. The milk could be kept in a fluid state by adding a little ammonia; and in this condition it might be despatched at once in casks. But the old routine will continue on the Amazon until European factories are established. It will, I trust, be for British India to lead the way in such reforms, when plantations of *Hevea* trees are fully established.

The achievement of this great object—the introduction of *Hevea* trees in India from the Amazon valley, has yet to be accomplished. Efforts have been made to obtain seeds, and a few plants have been so raised at Kew and sent to Calcutta. But, like most euphorbiaceous plants, the seeds of *Hevea* are very perishable, and I was convinced there would be no real success until a special agent was sent to Para, and up the Amazon, to make a collection of plants.

I am happy to say that the Secretary of State for India has sanctioned the employment of Mr. Cross on this duty, and it is very certain that no man in England could be found who would be likely to perform it better. He will leave England next June, so as to arrive in the Amazon towards the end of the rainy season; and his instructions will be not only to collect and bring home a supply of healthy young plants, but also to make detailed observations on the habitat of the trees, and on the methods of tapping, and of preparing the caoutchouc.

There is a third india-rubber yielding tree of South America of less value, whence comes the Pernambuco caoutchouc. It is an apocyneaceous tree, the *Hancornia speciosa*, known as *mangiaba* by the natives, and is found in the provinces of Rio de Janeiro, Bahia, Pernambuco, and Goyaz. It is a small tree about the size of an apple, and is more valued for its fruit than for its caoutchouc, which is not much collected.

It remains to consider the best sites in British India for the cultivation of the *Hevea* and *Castilloa* trees. The mean temperature of the province of Para on the Amazon—between 73° and 81°—is the same as that in British Burma, and in Canara, Malabar, and Travancore, on the west coast of India. Dr. Brandis points out the moist evergreen forests at the foot of the Coorg ghauts in Malabar, and the Attaran valley in Tenasserim, as localities where the temperature is very nearly the same as that of Para. The annual rainfall on the lower Amazon is about 60 to 90 inches, which is less than that on the Malabar and Burmah coasts, where it is from 100 to 160 inches. But the chief difference is that the supply of moisture is more uniformly distributed over the seasons in the caoutchouc-yielding region of Brazil than is the case in the moist zones of India. Mr. Spruce found that the *Hevea* trees throve best in a humid climate where there are rarely ten days together dry, even in the so-called dry season. The nearest approach to this would be found in some localities in Ceylon; but the southern parts of the Malabar and Burmese coasts are also likely to suit the *Hevea* trees. The *Castilloas*, judging from their wide distribution in South and Central America, are likely to accommodate themselves to a wider range, as regards temperature and humidity, in India. They will probably thrive in Assam with the *Ficus elastica*, as well as in Burmah and on the west coast.

It will be well also to introduce the climbers, which will give an earlier return than the great forest trees of South America, though of inferior quality, such as the *Vahea* of Madagascar, the *Landolphia* of Africa, and the *Urceola* of Borneo. Plants of *Vahea* have already been obtained and sent to Calcutta, and this is a kind which has been found to yield very superior caoutchouc, ranking next in estimation to that of Pará.

Thus it will be seen that, so far as British India is concerned, the necessary measures have now been adopted with a view to securing the permanency of a large supply of the best caoutchouc. Plantations of the indigenous kind, the *Ficus elastica*, have been formed in Assam, and operations have been commenced there on an adequate scale, and in accordance with a well considered plan. An expedition was despatched last year to obtain a supply of plants of the *Castilloa* kind, from the isthmus of Panama, with a view to their introduction into India, which was completely successful, and a good stock of *Castilloa* plants is now at Kew, nearly ready for transmission to their final destination. Sanction has been obtained for

* There are 20 species of these beautiful palms in the Amazon valley. They yield the black fibre called *piassaba*, which makes excellent cordage. The nuts are excessively hard, and beautifully mottled with dark and light brown.

the despatch of another expedition to obtain a similar supply of plants of the *Hevea* from the Amazon valley. While the indigenous caoutchouc tree of India is being converted from a wild to a cultivated state, the better kinds of caoutchouc trees of South America are being collected for introduction into India, in order that they also may be cultivated, and the best situations for their successful growth have been considered. Our hope and trust is that these measures will be the means of conferring a lasting benefit on British India, and through India on the industry of the world.

[The paper was illustrated by a large number of specimens, lent by Mr. Silver.]

DISCUSSION.

Mr. Silver could not allow the opportunity to pass without saying how much he felt indebted to Mr. Markham for the way in which he had come forward on behalf of the india-rubber manufacturers. He had staked a good deal of his fortune on this important article, and he could not but feel how much depended on the quality of the material. It was too much the fashion to consider only what a thing would cost, instead of how long it would last, but this was a great mistake. The superior quality of the rubber from South America had been spoken of, and he could prove that by showing a specimen of a golosh, made of pure rubber, which could not be worn out; it was already perhaps 20 or 30 years old, whereas the ordinary goloshes would wear out in a few weeks. That superior quality of rubber was the kind of thing which should be introduced into India, and if Mr. Markham could succeed in his endeavours to do so he would be the best friend the manufacturer had ever had. Next to iron, he believed india-rubber was the most important of the appliances to all engineering purposes, and if so, it was evident that good quality was a primary consideration. Every month almost showed more and more the importance of india-rubber for manufacturing purposes. It would be necessary to consider the suitability of the climate and *habitat* selected for the plant, and he believed Assam would be found on the whole most suitable.

Dr. Beattie had rarely listened to so exhaustive an essay, and he felt sure that if the Secretary of State for India would interest himself in the matter, and the Commissioner for Assam give his attention to it, most valuable results would be obtained. No doubt the climate of Assam was best adapted to the growth of these trees, but he was also acquainted with a large district in Oude, at the base of the Nepaul hills, which produced trees of a gummy character, and where he believed the india-rubber tree might be grown successfully. There was not the same warmth as in Assam, but there was a great deal of moisture. The climbing plants would probably succeed well in Chittagong also. From his experience of the tea cultivation in Assam he feared there might be difficulty in finding sufficient and cheap labour, for the Assamese were very apt to run away at the first signs of an epidemic, quite regardless of any contract they had entered into. They were much indebted to Mr. Silver for exhibiting so many articles in india-rubber, and there was no doubt that the demand was steadily increasing for machinery of all kinds.

The Chairman said that amongst other purposes to which india-rubber was now being applied was that of coinage. Mr. Silver had brought two specimens of coins which were being made for South America to take the place of paper currency. He thought the coffee planters of Ceylon would be very glad to cultivate these trees on portions of their estates if they could obtain them.

Mr. Hancock, who had been connected with india-rubber as long as he could remember anything, said hardly anything had surprised him more, considering the enterprise of Englishmen, than that they had not devoted more consideration to this subject up to the present time. On several occasions he had brought forward, though not publicly by reading a paper, the immense importance of cultivating india-rubber and gutta-percha, and seeing that tea, sugar, coffee, and other articles of much less value were so largely grown, it did seem surprising that attention had not been paid to india-rubber and gutta-percha, which were worth from 2s. to 3s. 6d. per lb. Beyond the expense of providing the trees, and waiting for five or six years for the first return, he believed the results would be much more profitable than from many other articles which were extensively cultivated. The immense increase in the price of india-rubber had been referred to, and he believed it arose almost entirely from the wholesale destruction of the trees. In 1835, the best Pará rubber cost 6d. a lb., but it was now worth from 2s. to 2s. 9d., and though an increased demand might have something to do with it, the main cause was the greater distance the collectors had to go to get it, and the increased expense of bringing it to the port of shipment. It must be remembered that these genera, like all vegetable products, were subject to vicissitudes and changes, and if a good result was to be obtained, not only must the tree be of the best class, but the time and mode of collecting must be carefully attended to. If the gum were collected either before or after maturity, the quality would not be so good. Any person of experience in the manufacture could pick out from a large parcel a certain number of blocks apparently perfect, and of good quality, having evidently been collected from mature trees and dried with care; but he would also find others which were undergoing a process of rapid decay. If these were kept for a long time, the result in the case of india-rubber was that it turned gummy, or sticky, whilst gutta-percha became came dry and perfectly friable, readily crumbling to dust. He believed this arose from want of care in collecting and drying.

Mr. Pearsall had not yet heard any allusion to the question whether we were better or worse supplied than other countries. A large trade was done both in the United States and in France in india-rubber, and from some former investigations into the subject he was inclined to think that much of the irregularity in quality of the rubber coming to England arose from the fact that the quality was better looked after by purchasers in other countries, who would give any price for a first rate article, and that the best was rarely sent to England.

Mr. Ingram said the last speaker was quite correct, the Americans had the pick of the india-rubber produced. He had worked for the New York India-rubber Company, and the best Pará rubber they used was far superior to that obtained in England. A great deal was now brought from Africa and Madagascar, and some of it was but little better than dirt.

Mr. Routledge, as a paper maker, was a considerable user of india-rubber in connection with machinery, and could fully endorse what had been said as to the necessity for an improvement in the quality. Belting was now being largely employed in machinery, instead of gearing, but for some years past the quality of the india-rubber had been deteriorating, he feared in part from adulteration on the part of the manufacturers, owing probably to the scarcity and high price. The consequence was, that india-rubber belting was gradually being replaced by leather, though it was more expensive, and sometimes not so applicable, because where there was much steam about, as in a paper mill, it was apt to slip. Mr. Markham had alluded to the case of another raw material, esparto, which was becoming scarce from the same cause, the greed of the collectors; it was introduced many years ago, about the same time that the great

demand for india-rubber arose in connection with telegraphy and other matters, and coming rapidly into use, the Spaniards had killed the goose which laid the golden eggs, and instead of promoting the trade, exhausted the plant. Sir Titus Salt had a large drum at Saltaire, 30 feet in diameter, with a belt of 30 inches, but he had been compelled to use a leather belt on it, because he could not get india-rubber of sufficiently good quality. He had noticed the same fault in gutta-percha which Mr. Hancock mentioned, but had attributed it to adulteration.

Mr. Hancock said it arose partly from the material not having sufficient stamina, and partly from having been over-heated in the process of manufacture. Both india-rubber and gutta-percha were very sensitive to heat.

Mr. Routledge said a great deal of india-rubber was used, by all who employed steam power, for coupling up joints; but he found now that after a short time it became hard and went to pieces. Having cut up some and dissolved it, he found a considerable residuum, which he feared was mineral adulteration.

Mr. Hancock said there were india-rubber joints of different qualities. If you paid a fair price you could get a good article. No doubt in the case referred to by Mr. Routledge there was adulteration.

Mr. Routledge said asbestos was now being largely used instead of rubber for steam packing, because although less convenient it was more reliable.

Mr. Bailey said there was no difficulty in getting a good article at a fair price. India-rubber was not so scarce yet as to necessitate adulteration if consumers would only pay a proper price. Unfortunately there were dishonest manufacturers in this as in all other trades, who sold a bad article at a low price, but the best would be found the cheapest in the long run. It could be made as good now as twenty years ago. It was very important in importing india-rubber to get it not only pure but of uniform quality. Sometimes that which came from Borneo would lose 20 per cent. in drying, and at other times as much as 40 or 50 per cent., and when this occurred several times, purchasers were disposed to avoid it altogether. Pará rubber was at present the only kind which could be depended on for regularity of quality.

Mr. Ingram also spoke to the possibility of getting a good article at a proper price.

Mr. Bramwell asked, what was the precise meaning of good rubber? He had seen a good deal of both good and bad when manufactured, but speaking of the raw material, he wished to know what was the difference between two kinds, assuming them both to be free from impurities.

Mr. Bailey said the better kinds were much stronger. He might add, however, that even the best could be improved in the manufacture. For some purposes it was desirable to add certain oxides, and, in fact, the quality of the manufactured article depended in great measure on the process of vulcanisation, which was a very delicate one.

Mr. Hancock added that Pará rubber was far superior to other kinds, because it was finer in texture and possessed vastly more tensile strength. It could be spread out to almost any fineness, whereas others were coarser in texture, besides being generally mixed with a great deal of foreign matter.

Mr. Routledge supposed the difference was similar to that between fine and coarse cotton, jute, or esparto grass.

Mr. Markham said the first question which had to be solved before introducing the cultivation of india-rubber was, whether one kind was intrinsically better than others, and it was soon made evident that the Pará was the best, being in every way the strongest. The other kinds varied, and, with regard to some, opinions differed, but all agreed that this was decidedly the best. The sum of all that had been said went to prove the necessity for this plant being cultivated; for all the mischief which had been complained of was caused by the reckless way in which the trees in a wild state were treated. It was found in the case of every other plant, that the product was much improved by cultivation both in quantity and quality. Thus, a larger percentage of alkaloid was obtained from the bark of cultivated chinchona trees than from wild ones, and the reason was obvious. In the latter case the tree had to take its chance with others, but when cultivated all its requirements were studied and attended to. The same thing would happen with the india-rubber tree; the best kinds would be selected, attention would be paid to the best period for tapping, and so an improved gum would be obtained, as well as a permanent supply. With regard to the difficulty of obtaining labour, there was one great advantage over a tea or coffee plantation, that if you did not tap the tree one year the crop was not lost but was there in greater abundance next season. There would be no difficulty in obtaining plants in Ceylon, since they would be sent first to the charge of Mr. Tait, one of the best horticulturists in the island, to dispose of, and anyone there who wished to introduce them would naturally have the first chance.

The Chairman said he was sure the coffee-planters of Ceylon would be glad of this information. He hoped that, in the introduction of these superior varieties, the conservation of the indigenous species would not be neglected, and concluded by moving a hearty vote of thanks to Mr. Markham for his valuable paper.

The motion was carried unanimously, and the proceedings terminated.

MISCELLANEOUS.

PATENT-OFFICE.

As briefly noticed in a recent number of the *Journal*, Mr. Bennett Woodcroft, F.R.S., has resigned the post of Clerk to the Commissioners of Patents. Mr. Woodcroft, who was then Professor of Applied Mechanics at University College was appointed, in 1852, when the Patent Law Amendment Act came into operation, and continued in the active discharge of his duties till his resignation. The indexes of all patents granted prior to October 1, 1852, which he had prepared were purchased by the Government, and became the foundation of the present series of official indexes. The existing organisation and arrangement of the Patent-office is almost entirely Mr. Woodcroft's work, while the great number of publications regularly issued by the office were all, in the first instance, started by him. The printing of all the back numbers of specifications, from James I. to 1852, was one of his first undertakings, and simultaneously with this began the work of printing the current specifications, which has continued regularly to the present time. The classified abridgments of specifications were also begun and carried on under his directions. The first absolutely free library in London was that opened in 1855, under his superintendence, at the Patent-office. The Patent-office Museum was opened in 1857, and this was not only originated by Mr. Woodcroft, but largely augmented from his private resources, many of the models being his own property. He also collected a number of potraits of inventors with the view of forming a complete gallery of this character. Besides his official publications, Mr. Woodcroft is the author of various works on technical matters, chiefly con-

nected with mechanics and engineering. It is to be hoped that the leisure ho has earned by a long official life may cnable him to add to the list of these works, as he must have a considerable amount of matcrial only requiring to be cast into shape, for perhaps no person living has devoted himself more assiduously to the collection of matter dealing with the history of invention.

CORRESPONDENCE.

AQUARIA.

Sir,—In my communication on "Aquaria," which appeared in your *Journal* of March 24, I quite omitted saying that both at Hamburg and in the Crystal Palace Aquarium I made observations on the surface floating character of the eggs of tho cod (*Gadus*), and also on the glass crab (*Phyllosoma*) being only the young of the sea craw-fish (*Palinurus*), as well as on many other things, long beforc the Brighton Aquarium was made.

I believe Mr. Kent knew of these discoveries (or he should have known them), but he did not mention them in his Society of Arts paper.

At this moment—April 5—while I am writing this note, our specimens of the sea-fish the Bass (*Labrax*), are discharging eggs in such enormous multitudes that the whole of the water in the Crystal Palace Aquarium has a tendency to be rendered turbid by them. This tendency is, however, counteracted by our largo reservoir, and by accelerating tho speed of the machinery which circulates the water between it and the show tanks. The eggs of the Bass also float on the surface with the spot, indicating the first rudiment of the embryo, upwards. These eggs are very minute, and they are so little lighter than sea water, that a very slight agitation of the vessel they are in sends them downwards in all directions. If we could breed or rather rear such an overwhelming mass of fish as these eggs represent, we should require to convert the whole of the Crystal Palace itself into a vast tank for their accommodation.—I am, &c.,

W. A. Lloyd.

Crystal Palace, S.E , April 5th, 1876.

HALL-MARKS.

Sir,—Although agreeing with much that Mr. Lutcshaunig stated in his interesting paper lately read before the Society, I cannot think that his plan to abolish the Goldsmiths'-hall altogether, either wise, or likely to be successful. By far the best plan would be to endeavour to induce the authorities at tho Hall, to make such improvements in their present system as would meet the requirements of the present day.

If a conference were to be held of the principal members of the trade, and some reasonable plan agreed upon, and the subject then brought properly before their notice, I cannot but think that it would spur them to some action in the matter. One most important point should be brought to notice, and that is, that all articles should be liable to be Hall-marked if so desired by the purchaser, and not the present rule continued, that is, that only articles of a massive and plain character can be, and those that are light and artistic, or elaborate in their construction, cannot be. This is, perhaps the greatest evil that exists, for it is certainly discouraging art. The present manner of stamping is also bad, the stamps should be more carefully made and fewer in number. The Goldsmiths'-hall should place on the article their mark, which in one stamp, should at once indicate its quality, and its having passed their inspection. If the different qualities were shown by a mark, such as a lion for 22 carat, crown for 18 carat, &c., it would soon become known to the public, and would be a much better plan than the present. And if the construction of any ornament were so delicate, that a stamp would injure it, then the mark of the Hall should be affixed instead, by soldering the sign on it.

I do not doubt that the trade would be much improved if some alterations of this kind were made. In France every article of gold can be and is stamped, and the same plan should be adopted here. At the same time, the rule existing there that everything must be stamped, is not one that I should recommend, but if the public desire for their security that the stamp of the Goldsmiths'-hall should be on the article they purchase, they have every right to have it, no matter whatever the construction of the ornament may be.—I am, &c.,

B. H. T.

5, Newcastle-place, March 22nd, 1876.

SOME RECENT METALLURGICAL PROCESSES.

Sir,—I very much regret my inability to be present when Mr. Phillips read his paper on the above subject, before the Chemical Section of the Society.

Will you allow me to draw the attention of those interested to a method of extracting and separating copper and silver from ores, and "burnt ore," which Mr. Phillips did not allude to? I mean the solution of the copper and silver salts—after calcination of the ore—by means of ammonia and ammoniacal salts, then passing this solution through a galvanic tank, formed by a suitable and economical arrangement of sheets of platinum and copper, by which means the wholo of the silver is deposited in, practically, a pure state, whilst the copper passes on—still in ammoniacal solution—and is precipitated as oxide, by passing steam into the solution with the simultaneous addition of a very small amount of caustic alkali.

This not only precipitates the copper as oxide, but drives off the ammonia, which may be collected for reuse.

The special advantages claimed for the ammonia-process are, chiefly, its economy and simplicity; and the purity of the products attained.

Patent No. 4,448, December 26th, 1874, more fully explains the process, and a copy of this I forward herewith.—I am, &c.,

Edward Smith.

Torquay, March 6th, 1876.

RAILWAY COUPLINGS AS A NECESSITY OF THE DAY.

Sir,—I should be glad to be allowed to add some rather important statistics to those contained in my paper on this subject. There were, from 1872 to 1875, no less than 910 collisions in which goods trains were concerned, resulting in 2,750 casualties to passengers only; whilst 216 collisions between two passenger trains gave a further total of 1,391 passengers. Delay in shunting operations is well known as a fruitful source of danger, therefore passengers as well as railway servants are very greatly interested in automatic couplings which facilitate the despatch of traffic. As shown above, goods collisions are some four times more numerous than passenger train collisions. Only one passenger train is in each of the former, yet the casualties about double the collisions between passenger trains, whilst the fatal accidents are 30 per cent. larger.

In the discussion which ensued, it was thought safety chains were imperatively needed, but if any of your readers who desire to satisfy themselves on this point will observe railway waggons, they cannot fail to come to the conclusion that the so-called safety chain is not generally considered a necessity in this country. In America there are none, and in this country nine out of ten waggons have no side chains. Objection was taken to my estimate of ten years as the life of a vehicle—the

average of about twenty railways shows 11·2 years. On four large companies my estimate is exactly correct —and as traders' waggons are as a rule never kept up to the standard of companies' rolling stock, I think my estimate would stand, were complete statistics procurable.

Thanking your Society for the opportunity afforded me of illustrating my invention.—I am, &c.,

T. W. Brockelbank.

2, Cowper's-court, Cornhill, E.C.
March 29th, 1876.

PRESERVATION OF MEAT.

Sir,—Observing in your interesting article on the transportation of American meat, some commendatory remarks in reference to my system of refrigeration, in which you speak of my "draught" principle, I would beg you to allow me to say that the principle is that of the "downward draught," and not simply that of the "draught." The very essence of my system is that the "draught" is "downward," and caused by the passage of the air over the ice, and by its exit at the lower part of the safe or ice-chambers; and this I claim as the chief excellence of my patent.—I am, &c.,

G. Kent.

February 29, 1876.

[This letter has been unavoidably delayed in publication.]

DEXTRINE-MALTOSE.

Sir,—At page 411 of last week's *Journal*, second column, Mr. Valentin is reported to have designated as "a well-earned discovery," the method of making what he calls dextrine-maltose by means of the reaction of sulphuric acid upon ground rice, and to have regarded it as something of the nature of an infringement of his patent to make very nearly the same, or "identical article."

Allow me at once to undeceive your readers in the brewery interest by assuring them there is hardly any chemist who does not well know it to be a fact that the whole of the process described by Mr. Valentin, down to the smallest detail, has been public property for fully twenty years, and I shall be happy to obtain overwhelming evidence for any brewer or sugar refiner upon the subject.

The process described by Mr. Valentin as his was largely in use to my personal knowledge so long as nineteen years ago, and the discovery that the product then called glucose should properly bear the new name of "dextrine-maltose," conveys no right whatever to any monopoly of the old and well-known means of production which is now set up as a new discovery.

In the library of the Patent-office I have met with several old descriptions in books relating to applied chemistry, which have anticipated Mr. Valentin's description—not by any means *his* process—to the most minute detail.

The following extract from Miller's Organic Chemistry, published in 1869, page 97, lays down the general principles in accordance with which glucose or dextrine, as it was then called, otherwise "the identical article" which is now patented under a new name, was known to be generally made.

"Starch, sugar, &c. Preparation. Starch sugar is prepared on a considerable scale by allowing a mixture of starch, with a sufficient quantity of water to render it liquid, to flow gradually at a temperature of about 131° (55.C) into a vat containing water acidulated with one per cent. sulphuric acid. This liquor is kept constantly at the boiling point, by which means the starch is at once altered so as not to produce a mucilage. The liquid, after the starch has been added, is maintained in a state of ebullition for about half-an-hour, at the end of which time the starch is usually completely converted into sugar. The liquid is drawn off, and the acid is neutralised by adding chalk in small quantities at a time until it ceases to occasion any effervescence."

Considering the fact that Dr. Miller's book is a standard work, it is strange that the above complete description should not be known to Mr. Valentin. Wagner's Chemical Technology, edited by Professor Crookes, F.R.S., gives at pages 384 to 386 a still more exact account of the very old "new discovery." Orlando Jones's patent for the manufacture of starch from rice was the first suggestion which led to rice flour—being largely used for producing, through the action of sulphuric acid, "the identical article" now re-christened.

The great and apparently insuperable objection to this unpatentable process lies, however, in the use of chalk, for the purpose of precipitating the sulphuric acid, because it is found necessary, as stated by Mr. Valentin, to leave the syrup acid, and this acidity, however slight, causes a small but unwholesome proportion of gypsum to remain in solution.

A knowledge of the latter fact will lead the public to shun the beer of any brewer who may substitute "dextrine-maltose" for honest malt, and I have as little doubt that the fear of such a consequence from publicity has been one reason why "the identical article" has been so long quietly made without any close scrutiny either into its chemical constitution or physiological effects. Perfect filtration would remedy this evil, but is expensive, and is, of course, neglected in actual practice.—I am, &c.,

W. A. Lyttle, C.E., F.C.S.

The Grove, Hammersmith, London, W.

OBITUARY.

Dr. Letheby.—The death of Dr. Henry Letheby took place suddenly on the 29th ult. He had for many years held the post of Lecturer on Chemistry and Toxicology in the Medical School of the London Hospital, as well as that of Medical Officer of Health and Chemical Analyst to the City of London. The latter post, however, he resigned about two years ago, but still held important public appointments in connection with the examination of gas and water. At the time of his disease he was 60 years of age, having been born in 1816. In 1868 he delivered a course of Cantor Lectures on "Food," which was afterwards re-published as a work both in this country and in France. He had compiled "Reports on the Sanitary Condition of the City of London," and was the author of a series of papers on the "Mode of Conducting Post-mortem Examinations in Cases of Suspected Murder," which appeared in the *Lancet;* a course of lectures on "Practical Toxicology," published in the *Medical Times*, and many other papers on sanitary and chemical subjects in the transactions of several of the learned societies, and the various medical journals and reviews. Besides delivering the course of lectures above referred to, Dr. Letheby on many occasions took part in the proceedings of the Society. His last appearance here was when he took the chair at the reading and discussion of Mr. Smee's recent paper on "Sewage Farms."

In the *Journal* of March 17th, page 373, Mr. Grosjean's name was erroneously reported as Cogan.

New South Wales is about to despatch a mineral trophy to the Philadelphia Exhibition. The trophy is of a pyramidal shape, with four salient angles and four corresponding recesses. The angles are formed by solid blocks of coal disposed like steps, each block being the representative of a different seam or pit. In the open spaces at the base of each recess samples of all the mineral ores found in the colony are shown.

NOTES ON BOOKS.

Bi-metallic Money, and its Bearings on the Monetary Crises in Germany, France, England, and the United States.—By Henri Cernuschi, author of "Mécanique de l'Echange." Translated from the French. Second edition. London: Sampson Low, Marston, Searle, and Rivington.

The author of this pamphlet contends for a currency of silver as well as gold coins, the former of which shall be a legal tender for any amount equally with the latter. He also considers that the most convenient proportion of value which gold should bear to silver has been found to be equal to $15\frac{1}{2}$ times its weight. While the new kingdom of Italy, in abolishing the ancient coinages, sanctioned a legal tender of both gold and silver, Germany, on becoming united, adopted a monetary uniformity which allowed of no other legal tender than the gold marc. In four years the Imperial Government has issued 1,200,000 gold marcs, pushed forward its new small-change coinage, prohibited the circulation of Dutch, Austrian, and French moneys, and called in nearly all the silver coins of the Southern States and the Hanseatic towns. In pursuance of this policy all that remains to do is to demonetise the 200,000,000 thalers, equal to £29,600,000, now in circulation; but the difficulty of finding a market for all this silver and obtaining gold in return has been foreseen by the ministry, who have decreed that from the beginning of the present year all payments shall be made in marcs, so as to retain the thalers in circulation. This process of slow demonetisation, however, has a serious drawback, inasmuch as it determines the exportation of gold, and causes a growing depreciation of silver. The monetary arrangements made by England in 1816 are compared with those going on in Germany at the present time, and it is asserted that Great Britain is, of all States, the most directly menaced by the monetary policy of Germany, as our bank reserve is about the sum that Germany requires to replace her silver, and therefore cannot serve for both.

The international monetary programme put forth by the author is that the proportion in value of gold to silver shall be as $15\frac{1}{2}$ to 1, that the silver shilling shall weigh $15\frac{1}{2}$ times the gold shilling, the silver dollar $15\frac{1}{2}$ times the gold dollar, and so on; that the holders of gold and silver be free to take these metals to be coined at the mint; and that it be optional to all to pay in gold or silver specie. This arrangement is shown to have the effect of giving stability to the relative value of gold and silver, and of reducing to a minimum the fluctuations in the buying power of money. Other advantages would follow in an increased value of silver; the avoiding of the losses caused in Germany and throughout Europe by the demonotisation of silver; the preventing of monetary convulsions due to the same cause; the facility of settling accounts in specie between Europe and India, China, and other Asiatic countries where gold is not accepted; and, finally, the abolition of paper currency in those countries where it appears to have become chronic.

The author concludes by answering two objections, which he considers small, because they have only a secondary bearing on the question. To the argument that silver money is heavy, and therefore inconvenient, he replies that the freight or carriage of silver is no more costly than that of gold, as the tariff is regulated by the insurance on the responsibility of the carrier, and not by the weight of metal; and the bank-note payable to bearer will prevent the necessity of a transfer of silver in the bank cellars, as it now does that of gold. In small sums for daily use, if the rich like to handle the lighter golden prices, the poor, on the contrary, prefer the heavier silver, which is not so likely to slip from their rough fingers. As the advantages or disadvantages on both sides are balanced, let there be a currency of both metals to suit all classes. In reply to the objection that silver is being depreciated, and that therefore a currency of the metal must be abandoned, the fact is admitted, but the conclusion combatted. The very advocates of an exclusively gold currency are pointed at as the cause of the progressive fall in silver, that metal having become considerably reduced in price when it ceased to be converted into coin.

The translation into English of M. Cernuschi's pamphlet appears to have been carefully done on the whole; but why does the translator retain the French spelling in "schillings," and persistently use the French word *lingot* for ingot?

GENERAL NOTES.

The National Penny Bank. — The first report, to 31st December, 1875, has just been issued. The company was registered on the 20th January, 1875. On the 31st December, 1,036 shares had been taken up, and donations amounting to £607 1s. more had either been promised or actually received. The first penny bank was opened at 257, Edgeware-road, on the 9th October, 1875. This branch was followed by six others:—at Hackney-road; Cannon-street-road East; Oxford-street; Brompton; Commercial-road; and St. Luke's. The committee cannot but express their satisfaction at the result which, as far as it has gone, has exceeded their anticipations. They are confident that their next annual report, when their banks have been in operation a year, and the public has become convinced that the scheme is a *bona fide* one, will show steadily and rapid progress. The facility for withdrawing small sums on demand is much appreciated, and induces many to open accounts who would not otherwise do so. The committee consider that the success already obtained justifies the accuracy of the calculations upon which the bank was founded, and they believe that, at no distant period of time the commercial prosperity of the bank will enable them to declare a dividend upon the shares.

The Channel Passage.—The following figures from the official returns show the largely increasing passenger traffic between England and the Continent by the Dover and Calais route. The number of passengers were, in

1866	125,732
1867	199,137
1868	142,223
1869	154,859
1870	107,308
1871	116,996
1873	181,270
1874	198,656
1875	208,432

The large increase in 1867 was due to the Paris Exhibition, whilst the fall in the number of passengers in 1870 and 1871 may be attributed to the Franco-German war, which interfered with the traffic to France during several months of those two years. The number of passengers that crossed last year *via* Folkestone and Boulogne was 110,419, whilst *via* Newhaven and Dieppe the number of travellers was 58,235, and only 24,265 by Southampton and Havre. It appears, therefore, that nearly 20,000 more passengers landed at Calais and Dover than at all the other ports named put together.

Market Gardening near Paris.—M. Herzé, Inspector General, and member of the Committee of Agriculture, has contributed the following statistics respecting the market gardening near Paris, in a paper read before that society. At the present time the market gardens in the suburbs of Paris are 1,800 in number, covering an area of 1,378 hectares (3,404 acres). Those within the walls of Paris occupy 750 hectares ($1,852\frac{1}{2}$ acres). The average size of these gardens is from 60 to 70 acrs ($1\frac{1}{2}$ acres to $1\frac{3}{4}$ acres). They generally contain a

dwelling-house, a well, a stable, and a shed. The land lets at from 1,000 to 1,200 francs per hectare (£16 3s. 4d. to £19 7s. 6d. per acre), and the house at from 300 frs. to 400 frs. (£12 to £16). The land is never at rest, and produces from two to three crops yearly. For such a cultivation a great deal of labour is necessary, abundant manure, and frequent watering, and often artificial shelter has to be provided for the crops, so that in these 1,800 gardens there are 360,000 forcing frames and 2,160,000 bell glasses. The owners rise at two o'clock in the morning in summer, at four o'clock in the winter; the master is always at the head of his men, whilst the wife looks after the women, and it is she alone who attends to market. The population employed in market gardening is about 7,500 persons, the value of the stock is estimated at 8 millions of francs (£320,000). 1,200,000 francs (£48,000) is spent annually in stable manure, whilst the value of the vegetables sold amounts to 12 millions of francs (£480,000), and 300,000 francs (£12,000) is obtained from the sale of exhausted soil.

NOTICES.

SUBSCRIPTIONS.

The Christmas subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

THE LIBRARY.

The following works have been presented to the Library:—

Shipping Legislation, reprinted from "Engineering." Presented by Samuel Plimsoll, M.P.

Idioms of the German Language, by J. H. Lloyd, M.A. Presented by the Author.

Technologisches Wörterbuch — Deutsch - englisch - französisch, by Alexander Tolhausen. Presented by the Author.

French-English Dictionary and the English-French Interpreter, by C. Horsfeld and L. Daniel.

Eighty-sixth and Eighty-seventy Annual Reports of the Regents of the University of the State of New York.

Annual Report of the Board of Regents of the Smithsonian Institution, for the year 1874.

The complete Works of Count Rumford, vol. 4. Presented by American Academy of Arts and Sciences.

The Royal Academy Album: a series of Photographs from Works of Art in the Exhibition of the Royal Academy of Arts, 1875. Presented by Spencer A. Perceval.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

April 12.—*No Meeting.*

April 19.—"The So-called Deposits of Onyx near Mexico, and their Value as a Decorative Material in this Country," by W. Eassie, Esq., C.E., F.L.S., F.G.S.

April 26.—"Sericiculture in Australia," by Mrs. Bladen Neill.

May 3.—"The Preparation of China Clay," by J. H. Collins, Esq., F.G.S.

May 10.—"A New Method of Propulsion for Street Trams," by E. H. Leveaux, Esq.

May 17.—"Railway Safety Appliances," by F. J. Bramwell, Esq., C.E., F.R.S.

May 24.—*The same continued.*

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

April 18.—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

April 21.—"The Sanitary Progress of India," by Captain Douglas Galton, C.B.

May 5.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

May 26.—"Thaumatodendra, or the Wonders of Trees in India," by William Tayler, Esq., late Commissioner of Patna.

Chemical Section.

Friday evenings at 8 o'clock. The following arrangements have been made:—

April (*date not yet fixed*).—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne.

Cantor Lectures.

Monday evenings at 8 o'clock. Third Course, "On Wool Dyeing," by George Jarmain, Esq.

Lecture V.—April 24th.

Logwood and other woods, and their application to the dyeing of wool and woollen fabrics (*continued*).

Lecture VI.—May 1st.

Aniline and other allied colours, and their application to the dyeing of wool and woollen and mixed fabrics.—Concluding remarks.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.
British Architects, 9, Conduit-street, W., 8 p.m. Mr. Alexander Payne, "Concrete as a Building Material."
Medical, 11, Chandos-street, W., 8 p.m.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Prof. A. A. Nicholson, "The Place of Science in Education."
Social Science Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. Baldwin Latham, "Are Subterranean Sources of Water-supply the cause of Enteric Fever?"

Tues. ...Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Renewed Discussion on "Sewage Utilisation."
Photographic, 9, Conduit-street, W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C.

Wed. ...Graphic, University College, W.C., 8 p.m.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.

Thurs...Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Civil and Mechanical Engineers' Society, 7, Westminster-chambers, S.W., 7 p.m. Mr. T. W. Gray, "Hydraulic Machinery."
Royal Historical Society, 11, Chandos-street, W., 8 p.m. 1. Dr. Zerffi, "The Historical Development of Idealism and Realism." 2. Captain Warren, "The Holy Sepulchre."
South London Photographic Society (at the House of the Society of Arts), 8 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,221. Vol. XXIV.

FRIDAY, APRIL 14, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

GENERAL MEETING.—ALTERATION OF BYE-LAWS.

The Council hereby convene a General Meeting of the Members, for the purpose of altering, varying, and revoking the existing Bye-Laws of the Society, and making new and other Bye-Laws in the place thereof, such meeting to be held on Thursday, the 27th day of April, 1876, at three o'clock in the afternoon.

By order of the Council.

P. Le Neve Foster, Secretary.

11th April, 1876.

HEALTH AND SEWAGE OF TOWNS.

The Conference on this subject will take place, as already announced, on May 9th and 10th. The Executive Committee have received a large number of answers to the queries issued, and these are now being digested, so that the information may be presented in a form suited for easy comparison. There yet remain some towns from which no replies have been received, and it is hoped these omissions will be repaired as soon as possible. A Sanitary Conference will also be held by the British Medical and the Social Science Associations on May 11th and 12th, in the Rooms of the Society of Arts. In connection with the Conference an Exhibition of Sanitary Appliances will be held. Only such apparatus will be admitted as have a distinct bearing on the subject of the Conference. Further information can be had on application to the Secretary.

REVOLUTION INDICATORS.

The Committee on this subject went down to Greenwich on the 5th instant, to make further trials of the selected instruments. Present:—Vice-Admiral Erasmus Ommanney, C.B., F.R.S. (in the chair), W. Froude, Capt. Nisbet, Rear-Admiral Nolloth, J. R. Ravenhill, and Seymour Teulon, with P. Le Neve Foster (Secretary).

The Committee met on the 7th instant. Present: —Vice-Admiral Erasmus Ommanney, C.B., F.R.S. (in the chair), Capt. Nisbet, Rear-Admiral Nolloth, J. R. Ravenhill, and Seymour Teulon, with P. Le Neve Foster (Secretary). They took into consideration their report.

SPECIAL LECTURES.

The sixth of the series of lectures on "Unhealthy Trades" was delivered by Dr. Richardson, F.R.S. (appointed by the Council to make special inquiry into the subject), on Friday evening, February 4th, as follows:—

Lecture VI.

At the close of the fifth lecture of this course, I said that science could afford signal service to the health of the industrial classes, if she were backed by wise legislation; and that she could also render service, in many instances, without the interference of the legislator, if she were backed by the assistance of those whom she was specially desirous to benefit—the industrial classes themselves. In this lecture I shall endeavour to indicate in what manner the applications and discoveries of science may be made useful under the circumstances I have defined.

First, then, what does science seem to demand of the legislator? What is it that a scientific society, such as the Society of Arts, may ask the Legislature to carry out, or suggest to the people to ask? What is it that a man of science, speaking independently of legal or political bias, may ask, from a purely scientific point of view, of the Legislature, after he has studied the facts and necessities connected with the classes of the community with which we are concerned, as I have essayed to study them?

I put these questions, knowing fully all the obstacles that lie in the way of a practical answer. No one can be more alive than I am to the almost insuperable difficulties that oppose even the best legislative efforts. A much briefer acquaintance with the subject than I have experienced in the past twenty-five years suffices to show the conflict that exists between enforced improvements of the slightest kind, and the free will of the worker whose case calls for the improvement. Many influences that are inherent to industrial work, obstruct the legislation. The automatic character of the work of most artisans is itself a primary and persistent obstacle. Automatic work begets an automatic mental state, an automatic line of thought, which, broken forcibly, seems to him who possesses it a breach of liberty, an act to be resisted to the utmost. In addition to this there is a compactness of thought and of action in the industrial masses, which is all but impenetrable. They think in a uniform method, and with a common degree of knowledge; they are keenly alive to the assumed encroachments of outsiders on their traditions and practices, and they unite with a cohesion which does not belong to any other orders of the community, which they outnumber in the proportion of nearly five to one. These influences are each alike, and equally forcible in their action.

There is another opposing influence to legislative interference on behalf of the teachings of science. The more rapidly and the more surely science advances, the more distantly she removes herself from the understanding and comprehension of the unlearned. To her votaries she may be simplicity itself, to others she is a closed book, or an unreadable book if not closed.

To the difficulties thus noticed, with which I fear many others might be named, there is added serious discouragement to all attempts at reform in the results that have, up to the present time, followed upon such reforms as have been actually carried out. One striking illustration of this truth, and one sufficiently illustrative in its simple self, is offered in the reduction of the hours of

labour. It might have been expected that reduction of hours of work would lead the workman to find leisure for the cultivation of both mental and physical strength and order. Unfortunately the expectation has not been realised. On the contrary, in too many instances it has happened that the greater leisure has led to the greater deterioration. I have before me a report on this subject, printed in one of the annual papers published by the Association of Certifying Medical Officers of Factories in 1874. The writer of the article is Dr. C. Brown, of Preston, a medical officer, whose duties as a factory surgeon bring him daily into contact with the class to which he refers. He tells us a series of facts which I will give in his own words. "The abridged hours of work have," he says, "led to more drinking and the pursuit of such amusements as pigeon-flying, and dog-racing. The increased wages (speaking generally) have not led to increased home comforts. The people try and get their children passed as soon as possible, and in many cases live on the earnings of the children, whilst they spend their own time in idleness and mischief. Their habitations are dirty, ill-ventilated, and over-crowded. As a class, the operatives are quite ignorant of housekeeping and cooking, and our wonder at this is diminished when we consider the way in which the wife of the working man, who is also the housekeeper and cook of the family, is brought up. At the age of eight years she begins to spend part of her day in the factory, and the other part in school. At thirteen the whole of the day is occupied in the factory. At an early age she is married, and in time has to undertake the cares and responsibilities of a family, without having previously acquired any knowledge of housekeeping and cooking. I think that this knowledge," continues Dr. Brown, "upon which the comfort and welfare of so many depend, might be imparted at the school where the girl receives her instruction in reading, writing, and arithmetic. The condition of the houses of the operatives is also, I believe, one of the chief causes of intemperance; and what is a more prolific source of disease than this? The poor workman, returning home from his day's toil, finds the atmosphere of his dwelling so polluted, and his food so badly prepared, that he hastens to the public house, where everything is made attractive, to arouse himself by stimulants from that depression which domestic discomforts have produced in him."

This evidence is, I say, sufficiently disheartening. It unfolds a series of facts which appear, however long they may be looked at, almost hopelessly irremediable by any kind of legislative action. For be it observed that this degraded condition is, after all, liberty; and liberty is the last gift that will be forfeited by a free people, who prefer that gift not only to comfort, to health, to home, but to life itself. Probably if we who live in better condition were told by some who were in an equal degree raised above us, how we might live more properly, we, too, might resent the advice if any attempt were made to enforce it upon us.

Notwithstanding these difficulties, it is necessary that some legislative action better and more consistent than that which now exists should be taken. At present to the scientific mind all the sanitary arrangements and managements in this country are in a state of chaotic disorder. There are no systematic means for prompt and uniform and effective action that can extend from one central authority into all the departments of sanitary work required by the necessities of the State. There is, therefore, first required, as it seems to me, for unity of legislative proceeding, a Secretary of State of a Health Department of the nation; a Minister having a place in the Cabinet, who in the House of Commons shall be ready at all times to answer for the governmental work that is in progress for the health of he people. The very fact of the existence of such an mportant public functionary would do more than anything else that has been and that, perhaps, could be done to keep the subject of health steadily before the mind of the community. The people generally do not understand the relation of the duties of the President of the Local Government Board in their bearings on health; they do not distinguish the meaning of the interference of the Home Secretary when he incidentally touches upon a subject that has a direct or indirect effect on affairs of national health. They only appreciate the specific duties of the Registrar-General of births and deaths, and why his reports on the salubrity of the nation are separated from these and similar reports. In fact the people see so many legislators in the sanitary department, they are confused; they feel consequently no pointed interest in the work that is done, and the result is an all but universal apathy, which stands formidably in the way of every advancement.

Meanwhile the issues at stake are of a momentous character. Say that the annual death-rate of England and Wales be at 25 in the 1,000, that means a mortality of 250 in 10,000, of 2,500 in 100,000, of 25,000 in a million, of 550,000 in a population of 22,000,000. If we take the industrial community specially into our calculation, the facts are still more striking. We must, I fear, take this community as dying at a rate of not less than 27 in the 1,000 annually, so that amongst its 5,000,000, no fewer than 135,000 die in the year.

Under a perfect sanitary code, thoroughly administered, I believe that these rates of mortality might be reduced actually to a theoretical figure of 8 in the 1,000. But I will not stop to argue this point. I will only put forward what would be the saving of life in our industrial community alone if the rate of mortality in it were reduced, not to any speculative degree, but to an admitted possible degree, a degree which has, in some favoured communities of our country, been realised. Let it be assumed that a third of the lives have been saved; that, in other words, the death-rates of the industrials have been brought down to the rate of 18 per 1,000. By this there would be saved as many as 45,000 lives in each year. Surely this saving alone would justify the establishment of a Health Department and the creation of a responsible Minister of Health.

In support of the same argument, let us take one other fact of a particular kind, one out of many I could readily adduce. Dr. Purdon, of Belfast, a certifying medical officer under the Factory Act, in the report for 1874 of the Association of Certifying Medical Officers, of which he is a member, writes an able account of the effect of flax-working on the health and life of those who are engaged at that occupation.

You will remember that I have already called your attention to this occupation, and have shown how serious are the consequences of labouring at it.

Dr. Purdon gives a still more direful history. He says, "In a short time the worker becomes affected with cough and attacks of dyspnœa; for two hours each morning these attacks are so violent that he is obliged to seize hold of the table attached to the machine in order to enable him to get over the paroxysm more speedily. This attack is so well known, that when one is seen labouring under it he is said to be 'poucey.' The machine boys are the first to feel the effects of the flax dust. After being engaged about four or six years, if not taken off by phthisis (for many die of this complaint at eighteen years) they are made hacklers or sorters, and as they still continue to inhale the dust, their lungs become more and more engaged, so that they become quite old looking at thirty years, the shoulders become high, and chest altered; they generally die at forty-five years, of phthisis, and if life is prolonged are compelled to give up work, so it is exceedingly rare to see a hackler sixty years of age. The carders are all females, and suffer from the same disease that the hacklers labour under. If they get a carding machine at eighteen years they generally die at thirty years. Those en-

gaged in the preparing of long line are very generally short-lived, and I have been informed that this branch is ' sure death.'"

You will say, is it possible that in our land there can exist such a state of things, that a young girl entering on a certain occupation at 16 years of age to earn her livelihood should go to what is all but certain death from that occupation within fourteen years. Well, the facts are as I have read them, and there they must remain for the consideration of all of us who are concerned to know them. To me they seem singularly worthy the concern of the statesman. We talk of that foreign sick man, Turkey, and appoint so skilful a State physician as Lord Derby to watch his condition; but what of the sick man at home? Does he not require an equally skilful State physician?

Special Legislative Reforms.

Some special reforms bearing on the sanitary management of certain industrial occupations are required. I take, for one example, the position of the factory surgeons. There are, I believe, nine hundred of these gentlemen, and it cannot be denied that as a body they are most efficient, earnest, industrious public servants. The reports they issue each year as an association, and the addressess of the most able president of their association, Dr. Arlidge, are evidences of tho soundness of their work, and of their earnest desire to be still more useful than they are now permitted to be. We have not, indeed, in any public service a class of scientific officers who know their duties better or who perform them with more spirited and steady effieiency. They are paid for the services they render by division of the cost between the employers and the juvenile operatives employed, and they are paid so much per case. Of the principle of this system of payment, I need not speak, because it seems that no other better method is at present open, but respecting the present limitation of their duties and useful offices very much might be said. Their duties, as they at present stand, consist in certifying the age and physical condition of all children who are brought before them for entry into life as factory operatives. They determine the matter of age from such evidence of birth as they can get, and from signs of age derived chiefly from an examination of the development of the teeth. They determine on the physical capacity of a child for work from the state of health in which they find it, and they also determine that it is protected by vaccination from small-pox. All children of eight years that pass this ordeal are put on to half-time work; half the day is spent at work, and half at school.

Practically, the duties of the certifying factory surgeon are finished in each case when he has certified in the manner I have described. The child having passed to factory labour under the certificate is protected no further by medical science. The factory surgeon may see the child placed at work that is altogether incompatible with physical strength; he may see it failing under its task; he may see it fail; but he must not interfere. If his certificate admits it into the factory at all, it admits it to the heaviest and most improper, as well as to the lightest and most compatible labour. In like manner the factory surgeon, though he may know all the dangers to which the factory operative of a more advanced age is exposed; though he may see the men or the women breaking down at their tasks; though he may see the woman, who is an expectant mother, overburthened with the work to which she is put, he must not interfere by one word of judicious authority, to save the labourer from the danger or weariness of the occupation.

Again, in the factory itself the surgeon may see errors which tend to injure the health of all who are in the factory, errors of ventilation, of cleanliness, of mode of work; he may know that these errors are remediable by the simplest means, but he has no power whatever to remove them.

I cannot but think, and I hope you will agree with me, that the Legislature might with advantage enlarge the powers of the certifying surgeon, so as to enable him to be of service beyond the mere act of certifying to age. In the Factory Act age is treated as though it were another term for strength, which we all know is a fallacious idea, and what is really wanted is, a correction of so great an error. To the health, to the life of the operative, it is essential that the authority of the surgeon should be extended, so that strength as well as age should be brought into consideration. It is essential, I mean, that a surgeon when he sees a child put to labour at work it has not strength to carry out, should be able to say, "This must not be; this child must be set to another and easier task."

In further exercise of useful duties, it seems important that the powers of the factory surgeon should extend to the correction of other sources of danger; to the supervision of the health of the adult operatives, and to the direction of the sanitary condition of the factory.

There is one other direction in which it would be wise to extend the powers of the factory surgeon. He ought to be enabled to carry out his duties in workshops as well as in factories. I think his power ought to extend further even than this; that it ought to reach into those places called work-rooms in private houses. In small shops and work-rooms more injury is inflicted than in any factory, and to let the young remain unprotected from the most dangerous forms of labour, on the mere pretence that they do not work in a place legalised as a factory, is a legislative failure of the saddest character. To the application of remedies for each one of these errors we might surely, without hesitation, ask the service of the legislator.

Another legislative task, the fulfilment of which should be asked, is the adjustment of the respective duties of the factory surgeon and of the medical officer of health in factory districts. You are, I know, all aware that of late years a new body of medical men has been organised, whose duty it is to look after the sanitary welfare of the different districts of the country. The members of this body are called the medical officers of health. Each of these gentlemen, in his own district, possesses certain fairly defined powers, and these powers extend to a certain extent within the factory itself. The medical officer of health, could, for instance, control certain causes within the factory which might be at work to excite or maintain an epidemic disease. His action here, however, is but partial, and it is less likely to be effective than would be the action of the regularly appointed factory medical officer, whose duties render him conversant with all the details of factory life. Here, therefore, some modification of rule is demanded by which the responsibility of sanitary supervision now partly and incidentally discharged in certain localities by the medical officer of health, should be removed from that officer and transferred to the factory medical officer.

A legislative reform is required in respect to the regulation of age at which half-time work should commence. The teachings of science are clear, that no child of either sex should be put to work at the early age of eight years. Ten years is the earliest age at which any labour should be commenced, and then the kind of labour ought not to be indiscriminately left to the choice of the employers; it ought to be placed under the wise direction of educated medical men, who know what can and what cannot be borne by the labourer.

Public Work-rooms.

There is yet another direction in which, if scientific reasoning could influence tho law maker, an improvement might be effected that would be most beneficial to the industrial community. What I am now about to suggest might be carried out by municipal authority in

an independent manner,—and I did once try to move one of our great metropolitan local boards to take action on the subject,—but it would be best to let the work proceed from the central authority. The suggestion is, to build in all our great industrial hives public work-rooms, for the use of those industrials who are obliged now to work at home in their little stifling rooms—rooms which are at once living rooms, bedrooms, and workshops. These new work-rooms ought to be distinct blocks, and arranged so that each industrial should be able to have his own office or workshop at a moderate cost per week. Each block of such rooms should be placed under proper superintendence, that intruders be not admitted, and each room should be applied to no other purpose except the work for which it was let, and should be occupied by no more persons than could work in it with perfect safety to health.

If these public work-rooms were established, the benefits resulting from them would be incalculable. The workman would pursue his avocation freed from those domestic cares and troubles which surround him in his household. The wife and family would be left to live free from the constant plague and worry of business and labour. In a word the simplest industrial worker would have the same advantages as the professional man, the merchant, or the clerk, who can leave home for his office, and can transact business free from all the annoyances which of necessity attend the processes of working for bread and living within the same four walls.

I say the industrial man would profit by this reform. I may add that every class of the community would profit by it in an equal degree, in relation at least to health, if that be an admitted matter of profit. As things now are the private work-rooms are *foci* of the spreading diseases. In these rooms, where lie the victims of scarlet fever and other contagious diseases, are made clothes that go forth to cover the bodies of the wealthier classes, and to carry into the richer homes those particles of disease which flourish wherever they are carried, when those who are susceptible to their influence are exposed to them.

Registration of Disease.

On the subject of legislative action in response to scientific requirements, I would add one more suggestion. This relates to the registration of the diseases of our great communities, by a system of registration similar to that which is carried on in the Registrar-General's office for the enumeration of the births, deaths, and marriages of the community. In the year 1855, I commenced an effort to test the practicability of this scheme, and was soon assisted by a large body of competent observers. At one time fifty observers were lending me their services, from forty-four points of observation, extending from the Scilly Islands to the Hebrides. The facts were published quarterly. The diseases affecting the human subject, the diseases affecting the lower animals, and the diseases affecting plants, were recorded with more or less of detail; and, in some instances, the observers added an excellent account of the meteorological conditions that had prevailed in their districts during the periods of observation. These returns were commenced in the March quarter of the year 1855, and were continued regularly for four years. They were published in my *Journal of Public Health and Sanitary Review*, the pilot literary journal of sanitary science in this country. The records of disease, obtained as I have described, may be read still with profit. In one of them, reported by Mr. Haffenden, of Canterbury, from the notes of eight observers, there was given in the spring quarter of the year 1857 the first distinct account of the outbreak of diphtheria in England, from a series of cases observed at the village of Ash, by Mr. Reid, of Canterbury.

The success of the experiment for the registration of diseases was the actual cause of its failure. It was impossible for any one individual to bear the labour and the expense of collecting and publishing regularly the returns of disease from fifty observers, though their valued labours were freely given.* When, therefore, the experiments had been fairly tried and shown to be practicable, I laid the results before Sir Benjamin Hall, who was for a time President of the Board of Health, and suggested to him that the weekly records of the Union medical officers of the kingdom should, by a very simple modification, be utilised for registration of disease, after they had served the primary local purpose for which they were intended. Sir Benjamin Hall received the scheme with much favour, and promised to take the opinion of the Registrar-General upon it; but, after a little time, he informed me that the carrying out of the design would involve an expense which the public, he believed, would hesitate to meet, so the effort was not made.

In scientific research it is so common for the most laborious series of researches to fail in their direct object that men of science become inured to failure, and soon cease to lament over it. I confess, however, I have never ceased to lament the failure of my original proposition for obtaining a complete registration of disease in this country. I regret most deeply the time that has been unnecessarily lost. If I could have continued to receive reports four times a year from but fifty observers during the twenty-one years that have now passed, I should by this time have collected over four thousand sets of facts relating to disease, from which something useful must have been derivable. If the larger scheme I proposed had been carried out—if the weekly returns of the three thousand poor-law medical officers had been utilised for the same period, instead of being allowed to go to destruction when their first use was over, some three million and a quarter of facts, relating to diseases and their causes in England and Wales, would by this time have been collected. It is impossible to estimate this deplorable loss of knowledge, and still the loss goes on. I name the subject in order to urge forward an endeavour to prevent the further and continuous waste of knowledge. To know the diseases of this country in their entirety; to know the relation of the diseases in men to the diseases of inferior animals and of plants; to be able to fix the special localities of special diseases; to be able to trace the diseases back to occupations, modes of life, and all the external exciting causes from which they spring, were knowledge which every statesman surely should long to acquire. Such knowledge is the best history, the best book of reference that could be obtained, from which to read the health, and thereby the wealth of our people. Domesday-book were a poor contribution by the side of that book of vital possessions to which I once again venture to direct public attention.

In respect to the industrial classes, the rulers of this kingdom can know nothing basic until they are fully aware of the physical health and strength of those

* I cannot let the notice of this first system of registration of disease pass without subjoining the names of the various observers who lent me their valued assistance. Many of these still remain at their work; some, I regret to say, have ceased their labours. They were, Dr. Moyle, St. Mary's, Scilly; Dr. Lake, Teignmouth; Dr. McIntyre, Odiham, Hants; Dr. Jackson, Portsmouth; Mr. A. Haviland, Bridgewater; Drs. Brown, Rigden, Haffenden, and Reid, Chatham and Canterbury, Kent; Dr. Greenhill, Hastings; Dr. Whiteman, Putney; Dr. Nicholas, Wandsworth; Dr. Kesteven, Holloway; Mr. Cox, Hawkesbury; Mr. Michael, Swansea; Dr. Barker, Bedford; Dr. Wilialms, Apsley Guise; Mr. Stedman, Sharnbrook, Beds.; Mr. Laver, Colchester, Essex; Messrs. Spurgeon and Stear, Saffron Walden, Essex; Dr. F. Collins, Wanstead, Essex; Mr. Rogers, Newport Pagnell; Mr. Dulley, Wellingborough; Dr. Crowfoot, Beccles; Dr. Vincent, East Dereham; Dr. Bailey, Thetford; Mr. A. Freer, Stourbridge; Mr. Houghton, Dudley; Dr. Thomson, Burton-on-Trent; Mr. Swann, Barrowden; Dr. Hole, Wisbeach; Mr Cartwright, Oswestry; Mr. Eddowes, Pontesbury; Dr. Robertson, Nottingham; Dr. Williams, Wrexham; Dr. Moffatt, Hawarden; Mr. Thorp, Stavely; Dr. Lowe, Lincoln; Dr. Mackinder, Gainsborough; Dr. West, Alford; Mr. Bickerton, Liverpool; Mr. Spinks, Warrington; Mr. Hussey, Wigan; Mr. Pendlebury, Bolton; Dr. Proctor, York; Mr. Radcliffe, Bramley (now of London); Mr Todd, West Auckland; Mr. Summers, Rothbury; and Dr. Spence, Lerwick, Shetland.

classes; and of such physical health and strength they can know nothing until they have complete and regular returns of the health of the people, and of the agencies which disturb it. Enlightened on these points, the legislator could put in force, with wisdom and effect, all those necessities of improved homes for the working classes which now, in comparative darkness, he is striving to establish; and he would soon learn the method for stamping out the communicable diseases from every centre in which they should occur, before they had time to spread into general catastrophe.

Influence of Science seconded by the Free Will of the Operative Classes.

It is constantly felt and expressed by men of science, who would apply their energies most willingly to the invention of means for lessening the evils attendant upon industrial labour, that all their efforts are obstructed or prevented through the objections raised to them by the industrial classes themselves. There is much sad truth in this reflection, and I have already many times alluded to it, accepting its accuracy. At the same time it is but fair to qualify the criticism by the free admission that much of the opposition that is attributed to obstinacy, to carelessness, and the like, is in truth imperfect knowledge, a deficiency of appreciation of the value of the service that is proffered. The workers are born and bred to accept certain fixed rules and practices. They are born and bred to believe that certain results of their work, which may even be of fatal import, are necessary parts of their life. You tell them they are wrong, but they doubt, because the proof is not before their eyes. They say, in reply, that you are theoretical, and they are practical. I really do not think they differ in any respect from other classes of men in this mode of receiving new light. It is but another illustration of Conservatism of thought, from deficiency of enlightenment, and I suspect we every one of us share in the same fault. Dr. Purdon, of Belfast, tells us in his report that girls who go to work at the flax trade at the age of sixteen years die, as a rule, from the effects of the trade by the time they have reached thirty years of age. I cannot believe that, if the flax workers were trained to realise this fact fully, and if they were distinctly conscious that the dangers of the work, so terrible in their results, as the work is now conducted, were all unnecessary, I cannot, I repeat, think that the whole body of industrials implicated would resist the reasonable endeavours which science would make to relieve them of the dangers.

I am told that in a factory the operatives are peculiarly susceptible to what is called ridicule, and that the wearing of any peculiar article of dress is so commented upon, until its use becomes a prevailing fashion, that many would not go through the ordeal of a process that would even save their lives. There is, we may fear, matter of fact in this statement, and it is deeply to be deplored; but it is also to be corrected as well as deplored, or the fact may remain for good. In simple terms, fashions must be set, and, if need be, gently enforced, until the useful objects of them be made clear.

Whatever may be the opinions, whatever the prejudices of the operatives themselves, the duty is none the less incumbent on the man of science to carry out his part of the work of amelioration. Though he may have to wait a lifetime for the application of his designs, he must be ready with them. He is bound to be as ready, if not as bountiful, as nature herself, whose servant he is, and who is always beforehand and abundant in every gift she bestows.

In the course of the last few years, many improvements have been carried out in different factories, where danger in previous times was imminent. At Amiens, M. Kuhlmann has devoted much attention to the process of fixing chemical vapours given off in various processes of chemical manufacture. He has invented a mill with wings, by which vapours are carried into neutralising solutions, distributed in fine divisions, almost like spray. In some aniline works in France, the distinguished Chevalier has successfully exerted his ingenuity in constructing a special room for the manufacture of aniline, so arranged that exposure to the vapour is practically an impossibility, and is indeed placed out of the reach of the workman be he even careless in the performance of his work.

With a similar worthy object of applying scientific skill to the protection of the working man in the factory, M. Galibert has invented his air reservoir, made for economy's sake of a goat-skin, by the use of which a man may carry with him on his back a good supply of pure air, and, by a little practice of breathing through the valved mouthpiece, may work in a deadly poisonous atmosphere without risk.

These are all useful advances in the modern life, but in other directions there has been a poorer advance than might have been expected, considering how largely, of late years, the science of chemistry has added to the progress of physical science. In one particular direction there has been serious omission, I mean in attention to the discovery of some process by which the use of lead may be dispensed with in the glazing of pottery, and some innocuous substance be put, for this purpose, in its place.

Half a century ago, this Society was actively interested in this subject, and awarded, in the session 1822-23, its large gold medal to J. Meigh, Esq., of Shelton, Staffordshire, for a glaze for vessels of common red earthenware not prejudical to the health of those who make use of them. Since then, however, but small progress has been made, compared with what might have been effected from ingenious and persistent experimental inquiry.

It may prompt to a more active research in this line, if I read to the Society the method employed by Mr. Meigh for making a glaze free of lead. That he was successful was proved by the circumstance of his having placed specimens of the ware, glazed with his solution, in the repository of the Society, and I am indebted to the late Mr. Davenport for a copy, from the archives of the Society, of the Meigh process. It is described as follows:—"The rock called red marl is usually in the form of beds, of a soft, coarsely slaty structure, and red colour, forming the chief part of the common soil, in many extensive districts in this island, to the N. and W. of a line running obliquely from Durham to Exeter. This marl is easily ground in water to an impalpable powder, which remains suspended for a considerable time in the fluid. A mixture of this kind is prepared, and the ware, previously well dried, but not burnt, is immersed in it. The superficial pores of the clay are thus filled with fine particles of the marl, and a fit surface is prepared on which to lay the glazing. Being again carefully dried, the ware is ready for the glaze, which is thus composed:—Take one part Cornish granite, consisting chiefly of felspar, one part glass, one part black manganese, the whole well ground together, and diffused in water, to the consistence of cream. Dip the ware in this mixture, and, when thoroughly dry, place it in the kiln, and fire it in the usual way. The result will be a solid black glaze, very permanent, and not containing any ingredients noxious to health. If an opaque white glaze is required, omit the manganese."

Mr. Meigh also employed common marl and the red marl as ingredients of the body of the ware, with excellent effect, without increasing its expense; he used for this purpose four parts of common marl, one part of red marl, and one part of brick clay. Vessels made of the above mixture were in the possession of the Society. The colour of the body is a reddish cream brown; it is harder, more compact, and less porous than the common red ware; and its general adoption, with the above mentioned glaze, would contribute in no inconsiderable degree to the health of the lower classes, by whom alone the common red ware is used for vessels of cooking.

Filtration of Dusts.—A New Mask.

For my own part I have paid attention to one line of research bearing upon the subject now in hand, I mean, the filtration of dusts, and the best means for preventing the introduction of dusts into the lungs of those operatives who are exposed to atmospheres loaded with particles of dust. This inquiry has led me to the construction of a new mask, which I am now about to submit to your notice.

At first sight it would seem a very easy task to invent a mask which shall exclude all particles of dust, and yet admit freely the atmospheric air; but when we come to the practical art of construction, the thing is not so easy as it looks. We may succeed in keeping out the dust readily enough, but may fail in letting in the air with sufficient freedom. We may succeed in excluding the dust and letting in the air, but may fail in letting out the expired air with sufficient freedom. We may succeed in keeping out dust, and in letting air both in and out, and may yet fail in removing the water that is expired with the breath. Anyone of these failures will be sufficient to spoil a mask intended for ready, prolonged, and easy application.

These necessities were plainly before me from the commencement of my research, and I soon noted down the following requirements as the points to be kept steadily in view:—

(*a.*) Perfection of action for free entrance of air, and for freedom of exit, with balance for inspiration and expiration so arranged that the expiration should be at least one-sixth freer than the inspiration.

(*b.*) Removal of water of expiration.

(*c.*) Selection of a material for filtration that would absorb the smallest possible amount of water, offer as little resistance as is possible, and filter finely.

(*d.*) Arrangement of the filter so that it should, as far as possible, clear itself in expiration of the dust it had received during the time the air was being drawn through it in the act of inspiration.

Through the kindness of Mr. Krohne, of the firm of Krohne and Viscusman, the well-known surgical instrument makers, of Duke-street, Manchester-square, I am able to place before you several respirators, which have been introduced for the purpose we are now considering. Here is a Swiss ori-nasal mask, made of vulcanite, in which the air is drawn through a layer or thin pad of cotton-wool, which can easily be changed. The instrument is very simple, and at first it seems easy to work. But in a little time, as you will discover if you try it, the cotton-wool is saturated with water from the breath, and the breathing is difficult, even in pure air. In air charged with dust the cotton pad is choked with the mixture of moisture and dust.

Here is a second respirator, made of layers of crape spread over a light wire framework. It is easily put on and off, and it lets air freely in and out. It has two faults—it allows water to accumulate in its meshes, and it filters badly. It answers fairly for very coarse dusts, but the finer sorts, such as flour, draw through it almost as easily as if nothing were in the way.

Here, again, is a third contrivance, which is much more elaborate. In this the filter, made of porous woollen material, is enclosed in a perforated metal box, and is worn on the breast, suspended by a cord which passes around the neck. The breathing tube is held in the mouth, and the inspiration is made by the tube through the filter. The expiration is through an independent valved opening, the valve being very light and easy of movement. This apparatus has two advantages; its filter does not become damp from the condensation of water by the breath, and its filtrating surface is large and free. The objections to it are, that all the air has to be drawn in through it by the mouth, an unnatural effect which cannot be persistently sustained for long periods of time. With the utmost care in breathing by the mouth, with care brought by habit to second nature, some dust will find its way into the lungs by the nostrils; it will find its way by mere diffusion, though nose breathing be suspended. The success of the apparatus is, therefore, not certain. The apparatus is also costly, and though it is neat and ingenious, and a really good filter, it could not, I think, be expected to come into general use.

There are some other masks on the table, but those I have shown are the best specimens. From them let me pass to the details of the new mask, to which I am anxious to draw your attention, and to the plans which have led to its construction.

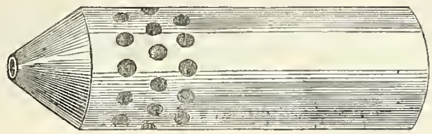
In order to get at the best filter for dusts, I fitted up a testing apparatus, which is here before us. It consists of a dust barrel, fitted with a revolving brush. When the barrel is charged with dust, and the brush is in motion, fine and copious clouds of dust are driven off. At the end of the barrel is a hole two inches in diameter, into which is inserted the neck of a large old-fashioned glass receiver or globe. This glass receiver is drawn out into a long terminal neck, and the neck is connected with a double-acting pump, which I have invented for artificial respiration, and which has been skilfully constructed for me by Mr. Krohne. The pump is worked by a handle, like an air-pump, and in its action it perfectly represents the action of the human lungs in their inspiratory and expiratory movements. At this moment the apparatus is all duly set for work. If Mr. Krohne, who is assisting me, were to put in motion the revolving brush in the dust barrel, while I, at the same time, set the breathing-pump in motion, the glass cylinder would be immediately filled with the cloud of dust from the barrel, because I should draw the dust in with the inspiratory stroke of the pump. To test the effect of different filtering substances, then, I have simply to remove the glass globe from the dust-barrel, introduce the filter I meant to test into the barrel, readjust the globe, and set the apparatus in action. Should the filter be perfect, no particle of dust will enter the glass globe.

There are, of course, great differences in fineness of dusts, and the value of a filter has to be determined by its facility for separating the finest. The dust I experiment with, as the best of all for testing purposes, is the flour called Colman's corn-flour. This flour is reduced to such an impalpable powder, that, when it is well dried, it can be drawn, as dust, with greater ease through filtering mediums than any other substance I can find. It has also another advantage—it is a pure starch, and when it is drawn over a solution of iodine, though the cloud of it be so fine as to be invisible to the eye, it combines with the iodine, and yields an insoluble deposit of the blue iodide of starch at the bottom of the solution, which deposit can be collected, dried, and weighed. A means of determining the filtering power of different substances is thus supplied, since the amount of air drawn over by the pump from the dust-barrel can be regulated, and the dust allowed to settle in the solution is fixed in combination as a chemical compound, which can easily be separated, dried, and weighed.

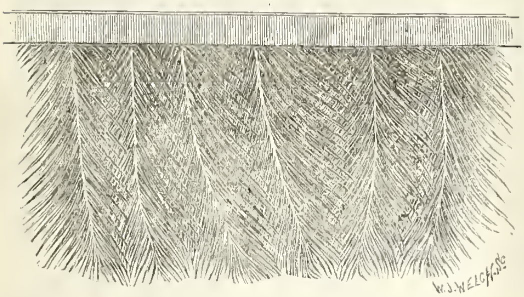
It is most easy, with this apparatus, to try any kind of filter with fine dust; and without troubling you with a number of negative details, I come at once to the fact that the best filtering medium I have been able to discover is a layer of soft feathers. The advantages of feathers as filters of dust are many. They are very light, they separate perfectly, admitting air in any quantity while excluding dust, and they absorb water less than perhaps any other porous flexible substance, They have the further advantage of being very cheaply procured, and of being easily made up into filters.

Having determined, in the manner related, the best material for the filter, the next step was to learn the best mode of construction of a mask. Many plans occurred to me before I could be satisfied. At last, I thought of that mode of natural filtration within the lungs, which I have already explained as ciliary motion. I tried to

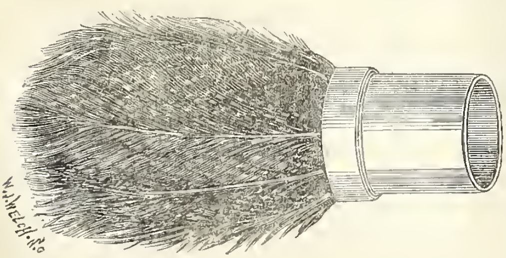
imitate this process, first, by a revolving wheel of feathers, which should draw down to an opening during inspiration, and should revolve like a fan during expiration, moved by the current of the expired breath. By this revolving movement, I thought the feathers would filter during inspiration, and would be cleared of their dust during expiration. The plan would indeed succeed, but the balance of the wheels has to be finely set, and the wheel soon gets out of gear, a misfortune that is fatal to success. Next, I planned to fix the feathers transversely across a breathing tube, giving them a direction so that in inspiration they would be drawn across the tube and filter, but in expiration would be driven out against the near side of the tube. This plan was imperfect, because the feathers could not be freed of their accumulated dust by the act of expiration. At last it occurred to me to roll the feathers round the outside of a perforated breathing tube, and so to arrange them that in inspiration they would come down over the perforations and filter, while in expiration they would be blown out from the tube as feather valves. This plan is most perfect. Here is one of the perforated breathing tubes.



Here is a piece of the feather valve. It is made by connecting the light feathers drawn from the leg plumage of the pheasant along a line of tape.



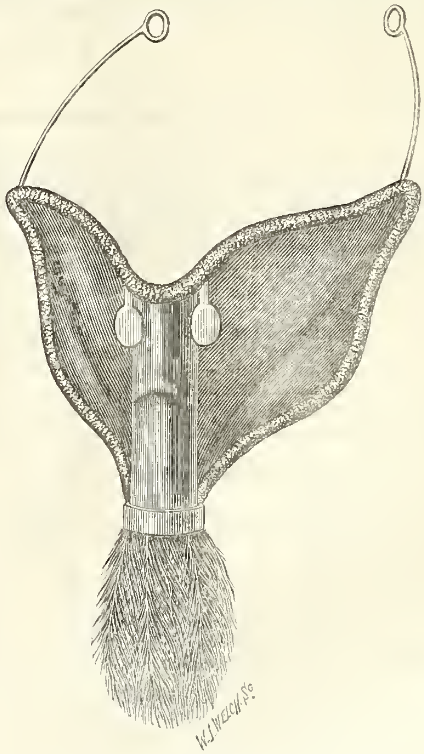
I wrap the band round the tube between the perforations, so that the feathers fall over the perforations. I secure the band in position with gum, and the tube is complete.



In order to give you an idea how one of these tubes work, I will insert it in the dust-barrel of our test apparatus. I will now fill the barrel with dust, and I will draw over the air from the barrel through the glass globe, by means of the double acting pump. You will see there is not a trace of dust carried into the globe, it has all been filtered out by the feather filter. I will now remove the filter, and you will see that one stroke of the pump is sufficient to fill the globe with the dust.

In this filter, lightness, dryness, perfect filtration and self-cleansing of dust are ensured, and I do not think any better or simpler method could come from further experiment. To adopt the filter to the worker, it is placed in a light face-mask, which is here at hand.

I can put it on and take it off as easily as if it were a pair of spectacles. The filter tube is placed below, so as to catch all the inspired air, and by means of the two side expiratory valves nearly all the moisture of the breath is set free. The outline of the mask is depicted in the accompanying diagram.



Conclusion.

The work of my present course of lectures on industrial pathology is now ended. I entered upon the work impressed with its importance, and with a due sense of the labour that would be involved in the prosecution of it. I leave it for the moment, impressed a hundredfold with a sense of its magnitude on the one hand, and of the littleness of the effort I have, even with much industry, been able to carry out. The subject is national in its bearings, and is a serious study for all sections of the community.

To those who take up the investigation of industrial pathology, for the simple purpose of learning how they can make the lives of the industrial toilers and spinners of our great country happier, healthier, longer, and better, to those,—who often in ridicule are called philanthropists,—the subject is of absorbing interest.

It is not, however, to them of greater moment than it is to the selfish, practical people who deem nothing useful, nothing of good report, except it bring them some instant or prospective advantage. One day these complacent, practical men will wake to realise the stern fact that neglect of the duty of brother-keeping is even worse

than the neglect of the duty of book-keeping, and that the natural cure of unnatural neglect is indeed a terrible remedy, and that it is like a plague, the causes of which, being known, are removable while they are quiescent, but which set in motion, are swift, beyond human control, and include all classes in the catastrophe they establish. In plain, solemn fact the whole of the industrial class of England, made up of five millions of living hearts, is sick at heart, is physically, and, therefore mentally unhealthy. It lives as if it were always in hospital, undergoing various treatment, but wanting the conditions without which, if by some miracle it were for a moment cured, it could not continue to live in health of body and of mind.

In this state it exists as sick men commonly exist, wayward, unreasoning, unhappy; reckless often about itself, angered with those it compares with itself; mistrustful of learned political leeches, and cheated by the unlearned, whom, in despair, and lured by their pretensions, it too often follows.

The political State doctors who would cure the disease must follow the ordinary modern physician, in giving greater attention to external conditions, and less to placebos and assumed specific cures.

If the Society of Arts can succeed in opening the eyes of the governing classes to these painfully simple facts, and can thereby induce an improved treatment in the practice of dealing with them, it will add to its credit another of those great works in which, for a century past, it has laboured with such untiring devotion.

MISCELLANEOUS.

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(*Subsidised by Parliament.*)

The results, giving important information for public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. Number of visitors for the month of March, 1876. When they are counted by sight the letter "S" is used, when by turnstile the letter "M":—

Institutions.	Amounts voted in 1875.	Number of Visitors in March.	How counted.	Remarks.
	£			
1. British Museum	107,471	33,270	S	Return refused. Number given for January of year last published in estimates. (1)
2. National Gallery, Charing-cross	6,346	69,969	S	Open 17 public days. Total for the first three months, 161,387. (2)
3. Kew Gardens and Museum	21,257	9,005	S	Open on Sundays and week days. (3)
4. South Kensington Museum	39,019	63,735	M	Total for year, 839,212. Open daily all the year and in the evening, except Sundays (4)
5. Bethnal-green Museum	7,325	35,595	M	Total for year, 522,098. Open daily all the year and in the evening, except Sundays. (5)
6. National Portrait Gallery, South Kensington	1,956	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines & Mining Record Office, Geological Museum, Jormyn-street	9,070	5,263	M	Open daily, except Sundays and Fridays, and in the evenings of Mondays and Saturdays.
8. Patent Office Museum, South Kensington	..	..	M	Total for the year 1875, 265,233. Open daily, except Sundays. (8)
9. Edinburgh National Gallery	2,100	5,307	M	(9)
10. Edinburgh Museum of Antiquities	..	4,753	M	(10)
11. Edinburgh Museum of Science and Art	10,509	26,546	M	Total for 1875, 455,784. (11)
12. Edinburgh Botanic Gardens	1,750	2,927	M	(12)
13. Dublin Museum of Natural History	1,717	8,464	M	Open daily, and in the evening. (13
14. Glasnevin Botanical Gardens and Museum	2,224	7,991	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland	2,389	10,853	M	(15)
16. Museum of Royal Irish Academy, Dublin	200	..	M	(16)
17. Zoological Gardens, Dublin	500	5,051	M	Open daily, including Sundays. (17)
18. Tower of London	1,500	14,289	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall	..	21,048	S	Open daily, including Sundays. (19
20. Royal Naval Museum, Greenwich	1,190	1,852	S	Open daily, except Fridays & Saturdays. (20)
21. India Museum, South Kensington	5,883	3,592	M	Paid for by Indian Government. (21)
22. Hampton Court Palace	3,465	..	M	Open on Sundays, and on week days except Fridays. (22)

(1) Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays.

(2) Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays.

(4) (5) Open morning and evening till 10, on Mondays, Tuesdays, and Saturdays. Students' days—Wednesday, Thursday, and Friday, 6d. entrance.

(7) (8) Open till 10 in evenings of Monday, Tuesday, and Saturday.

(9) (10) (12) (15) (16) (20) No information as to opening.

(11) Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days, Monday, Tuesday and Thursday; admission 6d.; other days, admission free.

(21) Open on Mondays, Tuesdays, Fridays, and Saturdays, one penny admission; on Wednesday and Thursday, sixpence admission.

IMITATION OF CHINESE AND JAPANESE BRONZES.

For a long time the *patina* given by the Chinese and Japanese to their bronzes has excited the admiration of Europe. The dead black especially, from which the delicate arabesques, inlaid in gold or silver, stand out, has always appeared remarkable; up to the present time, however, the method of its production has remained a secret. It is well known that in China and Japan, as there are no Patent-laws, various processes remain the property of a few families, and are handed down from father to son without the secret ever being made public.

The perfection to which chemical analysis has been brought at the present day makes known the secrets of eastern nations without any inducement to have resort to strategem for unravelling them. M. Morin, to whom were entrusted some specimens of various bronzes, submitted them to analysis, the result of which led him to form the opinion that the *patina* of black bronzes forms part of the metal, and is not due to a varnish or a superficial sulphurisation, but results from the use of a bronze of rather complex nature, in which are 80 per cent. of copper, 4 of tin, 10 of lead, 2 of zinc, and 4 of iron, gold, nickle, arsenic and sulphur. Some of the bronzes analysed show a proportion of lead varying from 10 to 20 per cent. added at the expense of the copper, and a quantity of 7 per cent. of tin. Moulded in very thin plates, this bronze readily takes any form given to it, and is easily worked, the *patina* appearing of itself when the finished work of art is subjected, in a muffle-furnace, to the action of a very high temperature. Unfortunately, these bronzes are very brittle, as many *virtuosi* have discovered to their cost.

Chemical analysis is, however, of little use in this case, unless it leads to synthesis. Incited by the high prices realised by black bronzes, and desirous of turning to account the effects of contrast obtained by the silver or gold inlaid on a black ground, French manufacturers have made experiments on various processes for the manufacture of bronzes like those of the east. M. Morin, and MM. Christofle and Bouillet, have been more fortunate than those who preceded them, having arrived at an imitation of the Japanese bronzes, if indeed they have not surpassed them, for to beauty of appearance the metal unites a strength equal to that of ordinary bronze. Starting from tho principle that to be lasting and uniform a *patina* should not be a simple varnish or the result of a laying on of colour, but should constitute a chemical change of the surface of the bronze; in the second place rejecting as too fragile the lead bronzes of the Japanese, to adopt the copper bronze worked by the hammer or deposited by electro-metallurgy, the manufacturers above mentioned have presented to the *Académie des Sciences* some specimens of their work. These objects had the black, brown, red, and also the green *patina*, perfectly uniform; some had more than one tint on their surface, and others were inlaid with gold or silver.

The processes adopted for obtaining the ground consist of subjecting the objects to the action of chemical compounds having the oxides and sulphides of copper as their base; and the principal condition of the intensity and uniformity of tint consists not only in the choice and the purity of the substances employed, but also in the length of time occupied by tho process.

If different tints be desired on the same object, it is sufficient to cover with a protecting varnish all portions of the surface except those to which it may be desired to give a certain hue; then, when this has been treated for a sufficient time, it is in turn covered with varnish while the other portions of the surface, now exposed, are subjected to the action of the chemicals, and so on for as many tints as may be required.

The inlaid enamel work which is performed by oriental artists with so much skill and patience, and at the same time with such primitive appliances, is now executed by simpler and quicker means. The object to be inlaid is entirely covered with varnish, portions of which are removed by a graver so as to form the design; and thus prepared, it is subjected to the action of a galvanic bath of gold or silver, which deposits the metal in the places laid bare by the graver. Another method is, however, mentioned by M. Morin. After the removal of the varnish according to the pattern by the graver, the object is plunged into a solution of cyanide of silver. The salt is deposited on the lines from which the varnish has been removed; the object is heated in a muffle-furnace, and the metal appears on the black *patina*. Inlaid patterns of gold and silver may be obtained, either of their natural brightness, or with a dead surface, the latter being effected by different processes of oxidation; so that, on the same object, by making use of the protecting varnish, designs in gold and silver of various degrees of lustre may be combined.

THE FAIR OF NIJNI-NOVOGOROD.

The fair of Nijni-Novogorod, or, as it is sometimes termed, Macarieva, is held on a piece of land opposite the town of Nijni-Novogorod, at the confluence of the rivers Oka and Volga, having been transported to its present position after the conflagration which destroyed the former fair, then held opposite the Macarieva Yellow-Water Monastery. The position occupied by the fair is unrivalled in the whole Russian Empire for the advantages of water-communication. On the one hand the Volga, united by a system of canals with the Baltic Sea, and flowing into the Caspian, the basin of the rivers of Central Asia, forms a cheap route for the transport of merchandise from Europe and from the North of Russia to Asia. On the other hand, the Oka, with a course of 2,400 versts through Central Russia, watering the Governments of Orel, Kaluga, Toula, Moscow, Riazan, Tambov, Vladimir, and Nijni-Novogorod, bears to the Volga the produce of the richest soil of Russia, as well as the manufactures of the most industrial and densely-populated districts: thus connecting by an inexpensive water route, the fair of Nijni with the commercially enterprising manufacturing city of Moscow. Here, also, near the confluence of these two rivers, and contributing a great volume of water to the Volga, flows the river Kamma, one of the few tributary streams which have a course from east to west, uniting the latter with the remote northern and north-eastern parts of Russia, Siberia, and the Ural, possessing rich deposits of minerals and metals. Not only, however, are the rivers then, as means of transport, favourable to the position of the fair, the position itself is the very centre of industrial activity and historical recollection.

In the year 1816, the fair was transfered to this place, the Government market-halls were erected, and opened eventually in 1818. Till that time the fair had been held near the monastery of Macarieva, Yellow-Water, on the left bank of the Volga, in the meadows opposite the celebrated village of Liskova, about eighty versts from Nijni, lower down the river. The ground occupied was purchased by the Government from the town of Nijni, and buildings were erected upon it, originally at the Government expense, on the plan laid out by the celebrated Russian engineer, General Betancour. The centre of the fair forms an immense market-hall, rectangular in shape, situate on the left bank of the Oka, between that river and Lake Mestcherski, a broad sheet of water almost adjoining the Volga, but divided from it by a narrow strip of land. The surface of the lake is about six yards above tho low-water level of the Volga. The rectangular market-place consists of twelve rows of commercial edifices, four in each row, the centre traversed by a boulevard planted with trees. One end of this boulevard opens upon the square in front of tho cathedral church, at the other stands the so-called "Chief House of the Fair," which contains the hall of the exchange, fair-office,

telegraph station, post-office, and apartments appointed for the residence of the Governor-General during the continuance of the fair. Near the square, behind the "Chief House," are several other commercial buildings, and between them and the river Oka is the Chapel of St. Macarius, on each side of which stands a tower with a flag-staff. The raising and lowering of the flags denote the inauguration and the close of the fair. Occupying the space between the twelve rows of market-halls and cathedral, and standing at right angles to the former, are four edifices, somewhat resembling the Chinese style. Formerly they were divided one from another by inner walls, but afterwards, with the development of commerce, many traders occupying shops on both sides took down the partition-walls, and formed the so-called passage-shops.

The whole of the rectangle occupied by the market-halls of the fair is surrounded by a moat in the shape of a horse-shoe, the fore part of which encompasses the church. The moat is planted round with trees, and has its waters supplied by the Mestcherski Lake, which, in turn, to prevent the possibility of its exhaustion, is connected by a canal, seventeen versts in length, with the river Pivira. Between the market-halls and the moat there exists the celebrated subterranean gallery, washed by the water from Lake Mestcherski, which, rushing with great impetus into the gallery, cleanses it thoroughly, carrying away all rubbish into the river Oka, whose level is six yards lower than that of the lake. Behind or outside the moat are the following Government buildings:—Armenian Church, Tartar Mosque, and the Persian buildings, which formerly served as the exclusive dwelling-place of traders arriving from Asia, but now more commodiously substituted by the recently-constructed caravanserai. Until a few years ago the use of fire was prohibited in all the buildings of the market-halls, and all lights had to be extinguished by nine o'clock. The trakteers, eating-houses, places of amusement, &c., having the privilege of illumination, were constructed outside the moat. At present, the rules with regard to fire are not so strictly enforced, but great caution is observed in the use of it, on account of the enormous amount of merchandise stored in the interior of the market-halls. In consequence of the development of the fair, all the space around the market-halls is covered with the private buildings belonging to commercial houses, formerly constructed of wood; now, however, the use of brick or stone material is obligatory.

The inauguration of the fair takes place on the 25th of June, and comes to a close on the 5th of September, the day on which the flags are lowered to denote that all trading has come to an end. There are, however, fifteen days more devoted to the settlement of all accounts. The supervision over all the different branches of the administration of the fair belongs to the governor, and the management of the transactions of the fair is entrusted to a committee, the manager of the fair-office, and the mayor of the town of Nijni-Novogorod. The president of the exchange committee of the fair, as well as the aldermen and the members of the committee, are elected by an assembly of deputies chosen from among the merchants, and serve for a term of three years, with the exception of the members of the committee, whose term of service closes at the expiration of one year. M. Doria, secretary of legation at St. Petersburg, likewise states that the number of visitors in 1875 was calculated at 1,000,000, of whom 150,000 were resident for a longer or shorter period during the fair at one time.

Since the year 1847 to 1874, the total value of the imports has more than tripled, from 55,000,000 to 180,000,000 roubles. The value of merchandise actually sold in 1847 was 48,000,000 roubles; in 1874 it amounted to 164,000,000 roubles. Judging from these figures it cannot be stated that the importance of the trade of Nijni has been diminished or to any extent directed into other channels throughout the Empire by the influence of the railways, although a diminution in the amount has often been expected, owing to the quantity imported by Riga from England.

ELECTRICITY AT THE NATIONAL ASSEMBLY.

The National Assembly at Versailles is illuminated by 356 gas burners, and these are lighted by electricity. The apparatus was constructed by M. Gaiffe, who had to deal with a difficult problem, as the burners were too far from each other to communicate the light to each other. The system, which is largely adopted in this and other countries, of heating a platinum wire to redness by means of electric piles, was rejected, as it would have required a number of batteries, yet the lighting would still have been slow, and the wires would be in great danger of being broken when the chandeliers and lustres were cleaned. M. Gaiffe adopted the system of lighting by the spark.

The apparatus consists of—1, a battery, with hydrochlorate of ammonia and peroxide of manganese; 2, an induction coil; 3, a series of conductors, with a total length of 1,400 metres, so well isolated as to lose none of the charge, although the tension is immense; 4, 356 inflamers, one to each burner; 5, a contact breaker between the battery and the coil; and finally, a distributor worked by hand, which sends the current to the various sets of burners in rotation. The batteries consist of four couples, 20 inches high, connected together by means of two thick copper conductors. There is a special arrangement for preventing the possible accident of the current not being cut off by the attendant; the apparatus is placed in a kind of press or cupboard, which is closed by a sliding door, and when the latter is shut it strikes down the lever of the contact breaker mentioned above. A conductor from one end of the coil touches all the lustres; a second, from the opposite end, is attached to an isolated discharging rod, which the attendant holds in his hand. The distributor on which he operates consists of a slab of india-rubber, having eighteen metallic buttons, each connected by a wire with as many lustres. The conductors are formed of four copper wires with triple covering of gutta-percha, tarred cord, and india-rubber ribbon. They are supported by vulcanite (*Caoutchouc durci*) isolators, and at all places where they require to be covered over, the parts of the wire are enveloped in an additional casing of india-rubber, two millimetres in thickness. The actual illuminators are fixed on a small circular plate, which is placed on the gas-pipe just below the burner; they consist of two pieces of thick iron wire, bent round above, so that their points, which are fitted with strong platinum wires about a quarter of an inch long, are exactly where the explosive mixture of gas and air is formed. The distance between the points is half a millimetre. All the illuminators of the same group are connected with one another, and with the conductors, so as to form a circuit with as many breaks as these jets. Standing in the current of air which feeds the burner the iron wires are kept cool. When the gas is to be lighted, the operator turns it on and waits a few minutes that the air may all be driven out of the pipes, places the coil in connection with the batteries, and touches the eighteen metal buttons of the distributor successively with his discharging rod. The whole of the burners are lighted in fourteen seconds. The apparatus has worked for two years without interruption, and the batteries have only expended three kilogrammes of zinc.

Formerly, in order not to interrupt the Assembly by lighting the house, the gas was burnt during the whole sitting, and although it was kept as low as possible, until required, it caused a good deal of heat, and vitiated the atmosphere; the cost of the wasted gas, too, was con-

siderable, for the present arrangement is said to be more economical than the former by about £80 a month.

M. Gaiffe has received the platinum medal of the Société d'Encouragement of Paris for his system and apparatus.

PARIS EXHIBITION OF THE APPLICATIONS OF ELECTRICITY.

An announcement of this projected exhibition has appeared in the *Journal.* The entire scheme is now published, and there is every reason to believe that it will be attended with success. The amount of interest which will be excited by such an exhibition may be best estimated by reference to the subjects of the eighteen groups which form the programme. The first group is retrospective, including as far as possible the apparatus of all the early discoverers. The second is devoted to laboratory apparatus, and static and dynamic electricity. The third group includes batteries, piles, and generators of all kinds. The fourth is devoted to electro-magnetism and its converse. The fifth group comprises the entire field of electric telegraphy. Others are devoted to electric horology, to the applications of electricity to railway trains, signals, &c.; to electric motors of all kinds; electric lighting, with its applications to photography; electro-chemistry, electro-metallurgy, synthesis and analysis; electro galvanic applications to the fine arts; electrotype and electro-engraving; medical electricity; lightning conductors, and other apparatus connected with atmospheric electricity; the applications of electricity to military and naval purposes; electric toys and curiosities; and, lastly, a collection of all the works that can be obtained upon electricity and its applications, whether French or foreign, with an analytical catalogue. The subject is a large one, and capable of interesting illustrations.

The proposal has been supported by the Government, and the letters of the ministers of war, of the marine, finance, public instruction, and public works, have recently appeared in print. The ministers of war and of the marine have authorised the officers of the army and navy to lend their aid, and have themselves named several officers of both services, and the other ministers have offered similar assistance.

Comte Hallez d'Arros, with whom the scheme originated, has formed a numerous and powerful committee of organisation, including many of the best known men of science, engineers, and others in France, for instance, in MM. Edmond Becquerel, Bréguet, Dalloz, Dumoulin, Gournerie (de la), Drs. Lionville, Lœury, Marié-Davy, Tessie du Motay; a large proportion of the members being engaged in the practical applications of electricity.

It is rather curious that while England and other countries have special publications devoted to electricity, France has not heretofore possessed a single one. Comte Hallez d'Arros has, therefore, established one under the simple title, "L'Electricité," the first number of which has recently appeared, and which of course becomes *pro tem.* the organ of the undertaking.

The exhibition is to take place in the Palais de l'Industrie in the Champs Elysées, and is announced to open on the 14th of July and to close at the end of November. As in the cases of the Maritime Exhibition held last year, and of that of Brussels which is to open in June, exhibitors will have to pay for the space which they occupy.

Commissions are being formed in various countries, the delegate for Great Britian being Mr. E. Johnson, 3, Castle-street, Holborn.

A telegraph line which is to connect Adelaide, South Australia, with the capital of the neighbouring colony of Western Australia, is reported as making satisfactory progress.

USES OF QUICKSILVER IN JAPAN.

In a paper read before the Asiatic Society of Japan by Dr. Geerts, and reproduced by the *Japan Mail*, it is stated that the metallurgy of mercury has never reached any great degree of importance in Japan, because the chief quicksilver ore—natural cinnabar—does not seem to be found in sufficient quantities to make the separation of the metal a profitable industry. Since the opening of Japan to foreign trade especially, nearly all mercury used in the country has been imported from Europe or America. In former times the Chinese of Nagasaki also imported Chinese-made mercury into Japan, but now even the Chinese, notwithstanding they have large quantities of cinnabar in their own country, buy foreign quicksilver, because it is much purer, and relatively cheaper than their own metal. In former times small quantities of mercury were distilled at the island Hirado, in the province of Hizen, in Nagasaki and Osaka, but now these manufactures are wholly given up. The only quicksilver ore met with in Japan is the cinnabar, or sulphide of mercury. It was known in China from the earliest times, and much esteemed as a wonderful, mysterious, celestial substance, which could give liquid silver when heated. The old Egyptians with their Hermes Trismegistus—the mysterious founder of chemistry, in whose grave the "Tabula Smaragdina" should have been detected by Alexander the Great, bearing the inscription, "*Itaque voca tus sum Hermes Trismegistus habens tres partes Philosophiæ totius mundi*" —the old Egyptians very probably knew cinnabar, although Theophrastus (371 B.C.) gives us in his work on minerals the first information about this substance.

It is a remarkable fact that the Chinese had even in the second century before our era considered the cinnabar as a celestial or fairy substance, and used the same in their alchemical pursuits to find "the medicine of immortality," or *elixir vitæ* of our western alchemists. If we may believe Mr. Edkins, it would seem certain that Ko-hung, a Chinese writer on alchemy, and editor of a work printed in the 4th century A.D., gives different minerals and herbs, which ought more or less to possess the properties of celestial medicine. It is in every case a fact that the Chinese had some alchemical literature anterior to the period when alchemy was studied in Egypt and the West; and if we take this fact in relation with others, it is suggested that the Egyptians, and later the Europeans, got the first idea of alchemy from China. Among the various grounds for this opinion, the chief is that the Persians often came to China at the beginning of our era. After the invasion by the Mohammedans of Persia, the Persians continued their intercourse with China. Persian, Arabian, and even Greek embassies from Constantinople, visited from time to time the Chinese Court. Arabian merchants settled in several Chinese ports, and had frequent intercourse by sea with the ports near the Persian Gulf. It is for this reason thought probable that an art, so full of interest as the art of gold-making, was introduced into Persia from China, and from that country to Egypt and the countries of Asia Minor.

The Japanese, like most of the other metallurgical processes, also learned the use of cinnabar and the distillation of mercury from the Chinese. Their method is nearly an exact copy of the process described in the Chinese technology. The cinnabar is first powdered by means of an iron boat-shaped mortar with a circular knife. It is then washed to remove the foreign matter, and to obtain the cinnabar in a finely powdered state. This is, after being dried, mixed with an equal weight of half-burned charcoal (half coal and half ashes), and the whole is put into an iron pot, which is carefully covered with a round iron cover. This cover has in the middle a round opening, into which a curved tube of plate iron is fixed, and cemented with a mixture of loam, salt, and a little water, the other extremity of the tube ending in a pot filled with cold

water. The whole tube is wrapped up in old clothing, or some fibrous substance, and kept cool by aid of cold water. The whole is gradually heated on a small open charcoal furnace, the quicksilver distilling into the pot of water. This process is founded on the fact that the sulphur of the sulphide of mercury (cinnabar) is retained by the ashes (calcium salts), and perhaps also by the iron of the inner surface of the pot, the mercury evaporating by the heat. This quicksilver is, however, not pure, but contains always a small quantity of foreign metals (lead, copper, &c.), which were also present in the ore.

The chief employment of quicksilver in Japan is in the manufacture of bronze mirrors. Another application is in the art of gilding in the dry way, and in the manufacture of different mercurial preparations, and in medicine. The Japanese are well acquainted with the method of testing the purity of mercury by heating a small quantity in a small open iron dish, and estimating the amount of non-volatile matter, after all the quicksilver has been evaporated. Foreign mercury is justly preferred by the Japanese to the Chinese or Japanese product. Cinnabar is imported for medical uses, and lacquer-ware from China and the Lin-kiu Islands.

A NEW PLANT FOR CATTLE FEEDING.

Under the above title some attention has recently been directed to a boraginaceous plant—a close ally to our common cornfrey—for extensive cultivation as a fodder plant. It is known as the Caucasian prickly cornfrey, and is the *Lymphytum asperrimum* of botanists. Though the plant is spoken of as a novelty for cattle feeding, its adaptability for such has been known for some years, and an analysis has been made by Professor Voelcker. It was introduced to this country from the Caucasus at the early part of the present century, more as an ornamental plant, on account of its bold foliage and light blue flowers, than for any useful purpose. The recommendation of agriculturists some few years since, to grow it extensively as a green fodder plant was not at the time followed up, and now that the plant has come before the agriculturist again, and that crowns and root cuttings suitable for planting are actually advertised at £5 per 1,000, it is to be hoped that it may have a fair trial. This particular species of cornfrey is described as being specially adapted for the feeding and fattening of stock, and for increasing the yield of milk in cows. Its growth is more rapid and luxuriant than any other green soiling plant, producing on a given space a larger yield than any other crop. Good grass land yields 8 tons of grass to the acre, cut green, lucerne 40, rye grass 50, vetches 20, while cornfrey gives from 80 to 120 tons; whether this return would be similar on all soils can only be authenticated by continued cultivation and experiment. It is, however, a deep-rooted plant, and is to a certain extent independent of weather and climate, for in the dryest and hottest seasons it has been known to afford several heavy cuttings when most other vegetation is burnt up or suffering from drought. Other advantages are, that it comes earlier than any other crop and lasts longer, frequently affording forage until it is cut down by severe frosts. Above and around the root-stem, are shoots or suckers which can be taken off for planting and the roots sub-divided, so that the plant can be successfully and easily propagated; the planting may be made at all seasons except during frosts.

Its cultivation is simple and not costly. The ground should be ploughed six or eight inches deep and then manured, the cuttings should then be planted like potato sets about three feet apart. In winter the roots should be well dressed with ordinary manure or sewage. Besides its use as a green food, when dried into hay it also forms an excellent food for horses, cattle, sheep, pigs, &c. The juice of the plant contains a quantity of gum and mucilage, but very little sugar.

COOKERY IN A VILLAGE SCHOOL.

Mr. Browne Clayton, who has been a pioneer in introducing cookery in schools in Ireland and elsewhere, sends a printed account of the successful working of a cookery class in the village school at Charlton Kings, of which the following is an abridgment:—

"The room was a square one, fitted up for present necessities. A large table in the middle, two cooking-stoves at the right-hand side, and broad shelves or tables by each wall, which perhaps were sometime school desks. On these shelves were bright saucepans and kettles, plates and dishes, basins and bowls, chopping boards and trays. Over these shelves or tables were wooden pegs on which hung all kinds of utensils, intended to act as aids to culinary skill; there were strainers, dredgers, tammy sieves, hooks, skewers, biscuit cutters, and conveniences innumerable.

"The workers clustered round the table, or busied themselves at the side-shelves, all intent on the matter in hand. Here was a tiny thing, of perhaps ten years, chopping away at Australian meat that had to be minced; there was another, scarcely so old, performing the same kind office on parsley and thyme. Here was one slicing potatoes and another cutting up beef, and another rolling out pie crust. So busy were they, and so constantly popping here and there, that it was some time before one could realise the perfect order of their work; each one was working to only one end, and, though the labour was divided amongst them, all of them were capable of doing any part of the work in hand. For instance, one made pastry; another rolled it out and cut it into strips; a third egged and lined the edges of a number of little dishes; a fourth put in the cut-up beef and sliced potatoes; a fifth seasoned and added water for the gravy; a sixth put on the top crust, notched the edges, and finished off with some wonderful decoration in the shape of a rose and leaves; and behold the table was covered with potato pies, which were at once carried off to the bakers. Then the croquet shapes were in requisition, and the minced Australian meat, nicely flavoured with onion and seasoning. Some of the little women lined the tins, others filled them and covered them. Others turned them out, covered them with egg and bread crumbs, while another fried them in the boiling fat. On the other side, one measured out the minced meat and made up dainty rissoles, while next to them three were busy with baked apple dumplings, while quite an interesting party weighed and measured, and discussed the preparation of some gingerbread nuts. And every now and then there was a running to the stoves 'to stir my stew,' or 'to look at my cakes,' or 'to see that my pudding was not boiled dry,' which showed them to be cooks in embryo. It would take too much of your space if I attempted to tell you of the preparation of everything made that morning. At half-past twelve, as if by magic, the table was cleared, and the cloth laid, and the spread began. The pies were fetched from the bakery, and each one dished up her own. There were potato pies, soup, stew, beefsteak pudding, croquets, rissoles (fried to such a delicious brown), raisin pudding, boiled bread puddings, apple and current dumplings, currant cakes, gingerbread nuts, and many other dainties. Twelve little children of tho village came in and ate their dinner there. Others came and purchased dinners to take home. Jugs were brought for soup, plates and dishes for other good things. Potato pies were sold for 2d., 3d., and 4d., according to their size. Croquets and rissoles cost ½d. each, a good meal of beefsteak pudding cost 3d., and the especially delicious stew was only 2d. a quart. We were informed that the little cooks themselves were large purchasers, and eventually dined heartily themselves off their preparations. I have said something of the workers and the work, but nothing of the teachers. What more can I say? Their work speaks for them. Two or three young

ladies — themselves arrayed in spotless aprons and sleeves, and the delightful French cap—were constantly watching over the youthful energy they had called into exertion. Advising, hinting, praising, and, with their own hands, setting plainly before their pupils the better way of doing everything. Stirring by the fire, peeping into the oven, chatting, and helping, their work speaks for them—it is not for me to give them higher praise than that—and surely not the least part of their reward was the perfect love and confidence evinced towards them by the whole of the youthful band. 'We find it costs us about 2s. a-week besides our trouble,' one of these ladies courteously informed me. Two shillings a-week! and such results. More than a dozen ignorant girls instructed and encouraged in the attainment of such skill as will be useful to them all their lives, and this for 2s. a-week! Surely, Charlton Kings is saying very plainly to larger towns—'Go you and do likewise.' "

THE CLEANSING OF WOOL.

MM. Salvetat and Barral, having inquired into the action of a great number of substances for the chemical cleansing of wool, have now submitted the result of their labours to the Academy. The original process consisted in treating the tissue with a weak solution of sulphuric acid marking 4 to 5 degrees on Baumé's hydrometer, and afterwards placing it in a stove heated to from 125 to 140 degrees Cent. (259 to 284 degrees Fahr.) But a considerable number of substances may replace the sulphuric acid in this operation, and frequent experiments have led to the following conclusions:—

1. Cellulose and lignose may be decomposed by the action of the following chemical agents, provided that the tissue, dried after imbibition, be afterwards raised in a stove to a temperature of about 140 degrees Cent.:—Sulphuric acid, hydrochlorate of alumina, hydrochloric acid, nitric acid; the chlorides of iron, zinc, tin, and copper; nitrates of copper, magnesia, and iron; sulphates of tin and alumina; bisulphate of potash; chrome alum; boracic acid; acid phosphate of lime; oxalic acid.
2. Wool, on the contrary, is not attacked under the same conditions.
3. The following agents, acting also under the same conditions, do not destroy vegetable fibre:—Chlorides of sodium, potassium, barium, calcium, magnesium, and mercury; hydrochlorate of ammonia; nitrates of ammonia, mercury, lead, soda, barytes, lime, and potash; sulphates of copper, ammonia, manganese, iron, lime, magnesia, soda, and potash; bisulphate of soda; ammonia alum; nitrate of alumina, potash of alum, tartrate of soda and potash; phosphates of ammonia, soda, and potash; iodide of potassium; tartrate of soda; chlorate of potash; hypochlorite of potash, oxalate of ammonia, oxalate of potassa; tartaric, acetic, and citric acids.

M. Broghelli, the Australian statistician, has calculated the total quantity of ores extracted from the whole of Europe, during the year 1874, to be:—Platinum, 1 ton; gold, 62 tons; silver, 300 tons; iron, 240,000 tons; copper, 600 tons; lead, 5,300 tons; zinc, 3,000 tons; coal 4,376,000 tons; salt, 50,000 tons; manganese, 1,616 tons; and antimony, 570 tons.

The Russian *Government Messenger* publishes an official report on all the fires which took place in Russia during 1875. According to his report there were 25,976 fires last year, of which 3,609 were due to incendiarism. The total damage is estimated at 64,096,896 roubles, or more than 8 millions sterling.

CORRESPONDENCE.

THE NATIONAL TRAINING SCHOOL FOR MUSIC.

SIR,—No one who has any real love for music, or who desires its advancement in this country, can fail to be interested in the efforts which the Society of Arts is now making for the permanent establishment of a National Training School for Music in London. The need of such an institution has long been felt, and now, after some years of careful deliberation, a system has been arranged, for which only a hearty national support is needed, in order that it may at once be carried into effect. The Training School itself is ready—nothing is wanting but sufficient funds to enable the institution to open wide its doors and begin its work in earnest. Now, then, let us ask ourselves, what is onr position, nationally, with regard to music? what is the boon which is thus offered for our acceptance?

Mr. Ruskin, in one of his many writings upon Art, has laid it down as a positively certain law, that "there is but one right way of doing any given thing," and though, just at first sight, this maxim may seem arbitrary, yet experience finds it to be true, and quite as true of music as of her sister arts. If, then, there is but one right way of studying music, alas for the would-be musician who shall fail to find it! and how many such failures are there not to be seen in England? Multitudes of counsellors the student has indeed had, but in their counsel there was no safety, for they were mostly amateurs, or, what is worse, half-taught professionals; he desired to make real progress, but he was met on all sides with counsel so various and so conflicting, that in his bewilderment and hopelessness of obtaining any definite help, he was forced to fall back upon his own judgment, and work on as best he could, vainly endeavouring to force his way through stumbling-blocks, which he knew not how to remove, and as often as not giving up at last the apparently useless struggle, in utter weariness and despair!

Such has been the lot of but too many an English amateur, and such—to judge at least by the little instruction he can give—has been the lot of too many an English professional also! And when into this musical class there comes by chance a professional, thoroughly trained German, is it to be wondered at if he should gaze around him in astonishment, and go home to pronounce in Germany, with greater confidence than ever, that "England is the most unmusical of nations?" An opinion which has so often been repeated of late years, that we in England are almost weary of attempting of to refute it, and seem at last sullenly to be acquiescing in its condemnation.

And yet, in spite of our apparent acquiescence, there still lurks within us the suspicion that we have been too harshly judged; in secret, we are stung by the reproach, and the pain is all the greater because we will let no outward sign of it escape us. The truth is we do not really believe that we are such an "entirely unmusical" nation as our neighbours think us, and when they force the unwelcome truth too rudely on us, we are disposed to retort as rudely, "Why then do we welcome foreign musicians as eagerly as we do? Why is our anxiety so great to engraft the precious bud upon our own wild stock, if in truth we have not even so much as a stock of any kind on which to graft it? Surely your assertions are, to say the least, ungenerous; if indeed we are so devoid of music, pity us, and assist us with the overflowings of your abundance, but do not scorn us. Give us at least some half dozen of live coals from your own glowing fire, instead of treading out with your contempt those few sparks which we have so carefully cherished. If we boast of them, then indeed you have a right to

complain, but if you find us humble-minded, you surely need not fill us with despondency, you need not drive us to despair!"

The vocalist of the south, accustomed to trill his melodies in the sunshine, shivers in our, to him dismal, climate, and the German, accustomed to deep chest vibrations, finds a want of tone in our English harmonies, and so to both we are unmusical—"hopelessly devoid of musical susceptibility!"

Now we do not deny their right to judge us if they choose; we do but plead for a suspension of their verdict, until they shall have proved, not only our national indifference to the study of music, but also our national inability to learn! Of this, as yet, there is no certain proof, for nationally, we are in the unfortunate position of a pupil who has grown up under adverse circumstances, finding his every effort condemned, his capabilities despised or ignored, until he can at last see nothing but his own utter impotence, and has hard work to disabuse his mind of the unrighteous judgment. But all the while he is conscious within himself of a love for the tender art; all the while he suspects within himself some capability, however small, only he dares not trust his own estimate of himself, where others, who should be judges, have condemned! But how earnestly he would work to obtain the desired end! how steadily he would persevere if any one would but take him by the hand, and not only show him the way, but actually place him in it!

Now this is the very object which the new National Training School for Music proposes to itself; it desires to provide an efficient training for anyone, in whatever station of life, who may desire to devote his or herself to the study of music, and in order that its benefits may be extended as widely as possible, and be in all respects national, the course of instruction is to be provided gratuitously, by means of free scholarships, in which every town and county of the United Kingdom may have a share and interest if it will but secure to itself the boon (giving at the same time a practical proof of its right estimation of its value) by a subscription to the funds of the institution sufficient to endow one or more local scholarships. And this is surely asking no hard thing of any music-loving public! Will not the musical enthusiasm of England now at last awaken? For the money which shall be given good measure shall be returned, and if, by means of this institution, harmony shall be established where discord has hitherto prevailed —a harmony of musical intelligence in place of a discordant ignorance—surely its promoters will be doing their part in furtherance of that "higher education" of which we nowadays hear so much, but in which so few of us, alas! find reason to believe!

By means of various societies and associations the knowledge of music has of late years been steadily advancing in England, but still it is confined too much to the few; the land at large brings forth only tares, and very little real music flourishes upon its soil. Some radical correction is required, which shall clear the roots of musical education from all the rubbish which at present surrounds them and checks their healthy growth; the ear and mind of the people must be trained, that they may know for themselves how to recognise the good, and be able to condemn with an unhesitating condemnation all that is false and spurious in (so-called) music.

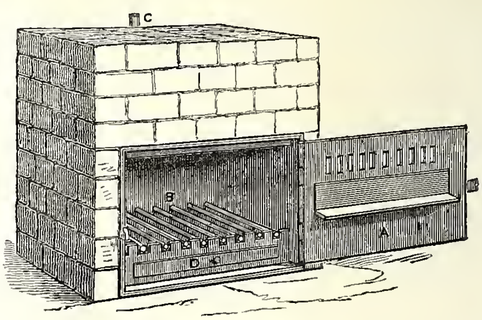
For a time this National Training School must, of course, be an experiment, which may or may not succeed; but it rests with the people of England to decide whether it shall fail through lack of public interest and support, or whether, by their hearty concurrence in its projects, it shall at least testify to the world that if the great gift of originating music has been given in but a small proportion to our land, we do any rate possess the ess enjoyable, but scarcely less important power, of scrutinising with a discerning mind the offspring of that precious gift in other nations, with a desire to reverence music in true humility, and to cherish her with an unselfish love!

And be it remembered, that while this institution desires to be for the entire nation, it must, in order to be this, meet with a truly national support. Let no country or town then be lukewarm in its zeal, for if encouragement given promptly is "twice given," assuredly that which is given with reluctance is as good as twice withheld! Such support can do no good; it will only damp enthusiasm; but let an eager grasping of the offered boon testify to our national estimation of its worth, and triumphantly refute the saying that England is a country in which the love of music does not dwell.—I am, &c.,

F. S. B.

ECONOMY OF FUEL.

Sir,—My Economic Smoke Consumer is to be built of the best fire-brick, which will absorb and radiate the heat for a great length of time, without any perceptible effluvia (as is the result with iron); it is applicable to the present chimneys, and generally for heating purposes. It can be made very elegant by being encased in marble, porcelain, or other suitable material, allowing a space for the radiation of the heat. The dense atmosphere of our cities and commercial hives, alike destructive to health, and a strain on the national exchequer by the immense cost of fuel, which bids fair to sap the national progress by the extinction of the supply, can be obviated by a simple means of consuming the carbon (which now escapes in the smoke), so as to render our atmosphere comparatively clear, at the same time obtaining an intense heat with less than half the usual quantity of fuel.



(A.)—The door for supplying the fuel to the fire, which is in part double, through which a current of air passes to prevent the metal burning the exterior air, and it also contains a talc window to see the fire.

(B.)—The tubular bars on which the fire rests; open on the back as also inside the door.

(C.)—The connecting flue to the chimney, with a damper to regulate the draught.

(D.)—The ash-pan fitted close to direct the draught.

Directions for lighting the fire.—Lay about three inches thick of cinders or coke on the tubular bars, over which lay some dry wood, which ignite, and shut the door; the cinders or coke will soon be incandescent; then lay on about one inch thick of coal, the draught being first downwards, the carbon contained in the smoke is burnt, and nothing but a clear smoke passes into the atmosphere.

The bars should be turned to clear them of the dust.—I am, &c., G. N. Shore.

Middle Chinnock, Ilminster,
February 24, 1876.

DEXTRINE-MALTOSE.

Sir,—Your correspondent in last week's *Journal* (Mr. Lyttle) has, I think, overlooked one or two matters connected with Mr. Valentin's recent paper on the above subject.

It is a well known fact that many processes have been adopted, some successfully, for the conversion of starch into sugar by the action of dilute acids; this was at the outset acknowledged by Mr. Valentin in his paper, and will be found in the *Journal*, page 409; but the sugar so obtained has been almost invariably glucose ($C_6 H_{12} O_6$), and the various saccharine bodies offered for use as substitutes for malt have consisted mainly of this substance (see table quoted in above paper, page 410). Now, very recently Mr. O'Sullivan has shown that the sugar occurring in malt wort is a sugar of perfectly definite constitution belonging to the cane sugar type ($C_{12} H_{22} O_{11}$) and not as has been hitherto supposed a mixture of two sugars, or a sugar and a dextrine soluble in alcohol; further, the researches of Mr. O'Sullivan have also indicated the great importance of having a definite quantity of dextrine present in the malt-wort, especially with reference to the after history of the beer when it has left the brewery. In tho light of these facts, the process brought forward by Mr. Valentin seeks to obtain a product which will much more nearly represent the natural bodies present in malt-wort than any malt substitutes at present in use, viz., the body called dextrine-maltose, which consists of the new sugar-maltose, 67 per cent., and dextrine, 33 per cent.

From this I think Mr. Lyttle will see that, although the use of sulphuric acid and starch in some form or other, for the preparation of sugar is not by any means new, the particular modification of it used by Mr. Valentin and Mr. O'Sullivan may claim some originality, seeing that a new and definite product is obtained by its means.—I am, &c. T. W.

April 11th, 1876.

NOTES ON BOOKS.

Science made Easy. By Thomas Twining. London: Chapman and Hall. 1876.

Mr. Twining, among his other efforts towards the promotion of a knowledge of economic science, has for some time been engaged in preparing a course of elementary lectures, suited for delivery to uncultivated audiences. These lectures he has now published in a form which enables them to be given by a person having no special knowledge of the subjects treated. The method recommended by Mr. Twining is for the lecture to be given by two persons, one of whom reads, devoting his whole attention to that, while the other performs such simple experiments as are required to illustrate the lecture, points to diagrams, and exhibits specimens. To enable this to be done, each lecture is printed in two parts, one giving the text and the other the illustrations. By the aid of certain marks, the reader is instructed when and for how long to pause; while the demonstrator, in his copy, has full directions for the illustrations he has to give. This system, of course, presupposes a certain small amount of skill, or at least aptitude, on the part of the demonstrator, and some practice together of both parties, to ensure harmonious working; but Mr. Twining states that, after some practical experience of the method, he has found it successful and attractive. Besides the special instructions for each lecture, general directions are given as to arrangement of the lecture-room and table, methods of showing diagrams, specimens, &c. A complete set of diagrams illustrative of the mechanical lectures is supplied with the letter-press. There are also lists of the apparatus required, and information as to their cost and the places where they can be procured. The four volumes published include lectures on mechanical and chemical physics, and chemistry, inorganic and organic.

Manual of House Painting, &c. By Ellis A. Davidson, London: Lockwood and Co. 1875.

The author's object in this, as in his other technical manuals, is to enable the worker in any particular trade to learn and apply the principles upon which his art is founded, instead of being merely dependent on practice and "rule of thumb." Though to the handicraftsman practical skill must ever be the first necessity, it is yet only by a knowledge of theory and principle that the highest and best work can be produced, and this knowledge it is Mr. Davidson's endeavour to supply. The different parts into which the book is divided treat of the following subjects:—The processes of house painting in oil and distemper; the colours used in house painting; graining and marbling; oils and varnishes used in house painting; letter painting; the principles of decorative art; elementary drawing for house painters, decorators and sign writers; and lastly, staining. There is also an appendix of "useful receipts." Under these heads the different materials, tools, processes, &c., are discussed at some length, with the view of making the book serviceable, not only to the professional artisan, but also to emigrants and others, who may not be able to procure ready prepared the various materials they require, or may have to make shift with such substitutes as they can obtain for the needful appliances. In his remarks on letter and sign painting, and his chapters on elementary drawing, Mr. Davidson goes beyond the purely mechanical part of the art, and strongly urges on his readers the necessity for careful and original study, advising them to examine and copy natural objects, to watch and note the effect of light and shade for themselves, instead of being guided by empirical rules. He even devotes some chapters to freehand drawing, and the simpler principles of perspective. Some observations are also made as to contrasts and harmonies of colours, conventionalised natural forms, the laws which govern the employment of colour, &c.

GENERAL NOTES.

Votes for Science and Art.—The *Athenæum* calls attention to the caprice with which the Votes for Science and Art are submitted to Parliament under the present irresponsible system. "Everyone who has ever worked in the reading-room of the British Museum, and in the Art Library at South Kensington, must be aware how much more available, at least for artistic study, the latter library is than the former. Nor is it only to metropolitan students that its advantages are confined, for it supplies all the art schools in the country with books. Some deficiencies may, indeed be marked in it, for its annual income, which has been fixed for the last ten years at £2,500, has long been reported as insufficient by its managers. This year, it appears, that sum is to be cut down to £1,000, a reduction which must all but cripple it. The serials and other works for which it subscribes, will, as may be seen from the reports for past years, absorb the greater part of the reduced amount, leaving scarcely any funds for the purchase of drawings, prints, photographs, and other objects having reference to the history and progress of art. The whole grant for the Art Museum is to be reduced, according to the estimates, to £4,000, having in former years been £8,000, and even £10,000. The Edinburgh Industrial Museum has also been shorn of half its income, £1,000 having been lopped off. Yet the British Museum, with all its short-comings, has suffered no reduction, and money has been showered upon the new buildings of the National Gallery, where, it is rumoured, the Trustees have not been allowed to check the expenditure on their own walls."

The Suez Canal.—The *Bulletin Officiel* states that the transport receipts on the Suez Canal augment every month in a notable proportion. During the month of January, they rose to 2,760,000 frs., the result of the transport of 142 ships. The following shows the annual number of ships that have passed through the canal since the inauguration:—1869, 10 ships; 1870, 486 ships; 1871, 765 ships; 1872, 1,082 ships; 1873, 1,173 ships; 1874, 1,264 ships; 1875, 1,494 ships.

The Turners' Company's Prizes. — The Turners' Company, according to their custom, propose to give this year their silver medals and the freedom of the Company, and of the City of London, to any workman who may send in the best specimen of hand turning in wood, pottery, and diamonds. The competition in wood includes turning in both hard and soft wood. The work must be all hand turning, produced in the lathe without special rest or tool apparatus, and the carving must be the work of the exhibitor. The competition in pottery includes terra cotta, stone, earthenware, and porcelain, but all unglazed. The bronze medal of the Company will be given to the competitor second in merit, and the Company's certificate of merit to the third, in each of the above subjects of competition. In addition to this, the Court has placed at the disposal of the judges a sum of £30, to be distributed, according to their discretion, as money prizes, viz., £15 among the exhibitors in wood, and £15 among those in pottery. In the diamond cutting and polishing competition, the Baroness Burdett-Coutts, who is a member of the Company, has placed at the disposal of the Court the sum of £50, to be distributed in this class among the competitors, according to the discretion of the judges. Specimens of work under this heading will be divided into classes, as follows:—Class A. Brilliants weighing more than one carat. Class B. Brilliants weighing under one carat. Class C. Single cut. Class D. Roses. In each class a prize will be given if the specimens entered are considered worthy, but the first prize of £25 and the silver medal will be adjudged to the candidate who shows the highest excellence of workmanship in the greater number of the above-named classes. In addition to the above-mentioned prize, there will be the bronze medal of the Company and certificates of merit; the remaining £25 will be distributed according to the discretion of the judges. Candidates for the first prize must send in specimens of work in not less than three out of the four classes. For further information as to conditions of competition, application should be made to Mr. R. L. Loveland, Hon. Sec. to the Competition Committee, 4, Harecourt, Temple, London, E.C.

NOTICES.

SUBSCRIPTIONS.

The Lady-day subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

April 19.—"The So-called Deposits of Onyx near Mexico, and their Value as a Decorative Material in this Country," by W. Eassie, Esq., C.E., F.L.S., F.G.S. Dr. Billing, F.R.S., will preside.

April 26.—"Sericiculture in Australia," by Mrs. Bladen Neill.

May 3.—"The Preparation of China Clay," by J. H. Collins, Esq., F.G.S.

May 10.—"A New Method of Propulsion for Street Trams," by E. H. Leveaux, Esq.

May 17.—"Railway Safety Appliances," by F. J. Bramwell, Esq., C.E., F.R.S.

May 24.—*The same continued.*

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

April (*date not yet fixed*).—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. Walker, Esq.

May 9.—"The Languages of West Africa." By the Rev. J. H. Schön.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

April 21.—"The Sanitary Progress of India," by Captain Douglas Galton, C.B.

May 5.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

May 26.—"Thaumatodendra, or the Wonders of Trees in India," by William Tayler, Esq., late Commissioner of Patna.

Chemical Section.

Friday evenings at 8 o'clock. The following arrangements have been made:—

April (*date not yet fixed*).—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. Paul.

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne.

Cantor Lectures.

Monday evenings at 8 o'clock. Third Course, "On Wool Dyeing," by George Jarmain, Esq.

Lecture V.—April 24th.

Logwood and other woods, and their application to the dyeing of wool and woollen fabrics (*continued*).

Lecture VI.—May 1st.

Aniline and other allied colours, and their application to the dyeing of wool and woollen and mixed fabrics.—Concluding remarks.

MEETINGS FOR THE ENSUING WEEK.

Tues....Statistical, Somerset House, W.C., 7¾ p.m. "The Supply of Gas to the Metropolis."
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.

Wed. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. Eassie, "The So-called Deposits of Onyx near Mexico, and their Value as a Decorative Material in this Country."
Meteorological, 25, Great George-street, S.W., 7 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. Percy Gardner, "Greek River-Worship."
Archæological Association, 32, Sackville-street, W., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.

Thurs...Linnean, Burlington-house, W., 8 p.m. 1. Dr. J. Kirk, "Identification of the Living and Subfossil Copal Trees of East Africa." 2. Mr. W. P. Hiern, "The African Species of *Coffea*." 3, Mr. Shirley Hibberd, "The Classification of *Narcissus*." 4. Professor Dickie, "Polynesian Algae."
Chemical, Burlington House, W., 8 p.m.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. George Fraser, "The Functions of Art Criticism."
Numismatic, 13, Gate-street, W.C., 7 p.m.

Fri.......SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Captain Douglas Galton, "The Sanitary Progress of India."

Sat.......Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,222. Vol. XXIV.

FRIDAY, APRIL 21, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

GENERAL MEETING.—ALTERATION OF BYE-LAWS.

The Council hereby convene a General Meeting of the Members, for the purpose of altering, varying, and revoking the existing Bye-Laws of the Society, and making new and other Bye-Laws in the place thereof, such meeting to be held on Thursday, the 27th day of April, 1876, at three o'clock in the afternoon.

By order of the Council.

P. Le Neve Foster, Secretary.

11th April, 1876.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The School will be opened on May 17, instead of, as previously announced, April 27.

DAVENPORT FUND.

The following additional subscriptions have been promised, since the last announcement:—

	£	s.	d.
F. Beasley, jun.	1	1	0
L. Biden	2	2	0
Jacob Brett	1	1	0
A. Budenberg	2	2	0
J. H. Dallmeyer	1	1	0
Charles Downes	2	2	0
Charles R. Ford	1	1	0
Charles Hart	2	2	0
William Hawes	3	3	0
Mrs. Holmes	2	2	0
J. Horton	3	3	0
T. O. Hutton	2	2	0
Arthur Jago	1	1	0
J. S. Lapraik	2	2	0
Alphonse Mariette	1	1	0
Swan Nash	3	0	0
T. S. Norton	1	1	0
Philip Palmer	2	2	0
Captain Bedford Pim, R.N., M.P.	2	2	0
W. H. Rodd, Mayor of Penzance	1	1	0
S. J. Smith	1	1	0
R. W. Thomas	1	1	0
Arthur Trevelyan	5	0	0
Edwin Tucker	1	1	0
E. O. Tudor	2	2	0
J. Werge	1	1	0

HEALTH AND SEWAGE OF TOWNS.

The Conference on this subject will take place, as already announced, on May 9th and 10th. A Sanitary Conference will also be held by the British Medical and the Social Science Associations on May 11th and 12th, in the Rooms of the Society of Arts. In connection with the Conference an Exhibition of Sanitary Appliances will be held. Only such apparatus will be admitted as have a distinct bearing on the subject of the Conference. Further information can be had on application to the Secretary.

NINETEENTH ORDINARY MEETING.

Wednesday, April 19th; Archibald Billing, M.D., A.M., F.R.S., F.G.S., F.R.M.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Allen, Stafford, Parkfield, Upper Clapton.
Barff, Arthur, Merton-cottage, Merton, Surrey.
Brazier, Charles Thomas, 106, Blackfriars-road, S.E.
Crossley, John Sidney, Barrow-on-Soar, near Leicester.
Eastwood, Arthur William, Junior Athenæum Club, S.W.
Ellis, Edward Shipley, Leicester.
Gordon, Rev. David, Downs-park-road, Clapton.
Soto, His Excellency Don Marco Aurelio, Guatemala, Central America.
Verney, Major Sir Harry, Bart., F.R.G.S., 32, South-street, Mayfair, W.

The following candidates were balloted for and duly elected members of the Society:—

Blashill, Thomas, 10, Old Jewry-chambers, E.C.
Dawson, James Thomas, F.S.S., 2, Royal Exchange-buildings, E.C.
Hirst, Charles, jun., Hungerford-house, Huddersfield.
Holtorp, Erasmus A. von, 21, Holland-villas-road, Kensington, W.
Lancaster, John, Vine-house, Canning-town, E.
Paterson, Edward James, 3, Bedford-court, Covent-garden, W.C.
Pattinson, John, 75, The Side, Newcastle-on-Tyne.
Samuel, Stuart M., 60, Old Broad-street.
Smith, Bridgman, 27, Lloyd-square, W.C.
Sykes, John Henry, West-field, Huddersfield.
Valon, William, Andrew McIntosh, Ramsgate.
Warren, Samuel Hillyer, 38, High-town, Crewe.

The paper read was—

ON THE SO-CALLED DEPOSITS OF ONYX NEAR MEXICO; THEIR HISTORY, AND THEIR VALUE AS A DECORATIVE MATERIAL.

By W. Eassie, C.E., F.L.S., F.G.S.

Some months ago I became acquainted with the Mexican product before you, and subsequent examinations of the same, and careful comparisons between it and similar materials from other lands, have brought me to the conclusion that here has been unearthed for the use of the nineteenth and succeeding centuries a material which has never been eclipsed in point of natural magnificence. I am speaking to many who doubtless recollect examining the beautiful examples of onyx marble

which were sent by France to the Hyde-park Palace of 1851, and also the still larger non-metalliferous collection from Algeria in the Exhibition of 1862, in which the onyx marble played a prominent part. Many here will also remember with pleasure the Oran Province exhibits of the several Parisian Expositions, whilst all will be well conversant with the *articles de luxe* made from the French colonial onyx which abound in the shops of every metropolis. But although these last-mentioned deposits are rich in lustre when polished, and possess a moderate range of colour, they do not closely simulate, as does the Mexican one, the true and precious onyx which the Jewish High Priest bore upon his breast-plate, and which, according to Prof. Ruskin, is the Queen of opaque stones. Neither will any of the Italian, Spanish, or Egyptian marbles more favourably compare with the material here than will the rough, grey, quartz-like marmoras of Asia Minor compare with the milk-white foliated marbles of Carrara. The people of Ancient Rome, who were the predatory explorers of old, do not seem to have ever encountered so rich a material as the one brought before you; and it would doubtless have remained practically unknown to Europe for another age, had not the French expedition to Mexico, in support of the martyred Maximilian, taken in its wake the English railway contractor and his "navvy," and permitted of its wholesale transport hitherward.

I ought, perhaps, here to say that I have not the slightest pecuniary interest in the product, either manufactured or unmanufactured, and that I volunteered a description of its composition, its history, and its uses, out of a pure love of Science and Art. I consider, and I hope that you will also consider, the theme not unworthy this home temple of the Arts, Manufactures, and Commerce.

The precious stone called onyx, which takes its name from the Greek word signifying a finger-nail, the lines of which it greatly resembles, is an agate variety of chalcedony, arranged in flat horizontal planes of light clear brown and opaque white. When the layers consist of sard and white chalcedony, the material is called sardonyx. The deposits before us are, however, not formed in the cavities of trap rocks and the like, and it is, therefore, neither onyx, chalcedony, agate, jasper, nor carnelian, which stones are all varieties of quartz, and composed of nearly pure silica. It is rather an onyx-like marble, and really deserves a scientific name to itself, which I hope some geologist will be induced to give it. Neither must it be confounded with the alabaster, properly so called, which it also closely resembles in fineness of grain, uniformity of texture, and beauty of surface polish, for that is a sulphate of lime. The ancients, however, did so confound it, as we shall see, and unwary moderns may easily do the same. Alabaster is, in reality, a fine granular crystalline variety of gypsum, and its usual component parts are sulphuric acid 47, lime 32, and water 21 parts. It is often found streaked with a red and yellow colour, due to the presence of oxide of iron and other minerals, and is chiefly found in the New Red or Keuper marls of our Midland counties—selenite and satin-spar being highly transparent and crystallised forms of this natural hydrate. When calcined, alabaster, or potter's stone, as it is called in Staffordshire, resembles anhydrite, a pure sulphate of lime, destitute of any essential water, and it then forms the well-known plaster of Paris, which is in such great demand by the potters, who from it form their moulds of plaster. The chief deposits of this hydrous sulphate of lime are found in the middle tertiary beds of the Paris basin at Montmartre, and it is there manufactured into plaster. For the rest, alabaster, which we now call gypsum, is not to be deemed the same material as the ancient substance from Alabastron, although it is in a similar way manufactured into various vases and other works of art. Another difference between alabaster and the onyx-like substance before us, lies in the fact that, whilst the former becomes yellow by keeping, and requires to be restored by washing and polishing, the latter, when once polished, retains its lustre. The alabaster is also found occurring in irregular-shaped masses, owing to the lime, as a sulphate, occupying more space than it did as a carbonate; and the Mexican material occurs in beds. Alabaster is also clouded in its appearance, whereas this is for the most part—save where greatly impregnated with mineral colours—almost white and transparent. Under the polariscope it is really a charming object. Some specimens are highly crystallised, but it is not akin to Iceland spar, although both are composed of the same material, viz., carbonate of lime.

If some pieces of the onyx marble before us were carefully examined, they would be seen to bear a great resemblance to quartz. But these two substances have nothing in common, for quartz, when pure, consists simply of silica, and its varieties are due to the presence of various minerals. It is the more necessary to note this, because the very tints of the rose-quartz and the amethyst are both to be found in the Mexican lime-carbonate, and are due to the same cause, oxides of manganese and iron. The marble here exhibited, which, as we have seen, resembles chalcedony, and might with equal propriety be termed a chalcedonic-like marble, as an onyx-like marble, also greatly resembles aragonite from some points of view, a substance which is also composed of carbonate of lime. But the physical conditions are very different. The colours, too, in the Spanish material just named, would be almost sufficient to mislead one, for a little carbonate of the earth, strontia, is a frequent constituent of aragonite, and when some bluish varieties of the onyx marble are examined, it might even be deemed that the sulphate called celestine had entered into its composition. Aragonite will also take a high polish, and a polished slab of stalagmitic aragonite from Beni-souef, in Egypt, may be seen in the collection of the Geological Survey in the Museum in Jermyn-street. This fact of stalagmitic occurrence might rivet the error. Aragonite, to conclude, may best be defined as a prismatic species of carbonate of lime.

We have seen that this new material closely resembles the onyx, chalcedony, agate, jasper, and other precious stones, all of the quartz family, the opal even, and alabaster, and yet is none of these. We have noticed, too, that although composed of the same material as calcite, aragonite, and the purest light-refracting spar—that is, carbonate of lime—it is, nevertheless, essentially different to all. Neither is it allied, save in composition, with the lamellar or concretionary carbonates of lime like

the Schiefer-spar of Wicklow, or the pisolites of Bohemia. We find it also called a marble, and as long as the term marble is confined to its true meaning—namely, to those varieties of lime carbonates which are sufficiently compact to take a polish—the nomenclature would be just. But, then, for the most part, marbles are taken from true stratified beds, and, with us, chiefly from the fossiliferous rocks of palæozoic age. What, then, it may be asked, is this substance? The answer to this is, that the Mexican onyx is a material of stalagmitic origin, formed by running water holding carbonate of lime, &c., in solution.

These Mexican deposits are composed of carbonate of lime, but I must not be understood as saying that they resemble either the water-produced or volcanic-produced tufas, which are also calcareous deposits. Tufa may be called a cave or fissure deposit of carbonate of lime, caused by springs or streams of water holding carbonate of lime in solution, and examples of it are plentiful amongst the Gloucestershire oolites. But tufa is not necessarily coloured by the action of various metals or earths, as is the material before us, and, moreover, is porous, whereas this material is compact, and surpasses in density and weight all known marbles. Nor is it travertin, which is a white concretionary limestone, far more compact than tufa, and abundant near recent or extinct volcanoes, formed by incrusting springs, like those in Derbyshire; or by petrifying wells, as they are called—springs or wells loaded with as much carbonate of lime as water will carry, and flowing through all time. I have used this material in Asia Minor for rendering over the interior of cisterns. Sometimes a concentric structure may be observable in travertin, proving that it was formed in successive layers, and much in the same way as the Mexican material. The latest volcanic efforts in Italy were marked by the production of huge masses of travertin, and these may, perhaps, best be observed in the plains below Tivoli, where there are wonderful grottoes, and where also are manufactured articles out of a material not unlike some of this onyx marble in appearance. Nor, because the travertin of Tivoli is devoid of organisms, whilst tufas commonly abound with encrusted relics of animal or vegetable life, is it the nearer to the marble before us. For the absence of life in the Tivoli deposits is owing to the fact that the water in which it was deposited contained in solution carbonic acid and sulphuretted hydrogen gases.

The so-called marble before us is therefore neither tufa nor travertin, although these are also carbonates of lime. It is, as I have said before, a stalagmitic production of that material. I may appear tiresome, but any geologist here knows that the limestone or marble, or whatever it may be called, of stalagmitic and stalactitic origin, is the one thing of which very little is known. And I hope you will pardon me if I occupy you one moment more upon this part of my subject.

Stalagmitic formations of carbonate of lime, such as this is, may be deposited either in the floors of caves, in depressions of valleys, upon rock precipices, or in river beds. But, as may be imagined, nothing but a careful examination of the deposits *in situ*, will enable a geologist to say with certainty what manner of birth a certain piece of stalagmitic marble may have had. In our own country it occurs in every way upon a small scale, and formations allied to the specimens before us can be seen in several museums in England and Wales. Specimens are also extant from the Mitchel Dean iron mines. The well known Gibraltar stone is another form of this stalagmitic carbonate of lime. Many of my audience have, no doubt, seen the Cheddar caves, and noticed the stupendous masses of this material which occur in rising forms or in pendants, and which mimic the appearance of nearly everything one has seen, whether beautiful or grotesque. These are all produced in the same manner, and only differ in point of age and impregnation with impurities. There is a vast difference between the onyx marble and the Cheddar sections, but then there is just as wide a dissimilarity between it and the stalagmitic carbonates of lime collected in the Pyrenees, Chili, and California. Neither do these samples resemble in appearance the similarly produced material from ancient Alabastron, in Egypt. The same may be said of the onyx from Algeria, which now alone, in point of extensiveness of deposit, can range with Mexico. I hope I may be pardoned if I venture to pronounce the Mexican product as in every way superior to the Algerian one. I love France and all pertaining to her, and would in nowise desire to depreciate her productions, but truth, in these days of free trade, demands that the palm be awarded where most praise is due. For myself, I believe that nothing which has come down to us in the shape of marbles, formed in a similar manner, can in any one way compare favourably with a single specimen here present, either in beauty, solidity, or weight.

Having described this material as a stalagmitic deposit, I have nearly said all that can be said concerning it. I have not been able to obtain much information from the place where it occurs, further than that the quarry lies on the side of a hill, in a hilly district, chiefly of limestone formation, and that the beds seem to be both resting upon and covered by earthy deposits. A petrifying stream also runs at the foot of the quarry, and minerals are said to abound in the neighbourhood. But I have not been able to learn whether the water is cold or sensibly hot, or whether it is colourless or tinted, like those of Atabapo, discovered by Humboldt. It would be highly interesting to know these things. My friend Professor Etheridge, of the Royal Society and Geological Survey, who has examined these and other specimens, is certain that they are of stalagmitic origin, and possibly deposited in a river bed. It is very evident that it occurs in beds lying on a given general horizon. It is possible that it is a calcareous deposit which arose through the influence of hot waters, highly charged with carbonate of lime or calcites, of different chemical compositions, the waters upon evaporation leaving deposits of such conditions of lime. If the geological or geographical position of this marble be igneous or volcanic rocks, such warm waters would be easily accounted for, as occurring in the form of springs.

I have not seen the analysis which has, I understand, been made by M. Boussingault, but a most careful analysis, made in the metallurgical laboratory of the Royal School of Mines, of London, by Mr. W. J. Ward, is as follows:—

"The three specimens of Mexican onyx marble received from you have been examined according to your instructions, for the purpose of ascertaining the nature of the colouring matters contained in them. The following constituents were detected by a qualitative analysis:—

Carbonate of lime.
Carbonate of magnesia.
Carbonate of protoxide of iron.
Hydrated peroxide of iron.
Oxide of manganese.
Sulphuric acid.
Water and silica.

"Copper, nickel, chromium, and cinnabar were specially tested for (as some of these were reported to be present), but none were found.

"The principal constituent, after the carbonate of lime, is the carbonate of protoxide of iron, both in the green tinted and in the white marble. The various shades of red and yellow are due to the hydrated peroxide of iron. The proportion of manganese is very small, also that of sulphuric acid and of silica. The amount of iron present in the green tinted marble is equal to 9·05 per cent. of carbonate of protoxide of iron. The peroxide of iron in the red and yellow marble is 10·20 per cent."

There can be no doubt that a material similar to that which we uow contemplate has been used from the very earliest times. It is, I believe, not a very uncommon thing to find implements similar to the flint flakes, scrapers, and arrow-heads, made of this onyx-like material, in the neighbourhood of the deposits. It may not equal in suitability the flints of the Britons, or the obsidian of the ancient New Zealanders, but it is, nevertheless, very hard in places, and would, at all events, prove at least equal to the chert and quartzite used by the Chatham Islanders for flakes, or to the metamorphic sandstone which was patronised by the aboriginals of Otago for adzes and grubbers. And the example of the stone age was followed by the age which succeeded it, the implements found in the rude mummy pits of ancient Thebes being followed by scarabæi of this same material. An inspection of any large collection of Egyptian relics will convince anyone that the old people of Egypt were well aquainted with the many advantages offered by this onyx-like material, and that they fully appreciated their own stalagmitic aragonite. A large number of canopi, or sacred Egyptiau vases, with covers shaped like the head of a mummy, are to be seen in any good collection. In like manner the onychina, as Pliny called this very material, was put to many uses in the succeeding ages, as the large museums of Europe will show on inspection.

The applicability of this material, in following out the decorative faculty which imbued man as he rose from the primitive conditions of life, will be seen by a glance at the many beautiful specimens by which I am surrounded. But its value as affording a new art material, will be best understood by noticing the immense distances from which the ancients, during the early and more historical times, imported this very substance. We know that the quarries at Oued Abdallah, in Algeria, supplied ancient Carthage and her dependencies with onyx marble. At Aïn Tekbalet, in Oran, may also be seen the excavations which formerly supplied the city of the Tiber, forasmuch as pieces of this very marble are continually being found in the gardens of Rome. Portions carved in various forms may also be seen in the private and public collections of Italy. No nation of antiquity more honoured art by an enthusiastic, and even discriminating search after beautiful media for its perpetuation, than did Rome. Porphyry columns, still to be seen there, were brought all the way from the quarries of Gebel ed Dokham, some 27 miles from the Red Sea. They also imported from the East that peculiar form of fluor spar, then known as *murrhina*, and had the mines of Cornwall or Derbyshire produced that variety which exhibited a layer of hornstone, we should have been plundered of it just in the same way. Even the excavations of Gebel el Fattéereh, in Arabia, were made to provide the Romans with its beautiful granite. And just as the beauty of the African onychina captivated the travelling lieutenants of Rome, and induced them, careless of cost, to convey blocks of it to the fatherland, the races which followed were in no way behind them in this particular; for, during sundry excavations in the mosque of Mansoura, enormous columns of this onyx-like material were dug up and are now to be seen near Algiers.

The quarry from which come the samples before us, is situated at Técali, about 35 English miles from the city of Mexico. The quarry is the only one in the country which yields a material so beautiful as regards colour, or so valuable as regards the size of the blocks which can be exported. The existence of these beds was doubtless known to the earliest inhabitants of the country, but I have not been successful in tracing any mention of them in the Mexican works which I have consulted. It is just possible, however, that the variegated alabaster with which Aezahualcoyotl the Magnificent decorated the walls of his palace, short descriptions of which have come down to us, was simply the earlier produce of these very quarries. Tezcuco was only about 30 miles distant from Técali, and thus the cost of transport would have been inconsiderable. The poorer and earlier Indians used it as floor tiles, and their more civilised and richer successors found use for it in the decorations of their houses and churches. It can also be noticed fulfilling various functions in the cathedral which now occupies the Teocalli, or site of the old Aztec pyramid and temple.

The size of the blocks which the onyx marble quarries will yield, depends, of course, upon the age and depth of the deposits, but not a little also upon the manner in which the excavations are worked. The ancient mode of opening up a quarry may still be seen in the stone quarries of Téhneh in Egypt, where, by the way, also occurs a crystallised carbonate of lime, assuming a stalactitic form. The workmen first bared the surface of the deposits, and then cut a deep trench, parallelogram fashion, around it, leaving one of the sides bare, to facilitate the removal of the blocks. Other parallel trenches were then cut every seven or eight feet apart, and still others again at right angles to these, until the whole area was divided into squares, after which the blocks were cut off to the required thickness. Some of the trenches measure 21 feet in depth, and the size of the stones removed must have averaged seven feet square. Such a

system of quarrying as the above must, of course, have entailed a considerable amount of waste, and I have no doubt that it was merely resorted to in order to provide as quickly as might be the square-shaped materials for the larger columns. These would only require rounding off at the corners, and the column would be ready for the skilled mason or sculptor.

The manner in which the rough masses of onyx marble are raised in Algeria and in Mexico does not differ much, and, although primitive, is well adapted to the circumstances. In Mexico the custom is to insert and drive into the beds large wedges, made of a peculiar hard wood, which is known to grow in the immediate neighbourhood of the deposits. The size of the quarry may be roughly given at 350 yards in length, 250 yards in width, and 27 yards in depth, which would give a total of over 63 millions of cubic feet of the material in that one deposit. I have several times been amused, however, with this class of calculations, and never so much as when once I checked the contents of a lignite quarry in Prussia by boring, and found that the cube result of the measurements very far from represented the true quantity of brown coal. The same rule may apply at Técali, although hardly likely. The stalagmitic onychina of Ain Tekbalet, in Algeria, likewise occurs in beds of about ten yards in depth, and extends over a large area. Practically speaking, therefore, the supply of onyx marble, both in Algeria and in Mexico, is inexhaustible. If the Algerian marble is so little known amongst us, it is doubtless almost entirely owing to the close manner in which the material is worked. A visitor to Ain Tekbalet would be able to inspect a large surface deposit, but he would not be permitted to remove any. Even the manager of the works is forbidden to sell the material, so strict is the monopoly. It is only in the markets, and when manufactured, that it can be purchased, and even then at a high price. The reason why the Mexican, and more beautiful product, is so very little known is, perhaps, entirely owing to the agitations and disorders which have always accompanied the Wars of Independence.

Blocks of onyx marble of large size have been quarried at the Oran quarries, and at Tlemçen may be seen ten columns of this material, seven feet in height, and nearly five feet in circumference, exclusive of the capitals. Similar columns, shapen out of the Mexican deposits, have been discovered amongst the *débris* of the Técali quarries, notably a dozen, each about 13 feet in length, and 18 inches in diameter. But this is nothing to the thirty pillars of this material, each 32 feet long, mentioned by Pliny, as adorning the dining-room of Callistus. The truth is, that there is, likely enough, hardly a limit to the size of the pieces which can be raised; and if a means were extant of conveying these huge blocks to the coast, obelisks of the hugest size, and sarcophagi, finer than those of Egypt, and more magnificent even than the luxullianite one which contains the body of Wellington, might be introduced among us. The largest monolith I ever saw lay at the foot of a quarry in the Lebanon, measured 63 feet long, 15 feet high, and 10 feet wide, and must have been quarried in some such way as is now practised at Técali, inasmuch as blasting was unknown. I saw, also, upon the terrace of the great temple of Baalbec, three other stones over 60 feet in length, and I have no doubt similar shafts could be produced from Mexico. Should we ever desire to monumentalise a great hero of the future, as the Emperor Diocletian was by a single piece of stone at Alexandria, here would be a material that would put Pompey's pillar, and even Cleopatra's needle, in every way far into the shade.

To come down to sober fact, I have an invoice before me of more than a hundred blocks of the onyx marble, which have been shipped to Europe by the *Comisionistas*, and I find among them the following sizes:—

Length. ft.	in.		Width. ft.	in.		Depth. ft.	in.
3	$3\frac{1}{8}$	×	2	$5\frac{1}{2}$	×	0	$8\frac{3}{4}$
3	$3\frac{1}{8}$	×	2	$7\frac{1}{2}$	×	1	$0\frac{1}{2}$
3	$10\frac{1}{2}$	×	1	$9\frac{1}{2}$	×	1	$7\frac{1}{2}$
4	1	×	1	5	×	0	$6\frac{3}{4}$
4	6	×	0	11	×	1	$7\frac{3}{4}$
4	$7\frac{3}{4}$	×	2	1	×	1	$0\frac{1}{4}$
4	$10\frac{1}{2}$	×	2	4	×	1	$8\frac{1}{2}$
5	6	×	2	8	×	1	7

These are all serviceable dimensions. The largest block of this material hitherto shipped from Mexico to Europe, measured 10 feet in length, 5 feet in width, and 4 feet in depth. The blocks are all conveyed from the Técali quarries to Mexico upon wooden carts, resembling arabas, and are then despatched by rail to Vera Cruz for shipment.

When blocks of this marble, to be used in slabs, are brought to the works, for instance, in Paris or London, they are sawn up by horizontal or other sawing machinery, in which the weight of the saw-frame and connecting-rod acts as a weight to press the saws down to their work. A 40 horse-power engine will suffice to compass the cutting of a block into thirty slabs at one time, the progress of sawing in such a case being three-eighths of an inch per hour. Machine-ripping beds can, of course, be made as applicable for this hard material as for the various marbles; so can the revolving cylindrical cutters for bringing into form circular slabs as table tops. The polishing is performed much in the manner as with other marbles, the rectilinear works in a polishing bed, and the circular works in a lathe. This work of polishing is also performed in much less time than when marbles are in question, thus compensating for the apparently excessive time taken up in the sawing. When in the lathe it can be polished with the greatest ease, and the excellence of the polish is equal to anything that can be desired. The superiority of this material over alabaster is here again manifest; for, whilst alabaster is polished by dried grass, and receives its satin-like lustre from the frictional action of soap-water, lime, and elutriated talc, such materials would have no effect upon the onyx marble. And another advantage is that it is not liable to show grease-contaminations, or be affected by them. Most marbles are also very susceptible to the stains communicated in an ordinary way by metallic solutions, spirituous tinctures of dyeing plants, and mineral oils; but the bulk of the Técali marble would remain unsoiled by them. I do not know of any material capable of taking a higher polish, or a more lasting one. Neither is the substance a brittle one, or

apt to easily fracture, as might be supposed. No veined chalcedony or agate can exhibit a finer surface, or a better aris, even after the conversion of those gems into onyx proper, or the precious gem, for the purpose of the lapidary. This can be seen by an examination of many specimens before you. Moreover, it is equal in colour, according to the portion of the slab from which the sample is taken, to any of the natural agates. I say *natural* agates, because the chalcedonies, cornelians, and agates were operated upon by the ancient engravers of gems in many ways, but chiefly by heating and steeping, in order to artificially heighten or alter the colours, and also to harden them by filling up the natural pores. There are no distinguishable pores to be seen in this peculiar onychinal material, as may be almost guessed when I state that a cubic metre weighs over 8,000 lbs. Here is a cube, which, were it in stone, a man might easily poise upon his one hand; and I can, I think, defy him to even lift it with the aid of two hands. It is indeed a connecting link, as Mr. La Mert (who introduced it to this country) truly observes, between the precious stones and the marbles. Portions of it closely resemble that silicate of lime and magnesia which is known as jade, and which is about the hardest of all the minerals known. I exhibit to you a nephrite-like cameo of this pseudo-onyx, which will bear out these few remarks; and there can be no question that, for cameos and intaglios, the material before us will be largely patronised. The collection of cameos now before me can hardly be matched for beauty out of the most precious substance known to the arts.

Before I forget, I may as well, perhaps, here mention the cost of this material in the market. I am informed, then, that a cubic metre of picked material, sells at about £105, or a cubic foot about £3 10s. The price of the slabs simply sawn, and for the slabs cut and polished, is as under:—

Thickness.	Sawn only. s. d.	Cut and polished. s. d.
$\frac{1}{2}$-inch	5 0	8 6
$\frac{3}{4}$-inch	6 0	11 6
1-inch	7 9	13 6

Per foot super.

I have no doubt, however, that these figures are susceptible of alteration, depending upon quantity, quality, and credit; at all events, I know most other commodities are. There can be no question that the material is highly appreciated in France, and that it is fast outrivalling its Algerian fellow. During four months of last year, over £10,000 worth of the *onyx de Técali* was sold in Paris alone. The only gold medal, too, awarded in the class of Natural Products, at the late Maritime Exhibition, was laid on the altar of this almost nondescript marble.

One of the most important matters, concerning which one ought to feel certain, before employing any new, or even old, material, or especially recommending it to the constructive professions, engineering and architecture, is the capability of such material to resist, at least, any crushing power. The architect or engineer, however, need not hesitate in employing the material before us in columns of any size, to support any weight which any member of the building fraternity is at present employed to support by means of stone, marble, or granite. An observer would feel satisfied of this by even a casual glance at the compactness of its appearance. I have just received a letter from Mr. Kirkaldy, to the effect that he is too busy to undertake the testing of a few cubes of this material—at least, in time for this evening; and I much regret this, as his fiat is final throughout the whole civilised globe as to the power and endurance of any material under varying conditions. I am fortunate enough, however, to have been able to peruse the report of the experiments made with the onyx marble at the Conservatoire des Arts et Métiers in Paris, by M. Tresca, a secretary of the Society of Civil Engineers of France, of which I have the honour to be a member. From the two trials made it appears that the first cracks occur at the same time as the crushing, and that it required a pressure of 674 kilogrammes to the square centimetre to effect these. The cracks were all vertical, and occurred in planes perpendicular to the stratification, being very generally parallel one to the other. The density was very considerable, viz., 2,742.

It will, then, be seen that the strength of this material is very great, a $\frac{3}{4}$-inch cube crushing only with a weight of over half a ton. It does not require, indeed, to be doubted, as would, for instance, the resistance to crushing of the serpentines and other building substances, which have been discarded owing to their liability to fracture from pressure of any kind. Frost, too, which sadly interferes with the suitability of many kinds of building materials, has, I understand, no effect whatsoever upon this onychine; and I know that it will also withstand the action of a considerable amount of heat. It has not, of course, been ascertained what resistance it would maintain against the action of the sulphuric acid and other destructive agencies in the atmospheres of London and our large manufacturing cities, but it may almost be successfully predicted that these will have no impairing effect.

One word, by way of comparison, between this so-called onyx marble, and the chief decorative materials of the day. No man of sense would attempt to decry the great value of our, happily, numerous species of marble, the bare enumeration of which, and a descant upon their many beauties, would take up a whole evening. Neither would he wisely seek to detract from the recognised value of our varied granites. He would not dare, either, to cry down the beautiful porphyritic granites of Shapfell, the pretty syenites of which we can fortunately boast, or the magnificent porphyries proper that comprise many of our rocks. He would only be laughed at for his pains if he did, and he would well deserve it. Enthusiastic as I am afraid I may have appeared in the matter of this substance, I would after all only claim for it a place on the dais of honour, where are ranged in glorious show the valuable materials which I have enumerated, feeling positive that it will meet with the attention which it deserves. It will be certain to do this, for there is scarcely a colour or a tint missing, from the cream and white of the statuary marble and building elvans down to the red of the Peterhead granites. The genius of colour seems to have run riot when the foundation of these beds were laid, and to have proved its sobriety only upon rare occasions. I am given to understand that the deeper the quarries are worked the greater are the surprises

which are opened up in the way of colour combination. I cannot say that I should feel absolutely enamoured of a very extensive series of even such beautiful panels as some of these slabs would make for a hall or a corridor, and I would, perhaps, prefer the quieter shades. If I desired uniformity of appearance in a moderate way, I know that I could get it here, as the deposits are able to produce continuous series of any style. Colour I certainly could obtain, colour too, without the many harsh changes of the porphyry, and decidedly without the monotony of the granite. The finest colour-imbued pillars in London are perhaps those in the British Museum Library, the Fishmongers'-hall, and the Carlton Club. But I wonder what would be the verdict of a jury of good judges of decoration, were these columns collectively compared with full sized, and even unpicked polished shafts from Mexico.

The application of this substance to the fine arts has not hitherto been very extended, owing to its recent introduction to Europe. Amongst the minor articles into which it has been manufactured, however, may be mentioned bowls, vases, stands of all kinds, handles of doors, &c., lamps, and toilet ornaments. I could not think of troubling you with a tithe of the list before me. I might mention, however, that, descending to buttons, I find machinery costing £1,000 is occupied in that manufacture in France. The future, however, of this new material will be seen, I verily believe, in the largest edifices of the country, in our mansions and in our clubs. Architects have long been seeking for a material of such universal application, just as they were seeking in the olden times, and will seek on for ever. They are weary, I think, of plastered hollowness, moulded weaknesses, gilded tawdriness, tinselled patching, and never-lasting shams generally. It is the untutored aspirations of taste only which patronise the monstrosities which we see all around us, and, unfortunately, this false taste for splendour makes itself manifest even in our most pretentious and costly structures. It is not only in the tavern bars that we meet with such a fall from our high estate, the decadence can be traced in our very palaces. The safe rule, I imagine, is to eschew the artificial and the false, and cherish only the natural and the true. The most pleasant hour which I have spent of late years was one spent in Chatsworth, whilst admiring the passage walls of simple polished stone. To my mind they appeared ineffably superior to all the painting, graining, and papering that I had ever seen. I know full well the value of these three branches of the decorator's art, and I mean them nothing discourteous. I only say that they, the paper decorators, rush in where angels ought to tread, and the one penalty I would exact from them for their audacity, would be to compel them to imitate these slabs as satisfactorily to their clients, as they have to their own mind rivalled the Isle of Mull granite, the Connemara marble, or the verd antique.

It is not necessary for me, in such an assembly as this, to enumerate what function in architecture such a material as this might well perform, for its name would be legion. Floorings, wall-casings (bed-rooms and living rooms excepted, for sanitary reasons) columns, pilasters, plinths, dados, consoles, carvings, and mosaics, all are possible. It would be unwise to overcrowd a building with any one material, of course, for if we could imagine a beautiful Gothic church, such as that of Mr. Gambier Parry, at Highnam, near Gloucester, with the clustered columns, arches, and all the rest, chiselled out of the choicest marbles exhibited here, the effect would be too overpowering, even did the purse allow of such a lavish expenditure. There is one thing for which thin slices of this material, such as I now hold up, are excellently well suited, and that is, for the panes of windows, where the entrance of unchastened light would be offensive. Some of the oldest panes in the Mexican Cathedral, for instance, are made of thin plates of this very substance, and I have no doubt that the light admitted has an admirable effect. The lower windows of the Cathedral at Orvieto, in Italy, are also filled with panes of diaphanous alabaster. And, if ever cremation becomes common amongst us, what substance could be more beautiful than this for the reception of the ashes? Nothing could possibly make a finer cinerary vessel than, for instance, the one I now exhibit to you.

In conclusion, the true position of this beautiful stranger amongst us is to heighten the duller charms of our own natural materials, and to relieve us from the abominable iteration of marble slabs; here, there, and everywhere—pillars of granite to right of you, pillars to left of you, and tiled walls and floors upstairs and downstairs, and in my lady's chamber.

The paper was illustrated by a large collection of specimens of "onyx marble," lent by Mr. B. La Mert. These included slabs, pillars, vases, and a great number of small ornamental articles, *étagères*, clock cases, tazzas, door handles, trays, boxes, cameos, &c.

DISCUSSION.

Mr. J. M. Knight said it would have been very interesting if they had received the benefits of the analysis which had been made, and knew positively the amount of silica that the material contained. He very much feared that the exposure of the marble to the sulphurous acids of a London atmosphere would have a detrimental effect upon its lasting qualities. He had no doubt whatever it was a hard stalactitic carbonate of lime, and if so, it must of necessity succumb to the injurious effect of sulphuric acid.

Mr. Etheridge highly complimented Mr. Eassie for his able paper, thus bringing to their notice a new material which would be of great service. He had no doubt it was a stalagmite, and the analysis which had been made by the French analyst required to be taken with very great caution. The fact of knowing what was in the material as a colouring matter enabled them to predict how it was formed stalagmitically; the question was, whether it was due to hot water or cold water holding a great quantity of lime and a little silica in solution, by evaporation leaving the carbonate of lime and silica, either stalagmitic or vertically, on the sides of the cave or river, or on a shallow river bed, or on a shallow lake, where sediment went on very slowly without impurities. The quantity of silica was extremely small, but that of lime extremely great, and the quantity of iron was astonishing. The pale green colour, which was so beautiful, contained 9·52 per cent. of iron; even the white was almost as rich with manganese in different parts. Therefore there could be

no doubt that the iron was truly the colouring agent. It was first thought to be due to copper, but not a trace of copper was found in it. Very probably the marble was produced by hot water holding in solution a very large amount of carbonate of lime, and of course the iron introduced at the same time, and the difference of the flow of this would account for the difference seen in the slabs on the table. As to its use, its density was equal to, and it was far more beautiful than, most of the agates, and could be applied to almost every one of the arts to which agate was applied, except for its hardness. If it could be dyed, say with some of the more delicate tints of apple green, nothing in the universe could equal it as a decorative material. There was almost every colour in it, and almost every square inch showed something different. Then the quantity of calcite was very remarkable, as also was its rhombic form. Yet another agreeable feature was the absence of chromium, nickel, copper, and cinnabar, which at once settled the question as to what it really was. No one who had ever entered the Cheddar caves could doubt that the rocks there were formed on the same principle, only that they were opaque. In parts of Derbyshire and Somersetshire the same thing was found, festoons as big as this room, the ingredients were the same, the marking the same, but there was not the transparency. It was that which made it so beautiful, and, added to the density (which was almost equal to granite), made it so valuable, for the compactness of the texture gave it its great strength, and he doubted not it would bear a greater strain even than Shapfell granite. The way in which it split was enough to prove its strength. As to what it was, it might safely be affirmed it was not a travertin, because if it were it would hold impurities, whereas there was not a grain of impurity in it; another proof that it was formed underground, uncontaminated, and from a spring, and whether it was found horizontally or vertically, required to be proved on the spot, and he hoped Mr. La Mert would ascertain that. It was not igneous, that is to say, it did not flow from a true igneous outlet. Then again it was not marble, for it was not found as ordinary marbles were. Then it was so imitative, that doubtless much could be produced by the art of the lapidary as had been done in the case of other minerals.

Mr. J. T. Wood, speaking from an architectural point of view, and of the value of the material for building purposes, thought it would prove highly useful. The cylindrical pieces might be used as columns in Gothic churches, and other pieces might be used as slabs for panelling in wall decorations. In excavating on the site of the Temple of Diana at Ephesus he had found a statue which he considered must have been of this material, though at first he thought it was of alabaster, and in that piece of statuary advantage had been taken of the colour to represent the drapery, the nude portion of the figure being left white. It therefore occurred to him that the material might be very suitable for little statuettes and small figures which were of such beauty and interest as ornaments in our houses.

Prof. Tennant thought they were all indebted to the lecturer for his interesting paper which had brought this new material to their notice, and referred to the sarcophagus which had been brought to England by Belzoni, and was now exhibited in Sir John Soane's Museum in Lincoln's-inn-fields, as a beautiful specimen of art production, and as showing what could be done with such materials. Mr. Eassie had alluded to some polished sandstone at Chatsworth. He was not aware of any. There were polished marbles, and one window which was most beautiful was ornamented with fluor spar; but that was in the passage from the conservatory to the ball-room.

Mr. Eassie said what he alluded to was in the offices, and not in the house at all. It was in the passages leading to it.

Professor Tennant said he had been at Chatsworth a great many times, and did not remember the silicious coating to which Mr. Eassie had referred. The substance before them was at once recognisable by any expert. In describing minerals it was customary to use numbers ranging from 1 to 10, 10 being the hardest, and representing diamond. The substance before them was a little harder than carbonate of lime, which was No. 3. This was No. 4. He had a piece of stone in his hand which was No. 6, and which was felspar, and with it he would cut a scratch in the material before them to show them its relative hardness. As to its transparency, there were specimens quite as good to be found in the neighbourhood of Matlock and Castleton, and he would undertake to produce some quite equal, though, of course, they were very diminutive compared with the fine specimens before them. It was only in hot countries that such fine specimens could be produced. The sarcophagus he had alluded to was a very magnificent specimen of its kind, and had been carved more than 1,000 years ago. It might be rendered more beautiful by polishing, but if it were re-polished, its appearance of antiquity would be destroyed.

The Chairman said he had been very much delighted with the paper, as he was sure everyone must be, whether scientific or otherwise. It was so admirably written, that he felt it must have delighted everyone. His opinion of the stone was that it was just a carbonate of lime—that it was a marble, though not exactly what was commonly called Carrara marble, or like the marble used for sculpture. He thought it had exactly the quality of aragonite, which was a little harder than marble. There were innumerable qualities of carbonate of lime, but though there was such an enormous variety of them, they all possessed the same property; there was the same tendency in crystallising. There were differences of hardness in stone of the same kind. He did not quite agree with Professor Tennant on this point, for he thought wherever a mineral was crystallised the crystals would scratch the other parts of the stone. Stones were not all of the same hardness, though they might be the same mineral and have the same analysis. As to the question of colour, he thought that was perfectly accidental, and as to the position in which they were found, the paper had informed them, and would be easily understood by persons who had seen a variety of stalagmites. He had seen the stalagmites in Yorkshire, in different parts of England, at Edinburgh, and in different parts of Germany, and they were all nearly of the same nature. They were in layers generally, and you could cut them, and there was a great variety of colour because of the different combinations of iron. On the question of colour, he thought there was no difficulty, a beautiful new colour having lately been produced by the use of chrome. As to its formation, he did not think it was of consequence whether it was hot water or cold that produced it. In the springs he alluded to in Yorkshire and the different caves, the floors were stalagmite and the walls stalactite. The marble was a congeries of small crystals like white sugar. There were a great many marbles used for the purposes of architecture. There were the Kilkenny marbles, and the different marbles which came from the coal strata. They were called marble, and were very handsome; but when marble was spoken of as a generic term, that fine crystal marble which was used for sculpture was meant.

Mr. Charlesworth thought the material before them was more beautiful, more varied, and less expensive than any material of the kind known. It would be difficult to name a material of which there was the same amount of supply, which could be produced at the same cost, and put to the same purposes as this so-called marble onyx It would be of great interest to know a little more about its history, and when and under what circumstances it

first became known. He had visited some mines in Mexico, and also the museum, but he recollected no articles of this material, nor had he seen it in any of the great collections of Mexican antiquities which had reached this country. It would be also very interesting to know whether the Aztecs, or those who preceded them, were acquainted with the material, or whether amongst the objects which were dug up, any were found to be of this material. He supposed it was found in the course of the excavations for the line of railway.

Mr. Eassie observed that specimens had been traced to a period about 400 years ago, and pieces had been used for decoration for 300 years in the cathedral.

Mr. Charlesworth remarked that Humboldt had written a great deal about the primitive limestone that occurred in this region, and he had himself seen one of the most wonderful stalagmites in the world. There was a cave in Mexico, which was most remarkable in its formation. He remembered going into it with a party of Indians, and firing some large rockets, but they all went out before they reached the roof. It would have been very interesting to know whether there was any similarity between this and other marbles which were known.

The Chairman said the simple fact was it was a new kind of marble—a carbonate of lime very much in the nature of aragonite. But aragonite was generally found upon the surface, while this substance was found connected with water like the stalagmites which were found in the caves, and he believed anyone much acquainted with mineralogy would understand the process of its formation at once.

A vote of thanks to Mr. Eassie for his able and interesting paper then terminated the proceedings.

MISCELLANEOUS.

NORTH-WEST AFRICAN EXPEDITION.

A meeting to promote the objects of this expedition will be held in the Society's Great Room (by permission of the Council) on Thursday, the 27th, at 2 p.m. The following has been forwarded for publication by Mr. Donald Mackenzie:—

A scheme to open up Central Africa to commerce and civilisation is of the highest importance to this country, as well as to the natives themselves, since the introduction of legitimate commerce would cause the slave trade to disappear for ever, while an outlet would be opened for manufactured goods of the greatest magnitude. The plan that the North-West African Expedition has in view is to open a direct road from the north-west coast of Africa, opposite the Canary Islands, to Timbuctoo on the Upper Niger, a distance of about 800 miles. It appears from information that by this route every difficulty which has baffled former attempts to penetrate these regions are avoided. Indeed, it holds out every inducement to the engineer and enterpriser, since the climate of the north-west coast is healthy and well suited to the European constitution, as well as the country that would have to be traversed to the Upper Niger at Timbuctoo. No mountain ranges would have to be crossed by this road, neither would savage tribes, swamps, or jungle be encountered. The point from which it is proposed to open intercourse with North Central Africa is also the nearest and most convenient to England, Cape Juby being distant only about 1,500 miles from our own shores, while the distance across the Desert of Sahara to the interior is less than half of any road that has yet been pointed out, and not beset with any insuperable difficulties. It is also supposed that this project would be the means of establishing a water communication with the interior, since a great part of the western desert is one vast depression below the level of the Atlantic Ocean. This basin is known as El Jûff, or the Great Hollow, and is similar in its geological character to the one existing at the Gulf of Cabes. From El Jûff the interior regions of Africa are supplied with salt, this depression being covered with extensive layers of it. The most authentic information relative to El Jûff concurs in the view that it formed an arm of the Atlantic at a comparatively modern period. The reason which is assigned for it being now dry is, that the current which sets in direct on the north-west coast created a sand-bar across the entrance of its ancient channel, called the Wad Belta, which finally cut off the communication with the El Jûff and the ocean. The geological evidence is such as to establish this idea without a doubt, since the depression is scattered throughout with Atlantic shells, pebbles, and other marine remains. Such is the testimony of Captain Riley and other eminent travellers. It is supposed that if once the sand-bar at the mouth of the Belta valley was cleared away, the waters of the Atlantic would flow into El Jûff, establishing at once a direct navigable communication within about 60 miles of Timbuctoo itself, thus opening up the whole of the populous regions of North Central Africa to commerce and civilisation, and within easy distance of our ports. The most experienced merchants and travellers conversant with that part of Africa are in favour of the proposed route, as well as the most eminent inquirers at home and abroad. Her Majesty's consul at Mogador sent a dispatch to the Foreign-office, confirming the practicability of the scheme. From this report and other information, it is shown that the present trade of North Central Africa, from Morocco, Algiers, Tripoli, and Tunis, amounts to about £3,000,000 a year. This trade would be concentrated into the proposed route, since the journey could be shorter by 1,200 miles. This trade, by a more expeditious means of transit, would soon be developed to a great extent. The first part of the work to be undertaken by the North-West African Expedition is to make a survey of the regions through which it is proposed to construct a highway to North Central Africa, in order to obtain levels, collect information, and enter into commercial treaty with the native chiefs. It is also proposed to establish a commercial station on a convenient part of the coast as a basis of operation. At the meeting announced as above, the Honourable Evelyn Ashley, M.P., will take the chair. General Sir Arthur Cotton, Andrew Cassels, Esq., Admiral Prevost, and other gentlemen are expected to be present. Any of the members who are interested in the question are invited to attend this meeting.

A circular has been issued by the committee for organising the permanent museum at Philadelphia, to all the exhibitors at the forthcoming Exhibition, asking for information as to the articles which might be given, lent, or sold to the museum.

The jury of the Exhibition at Philadelphia will consist of two hundred members, half of them Americans, chosen by the Centenary Commissioners, and half foreigners. Their business will be to award the prizes, and they will receive 1,000 dollars, in addition to their travelling expenses. Their decisions will be without appeal.

M. Hausen, of Stockholm, gives the name of *argentina* to his method of covering unglazed porcelain with a coating of gold, silver, or copper. It is thought the porcelain articles are dipped in a solution of a salt of the metal, and then, by a peculiar process of reduction, the metal is deposited within the pores of the earthenware.

The imports of bituminous coal into the United States in 1875 amounted to 411,723 tons, of the value of 1,511,083 dols. The exports of bituminous coal from the United States in 1875 amounted to 235,060 tons, of the value of 867,586 dols., and 361,669 tons of other coal of the value of 2,039,259 dols.

COST OF EDUCATION IN ELEMENTARY DAY-SCHOOLS.

I. The "Revised Code" for 1876 prescribes the following subjects on which yearly payments may be made out of the Parliamentary grant for elementary education, exclusive of payments made by the Science and Art Department:—

1 Attendance, 4s. a year per scholar.
2 Singing, 1s. a year per scholar.
3 Discipline, 1s. a year per scholar.
4 Drill and — each counts as "attendance."
5 Cookery
6 Reading, 3s. a year per scholar.
7 Writing, 3s. a year per scholar.
8 Arithmetic, 3s. a year per scholar.
9 Grammar, — 4s. a year for two of these subjects.
10 History,
11 Elementary Geography, and
12 Plain Needlework,

Subjects of Secular Instruction,

in Fourth Schedule, 4s. yearly in not more than two subjects.

13 Mathematics,
 a Algebra,
 b Euclid,
 c Mensuration.
14 Latin,
 a Grammar,
 b Delectus,
 c Cæsar.
15 French,
 a Grammar,
 b Translations.
16 German,
 a Grammar,
 b Translations.
17*a* Mechanics,
 b Physics,
 c Chemistry.
18 Animal Physiology.
19 Physical Geography.
20 Botany.
21 Domestic Economy,
 a Food-cooking, — 1st year.
 b Clothing,
 c The dwelling, — 2nd year.
 d Washing and materials,
 e Health, — 3rd year.
 f Cottage expenditure,

II. Note.—Drawing, freehand and mechanical, and twenty-three branches of science are paid for by the Science and Art Department separately.

III. The vote for 1876-7 proposed to Parliament is £1,707,055, including cost of administration.

IV. The estimated number of students is 2,071,997.

V. The rate of the grant actually paid per day scholar in 1875 was 12s. 7d., and estimated to rise in 1876-7 to 13s. 8d.

VI. The rate of grant actually paid for evening scholars in 1875 was 7s. 9d., estimated to rise in 1876-7 to 7s. 10d.

VII. The number of subjects on which payments are made are twenty-one, without, say, seven subdivisions; of the first eight subjects six have a clear yearly value assigned. Drill and cookery are encouraged, but lumped in with "attendance." The rules and conditions under which payments are made are complex and difficult to be understood. Thus cookery is paid for indirectly as "attendance," and, again, in connection with "food and clothing," it is encouraged, provided the fourth standard is passed. Why not make a simple rule that if practical and theoretical cookery is taught in an elementary school, in say forty weekly lessons, 2s. yearly per scholar passing should be paid on passing. The grant could not be earned without at the same time affording proof that the child could read, write, spell, and cypher.

VIII. Dividing the grant over the twenty-one principal subjects with their subdivisions, say twenty-seven in all, the average cost of each subject is £63,224. The ten first subjects would thus cost say £632,240. But they cost much more, if it could be found out. This is an unsatisfactory method of computation. It seems impossible to find out from any published returns what is spent to encourage military drill, or cookery, or music —subjects especially interesting to the Society of Arts. But it would not be difficult for the Education Department to state in the Estimates what has been the probable cost of each subject in the past year. The knowledge would be most valuable, and show at once what subject is making way in schools.

PARIS EXHIBITION, 1878.

The *Daily Telegraph* of Tuesday last (18th inst.) quotes from the *Journal Officiel* some extracts from the address presented by the Minister of Commerce to, Marshal MacMahon on the subject of the Exhibition which is to take place in 1878. The portions given are as follows:—"Great progress has been made in almost every branch of art and industry since the International Exhibition of 1867, and there can be no doubt that after a lapse of eleven years the public will be delighted to witness another great collection of all the industrial and artistic productions which have come to light during that time. Two years will suffice for the realisation of this grand enterprise. The Exhibition of 1867 was only resolved upon in 1865, and it was only in the month of August of the latter year that the plan of the palace was definitely adopted. The selection of a site is a most important matter, and the decision of the sub-commission will have to be well weighed by the superior commission, which will be appointed later. The situation of the building exercises a great influence on the number of visitors, and on the amount of profit which the general mass of humanity derives from the spectacle. In 1862 the Exhibition occupied a space of 120,000 square mètres; that of 1867 necessitated a covered surface of 153,000 mètres. Since 1867 industrial art and agricultural production have been steadily improving all over the world. The commerce of France alone has increased from five milliards eight hundred millions to seven milliards seven hundred millions of francs, a fact which may be accepted as a measure of the impulse given to business by these great international competitions. Taking these facts into consideration, it is evident that a much larger area than the one employed in 1867 will be required. The surface to be occupied in 1878 must be estimated at 225,000 mètres. Round the principal edifice gardens will have to be laid out, and wide roads leading to the building will have to be constructed. These necessarily add to the difficulty of finding a suitable situation. The expenses of the necessary works must be set down at thirty millions of francs. Judging by experience, it is probable that the State would recover about eighteen or twenty millions of this money from the entrance-fees and other sources of profit. Constructed of iron and glass, the materials employed could be sold again after the Exhibition had been held, and thus the sacrifice made by the State would be considerably lessened."

The document concludes as follows:

"In announcing to the world the fact that a new International Exhibition is to held, France asserts her confidence in the institutions which she has founded. She declares it to be her intention to persevere in the ideas of moderation and wisdom which have inspired her policy during the last five years. She proclaims her desire for peace, which has alone the power to render

human activity really fruitful by giving it security. We have confidence that her appeal will be sympathetically received, and that the year 1878 will be marked by a glorious page for civilisation and for our own country in the annals of the *fêtes* of industry. Pray accept, M. le President, the homage of my profound respect.

"(Signed) "Teisserenc de Bort,
"The Minister of Agriculture and Commerce."

The *Journal Officiel* of the same date (the 17th) contains the following decree:—

"A Universal Exhibition of Fine Arts, independently of the Annual Exhibition of the Works of Living Artistes, will be opened in Paris at the same time as the Agricultural and Industrial Exhibition, on the 1st of May, 1878, and will be closed on the 31st of October following. An ulterior decree will determine the conditions of this Exhibition. The Minister of Public Education and of Fine Arts is charged to carry out the present decree."

THE PHILADELPHIA EXHIBITION.

The New York correspondent of the *Daily News* writing on the 8th inst., says:—There is not very satisfactory news from Philadelphia respecting the preparations for the Exhibition, and the prospect now is that, in spite of the early completion of the buildings, the usual fate of world's fairs will mar the opening of this one. The American exhibitors in nearly all departments are far behindhand. By hard work, and with the help of the excellent transportation facilities provided by the Commission, the goods in the main hall will probably be got in order by the 10th of May, but in the machinery hall the outlook is dismal indeed. "Not one-hundredth part of the machinery is yet in place," says a correspondent, "and not a tenth part has arrived. If every article were now on the ground, it would require a month to get things together and in running order." In the agricultural hall not a single American exhibit has yet arrived. The horticultural show also is still meagre; and the art buildings will not be ready much before the 1st of May. There is no excuse for the delay of the exhibitors, for they have had ample notice, and the preparations to receive and handle their goods were completed long ago. The pavilions, offices, and other small buildings erected by the separate States or by foreign Governments are fast assuming an appearance of comfort and elegance. England and Japan still attract the most notice. The ceremonies of the opening will be short. They are copied pretty closely from those of Vienna. The inaugural march, written for the occasion by Herr Richard Wagner, was despatched two or three weeks ago, and is probably now in the hands of the copyist. It will be executed by an orchestra of 180 musicians, under the very best of American conductors—Mr. Theodore Thomas. There is a short and good cantata, also written for the occasion, the words by Sidney Lanier, a rising young poet from Georgia; the music, which is simple, dignified, and effective, by Dudley Buck, of Connecticut. There will be a brief address by General Hawley, the chief of the Centennial Commission, and a few words from the President of the United States. These exercises will take place in the open air, between the main Exhibition building and the art hall. The celebration of the hundredth anniversary of American Independence on the 4th July, when Mr. Evarts is to deliver the oration, Bayard Taylor to recite an ode, and John G. Whittier to write a hymn for music, will perhaps be more interesting than the opening of the World's Fair.

An improvement in the preparation of wood for wall-paper has been lately made in America. The wood is cut to the thickness of paper, and by a peculiar process stuck on to the paper, which serves as a protection against the influence of the walls on the graining and colour of the wood.

THE RESOURCES OF EPIRUS.

The province of Epirus forms the southern portion of Albania in European Turkey, and is bounded in the east by Thessaly and Macedonia, upon the west by the Ionian Sea, and it has Janina and Zagori for its chief towns. The population about fifteen years ago was reckoned at 360,000 persons, since then, however, the number has been constantly diminishing, and so far as private researches may be relied upon, it may now be stated in round numbers at 313,750 persons, of whom 210,000 were Christians, 100,000 Mussulmans, and 3,750 Jews. Several causes contribute to this decrease. First of all, according to the concurrent testimony of well-informed persons, the total of deaths exceeds in the year the total of births. This applies to every section of the population but the Jews, who are on the increase. As regards the Mussulmans, with whom the diminution is greatest, several hundreds of them are every year drafted out of the country by conscription, of whom a large per-centage never return. There is also a continual emigration of them, men and even families, to Larissa, Constantinople, and other Mussulman centres, to which they are attracted by special interests or the hopes of advantage. Of the Christians, great numbers of young men also emigrate. This is particularly the case with the men of Zagori, of whom some are found in every country where there is an opening for enterprise or address. From the purely agricultural districts of the interior there is little or no emigration; but from the maritime districts there is a constant outflow of men, who as labourers, servants, sailors, and the like, are in demand at various places in the Levant, in Greece, Smyrna, Constantinople, Alexandria, Suez, &c. The decrease in the population being thus accounted for, it has further to be noticed that the constant drain of men has led to a great disproportion between the sexes. In some localities the ratio is as seven to four, and taking the whole of Epirus, the disproportion between the sexes is somewhere about three males to five females.

Consul Stuart states that the cessation of British protection in the Ionian Islands had a most damaging effect upon all the material interests in these parts. From Epirus there used to be a large exportation of provisions to Corfu and some of the other islands, the cash returns of which constituted a large part of the wealth of the country, at the same time stimulating its productive powers. The foreign goods imported consist for the most part of rice, sugar, coffee, rum, wine, petroleum, iron, lead, copper, timber, tanned hides of various kinds, cotton and woollen cloths, silks, druggets, candles, crockery, pottery, paper, lucifer matches, &c.; to which are to be added gold and silver thread for the embroiderers. The exports are chiefly made up of valonea, wool, sheep, lamb and goat skins, leeches, liquorice, olive-oil, pickled olives, snuff, tortoises, &c. All these articles being in demand in the neighbouring markets, it might be supposed that the exportation would be steady, and even on the increase. It is said, however, that such is not the case, and whether it is that foreign dealers can be better supplied elsewhere, or that the producers in the country are less active or less numerous than formerly, it is constantly affirmed that the export trade has much fallen off, and is still on the decline. English manufactured goods to the value of a few thousand pounds arrive every year; they come by the Liverpool steamers to Corfu, where they are transhipped into country boats and fetched across. But the chief part of the imports are from Trieste—there are some also from Greece and Italy—and to these three places the bulk of the exports are in turn directed. There is a small direct trade between Prevesa and Malta, carried on in sailing craft of 40 or 50 tons and under. The exports from Epirus consist chiefly of cheese, butter, figs, pickled olives, &c.; the imports of cheap crockery, glass, oil-paints, salt fish, and the like.

With the exception of Indian corn, this country does not, even in favourable years, produce enough bread-

stuffs for home consumption; the deficiency is supplied from Thessaly. The wine is a very important part of the yearly produce, for it enters largely into the every-day consumption of all classes of the population, holding the place of all malt beverages in England. The wines are of an inferior quality: they are light and acid, and if kept to the second year they mostly turn into vinegar. The oïdium has now quite disappeared from the vines. Epirus consumes all its own wines, and besides considerable quantities from Macedonia and Greece. The tobacco plant is grown, especially the "Inglesicon," a pungent sort, of American origin, from which is made a dark coloured snuff, which is highly prized throughout the Levant. The other kinds of tobacco grown, but not much esteemed, are for the most part consumed by the poorer classes. The better qualities are imported from Thessaly. The soil and climate are both congenial to the olive, which to some extent compensates for the want of care and culture. The trees, as a rule, are left to nature, they are seldom manured, never pruned: hence the sap, which should be husbanded as much as possible for the fruit, is nearly all consumed in maintaining the trunk and overgrown branches. The yield of olives is therefore always uncertain, and at the best falls short, both in quantity and quality, of what it should be if the tree were properly dressed and cared for. Flocks of goats and sheep constitute one of the chief sources of wealth; the goats are of a good breed, the sheep not so. The profit of a sheep, including wool, lamb, cheese, butter, is about 14s. a year; of a goat, about 9s. A tax equivalent to 6½d. a head is levied on all sheep and goats of a year old and upwards. This tax is taken in lieu of a tithe, and as such has been estimated on the average market value of the animals. It is every year farmed to the highest bidder. The wool is of inferior quality: the greatest part of it is worked up in the country for home use, but some picked lots are sent every year to Trieste. The production of silk is at best but stationary, and does not contribute much to the wealth of the country; and cotton growing, which was rapidly increasing in 1862 and 1863, has relapsed to its former insignificant proportions.

In Epirus the working classes are physically inferior to the average standard of European countries; both men and women are stunted in growth, slightly built, and in weight and muscle quite unequal to the heavy work required for high production; add to this a want of energy, which renders them averse to exertion and slow to improvement. Even placed in the most favourable circumstances it would take some generations to elaborate out of them the agents of highly productive labour. They have long been under conditions of the very opposite tendency, and these conditions, so far from improving, are becoming sensibly worse. But not only the population, the agricultural stock is diminishing. In the country neither machinery nor the wheeled carriage is employed in aid of labour. The ox is used for ploughing, &c., the pack-horse for transport. Both are falling off as well in quality as in number. During the British protection of the Ionian Islands, the Epirote farmers used to obtain supplies of large powerful Vallachian oxen through the Commissariat-contractor's droves. This they can no longer do. The Vallachian ox has almost disappeared from Epirus; and all the ploughing is done with the country ox, which is small, light, and of feeble draught power, but even of these the breed is declining. In 1861 it was calculated that there were 29,000 head of horned cattle in Epirus. A large substraction must now be made from that number. The horses were, not many years since, well thought of. Though small, they are hardy, strong, and active. Numbers of them used every year to be bought up for the Ionian Islands and Continental Greece, as well for country work as for the saddle and light carriage. For the demand occasioned by the Crimean War, some thousands of the best of them were exported; the deficiency thus created has never been supplied, and from that time dates the deterioration of the breed, which every year becomes more observable. In 1861 it was made out that there were 13,000 horses and 4,000 mules in Epirus. Well-informed persons are of opinion that both are now less numerous by at least a fourth.

No means exists of procuring anything like correct information with respect to agricultural or industrial produce. No statistics are ever attempted; and, as there are many motives for concealment, all inquiries on this subject are studiously evaded or misled. But though this is and always has been the case, certain general conclusions can be arrived at by observation and by the collection of such loose data as are currently known. The opinion is general that the produce of the country is diminishing, and in a ratio, too, which exceeds the decrease of the agricultural population. For, in many places, the hands are still there, but the means of tillage are wanting; no cattle, no seed, no money, no credit. The landowners, who are sharing the general poverty, cannot, as in other times, make loans or advances to their villagers; and the moneylender, seeing their condition, avoids dealing with them. Under these circumstances, the work of agriculture becomes impossible, and the villager, leaving his plot of land fallow, tries some other way of finding subsistence. He seeks employment as a shepherd; or, if he has the good fortune to possess a few sheep or goats, he devotes all his care to them, in the hope of raising a flock numerous enough to support himself and family. But few, however, are in so favourable position, and in many districts the peasants are reduced to great distress. It is credibly reported that in some places they are in want of bread, and are forced to live on wild herbs, roots, and other unwholesome and insufficient food. Hence, an unusual mortality among them, and the appearance of new and strange diseases, previously unknown in the country. Nevertheless, with all this, the Government bates nothing of its claims on the land, the tale of bricks is not diminished; and the attempt is rigorously made to exact, not only current charges, but arrears extending back over many years. To those who cannot pay is applied the law made for those who can but will not, to wit, first, fifteen days' imprisonment, failing which, seizure and sale by auction of the defaulter's personal chattels, agricultural implements excepted. If the proceeds of the sale do not cover the defalcation, the balance is held over to a future time, but remission is never made. This law is absolute; the execution of it is often attended with circumstances of great hardship and oppression; and nothing is more dreaded by the villagers than the visits of policemen sent to collect arrears of taxes. The Mussulmans of every class are more distant and reserved towards Christians than they used to be, and though sensible of their increasing poverty, they would still, in some way or other, maintain or assert the superiority accorded to them by their religion. As they seem to be incapable of retrieving their sinking estate, one is tempted to believe that they are bent in obstructing all progress among the Christians, and thereby of keeping them as much as possible, and as long as possible, in a condition of inferiority. If there is any such motive in the spirit and policy of the governing party, the continued decay of the country is inevitable.

During the year ending July 1, 1875, the produce of duties on beer in America shows that 8,880,629 casks of this beverage were produced there. In New York there were 203 breweries; in Pennsylvania, 235; in Wisconsin, 232; in Ohio, 210; in California, 202; in Illinois, 165; and in Michigan, 149.

In 1829, New South Wales produced 780 tons of coal. In 1874 the corresponding production had grown to 1,304,567 tons. It is calculated that the total extraction of coal in the colony in the 45 years embraced between 1829 and 1874 was 12,387,279 tons, of the value of £6,655,328.

PRODUCTION OF SILKWORMS' EGGS IN ITALY.

Great attention is being paid in Italy, as stated by Consul Colnaghi, in his report upon the yield of cocoons in 1874, to the restoration of the native breeds of silkworms, and apparently with every hope of success. Government stations for microscopic examination are established in various provinces, and private individuals are not behindhand in experimental studies, which, in some cases, have assumed an important industrial aspect. At Albiate, in the province of Milan, there exist the important Cascina Pasteur for the production of silkworms' eggs, founded about 1868-69, and conducted by Mr. Guido Susani. The Cascina Pasteur has been continually increasing its productiou of grain under cellular selection, and in 1874 furnished 18,000 ounces (of 25 grammes each) of eggs, a quantity that could be greatly increased on the receipt of early commissions.

Microscopic examination of the moths, and not of the eggs, is the foundation of the system of selection. While, however, this examination is a certain safe-guard against the corpuscular disease, or, as it is usually termed in Italy, "la petrina," it is of no avail against other sicknesses. Here the remedy is found in a series of physiological selections, costing both time and money, and requiring more than two years to be certain of effect. Mr. Susani has obtained equally good results with regenerated Italian breeds as with the green and white Japanese, which he has reproduced for the last seven years without requiring to renew the stock from Japan. In Lombardy these Japanese reproductions are preferred, and are the only ones generally used. They have given of late better results than the Japanese cards, which are found every year to be more and more infected with disease. In Central Italy the yellow Italian breeds are more usually cultivated. These, when ill-attended and the season is unfavourable, suffer from "flaccidezza," and this is why the Lombard peasants prefer the cellular selections of the more hardy green Japanese race. Among the Italian breeds Mr. Susani prefers the old "Brianzola" and the "Biona," which he has regenerated, for hill cultivation, or at least for dry localities, and where sufficient care is taken; for the lowlands he prefers a commoner quality.

On a smaller scale than Mr. Susani's, but very complete in its arrangements, is an establishment in the immediate neighbourhood of the small town of Arezzo (Tuscany), overlooking the Val Tiberina, and founded by Count Polidori and Co. three years ago, also for the special purpose of producing silkworms' eggs for sale. Mr. Colnaghi mentions that he recently had an opportunity of visiting this establishment. A convenient two-storied building has been erected, in a garden in which a plantation of young mulberry trees is growing. The rooms in which the silkworms are reared are light, airy, and well ventilated: the open fireplaces are of brick, and, by a simple system of tubes communicating with the outer air, a constant supply of fresh air, warmed in its passage through the stoves, is brought into the rooms, the foul air being carried away by means of ventilators. Light wooden frames are raised in each room, leaving sufficient space for the attendants to walk round them. On the frames trays are laid in rows, each tray measuring 75 centimetres; the height between the rows of trays is 55 centimetres. To rear one ounce of eggs 72 trays are required—*i.e.*, a superficial area of 56 square metres—and they may be placed in a small space if it is well aired. The bottoms of the trays are of string, over which a piece of white gauze is laid to support the worms. Twenty-six microscopes are in use to examine the moths. A power of 560 diameters is considered the most suitable. Sixty women are in constant employment, varying according to the season, in examining the moths and rearing the worms.

The system of microscopic selection used in Italy is that of Pasteur, modified slightly by the experiments of Cornalia and Cantoni. The moths (male and female) themselves carefully selected, are placed in a small gauze bag, where they couple—the female depositing her eggs—and die. After death they are taken out of the bag, the wings carefully stripped off, the bodies pounded, with a little water, in a small porcelain or glass mortar. If on examination under a microscope, no sign of corpuscules are found, the eggs are considered healthy. The examination of the eggs themselves is not required, being superfluous if the moths are healthy, and useless when they are not, as the germs of the disease may be contained undeveloped in an apparently sound egg. The healthy eggs are suspended in the little bags in a cool and airy place. For the due hatching of the worms in the following spring, it appears to be absolutely necessary for the eggs during the winter to be exposed to the influence of frost, or at the least of a certain degree of cold.

Count Polidori and Co. rear worms enough to produce 3,000 ounces (of 28 grammes each) of grain, for which about 270,000 couple of moths have to be examined under the microscope. The breed of the worms at present obtaining the preference at the Anghiari establishment is the French roussillon, which produces a small but compact and well made cocoon, contracted in the middle, yellow in colour, with a slight roseate hue. The silk is elastic and lucid. The cocoon resembles that of the well-known Brianza breed, of which it is probably a descendant. The yellow Tuscan breed, although it has been preserved in the province throughout the silkworm disease, is said to be weakly; the cocoons do not spin well. The Novi breed (white cocoon), yields a beautiful silk. A race of worms from Sardinia, with a roseate cocoon, was of good promise, as also a French breed from the Var, of striped worms, and producing a nankin-coloured cocoon.

With reference to the product of the various breeds, on an average, one ounce of Japanese grain yields from 16 to 20 kilos of green cocoons; one ounce of Japanese grain, reproduced in Italy, yields from 40 to 45 kilos of green cocoons; one ounce of Italian green yields about 60 kilos of yellow cocoons; one ounce of French striped breed (Var) yields about 35 kilos of nankin cocoons; and one ounce of roussillon yielded last year 80 to 85 kilos of yellow (roseate tinted) cocoons, but this was a maximum, and cannot be taken as the average.

THE PRESERVATION OF TIMBER.

Buried in the earth or exposed to the air, timber rapidly deteriorates, and undergoes the species of decomposition known as dry-rot. This decomposition may be retarded by the application of a coat of paint to the timber exposed to the air, or by carbonising the surface of that which is intended to be sunk in the ground.

During the last twenty years, several methods have been tried for making timber more durable, the principle of which consists in expelling the sap remaining in the ligneous fibres, in order to replace it by chemical solutions, such as sulphate of copper and creosote; but these processes, comparatively costly, and only partially successful, do not entirely accomplish their object. Starting from the fact that oak, chestnut, and certain American trees resist the action of air and damp better than others, and that they owe this property to the tannin which they contain, a chemist proposes to tan the timber by substituting for the sulphate of copper and creosote a compound of tannic acid and iron. The object of injecting various substances into wood is to poison them, so that germs and microscopic growths may no longer live and propagate either on the surface or in the interior. Now tannin is one of the most active and certain destroyers of

germs both vegetable and animal, which fact accounts for its preservative agency. Besides, it is to tannin that is due the almost indefinite preservation of leather. One peculiarity to be noticed in this process is that timber treated with this compound of tannin and iron, that is to say a composition similar to ordinary writing ink, is turned black.

The process of injecting timber with tannate of protoxide of iron is due to M. Hatzfeld; the Eastern Railway Company of France has experimented with it on some sleepers, and the telegraph department on some posts.

M. Boucherie has denied, in a note to the *Académie*, the efficacy of this process, contending that the attempts already made to preserve timber from dry-rot by injecting it with iron salts have yielded only partially successful results, while sleepers treated by sulphate of copper have lasted twenty-five years and more. Reply is made to these objections by quoting—not the experiments of the laboratory or the workshop, but those made by time itself. It is not a rare circumstance to encounter in earth of a ferruginous nature the trunks of very old oaks, blackened and perfectly preserved; at Rouen, in 1830, some old oak paling was discovered as black as ebony, and dating back to the Middle Ages. Not very long ago, too, a Norman vessel built of oak was discovered in an almost perfect state of preservation in the neighbourhood of an iron mine in Norway. It is more than probable that the preservation of the oak under these circumstances is due to the tannin contained in the wood; it follows, therefore, that by introducing a substance rich in tannin into timber that does not naturally possess it, its resistance to decay is increased.

PAPER BOX MAKING MACHINERY.

The following account of a new method of making paper boxes by machinery, is given by *Engineering*:—

"Without counting the pulp-making apparatus, which possesses no special feature of interest, there are five distinct machines, each of which advances the box one stage towards completion. In the first of these machines the pulp is pumped into a small cylindrical receiver, provided with a discharge pipe, through which the surplus pulp is pumped away at each stroke of the machine. Within this cylinder two pistons—one working within the other—are moved up and down by cams, the outer one being in advance of the other and cutting off the supply of pulp, and the inner one following it, and exerting a powerful pressure on the top of a core box which has been brought underneath it, and immediately in the centre of the mould, which is as much larger in diameter than the core box as corresponds to the thickness of the sides of the box. The core box is of brass, perforated with a large number of openings, and, before it is brought under the piston before mentioned, it is covered with a sheathing of fine wire gauze, which allows the water to flow away freely, but prevents the pulp from escaping. The core boxes, of which there are several attached to the machine, are carried at the ends of arms revolving freely around a vertical central spindle, and as each one is brought round automatically within the mould, its underside forms a tight joint with the top of an open pipe in connection with an exhaust pump driven by the machine, so that the perforated cores form vacuum boxes, through which the water flows from the pulp, while through perforations around the lower part of the cylinder, corresponding to the position of the flange of the box, the water from that part is also expelled. One of the most ingenious features of this machine is the arrangement of the brass mould surrounding the core box. It is of brass, formed in eight pieces, and so designed as to expand and contract without parting at any of the joints. Each piece is attached to a slipper working to and fro on a guide and to a short connecting rod attached to a strong cast-iron ring. By a suitable mechanism the ring is made to travel to and fro through a small portion of its circumference, one movement expanding and the other contracting the mould, the latter motion taking place when the inner piston descends and compresses the pulp on top of the core to form the top of the box. This contraction of the mould exerts a very powerful pressure round the sides of the boxes and consolidates the pulp.

As soon as the body is thus formed the core travels around and a new one takes its place within the mould, while the body is placed upon an endless chain, and deposited automatically in a drying stove, where it remains for 24 minutes, the rate of discharge being ten per minute, corresponding to the number of boxes moulded in the same time on the first machine. The next operation is to place the boxes in the flanging machine. Two bodies are treated at a time in this machine. They are placed each on a mandrel, which revolves at a high speed and then stops automatically long enough for the boy working the machine to remove the body and put on another. The bodies are held upon the mandrel and caused to revolve by a driver consisting of a disc, rising and falling automatically, the former motion bringing the disc fairly against the bottom of the box, and the latter throwing it down clear, so that the body can be be removed as soon as the mandrel is at rest. When the body is revolving, a circular brush, charged with china-clay and water, presses against the flange of the box, and softens it, while immediately after, a moulding tool rises and reduces the flange to the desired form.

In the succeeding machine the box bodies are placed on projecting pins, attached to a long endless chain hanging vertically, and the upper parts of which are enclosed in two wooden trucks charged with heated air. As the bodies are placed on the pins, the chain revolves and brings the bottom and sides of the box into contact with colour brushes, which cover the whole surface; the box then passes upwards, giving place to another, and so on, the bodies travelling up one trunk and down the other until they arrive near the point where they were first placed on the chain. Here they are covered with china-clay, and brought into contact with revolving and polishing brushes. Finally the boxes are placed in the last machine, an embossing press, in which the top and sides are stamped, and, if necessary, gilded at one operation.

The advantages connected with this interesting manufacture are very apparent. As the boxes are made from the pulp direct, all the preliminary expense of manufacturing materials is saved, there is none of the waste of material inseparable from the making of boxes by hand, and finally, a plant consisting of the four machines and drying stoves, can produce 600 finished boxes or covers an hour without the employment of skilled labour, one boy to each machine being all that is necessary.

CORRESPONDENCE.

DEXTRINE-MALTOSE.

Sir,—I was much amused, as well as astonished to read a letter in your *Journal*, a week or so ago, purporting to be written by a Mr. W. A. Lyttle, C.E., F.C.S., in which that gentleman states his views in respect to "dextrine-maltose," the new artificial malt extract, brought under the notice of brewers by Mr. Valentin, of the Royal College of Chemistry, South Kensington, in a recent paper at your rooms.

Mr. Lyttle, strange to say, clearly misunderstands the whole subject under debate, and although a Fellow of the Chemical Society, seems to have but a scant know-

ledge of the marked differences that exist between dextrine, glucose, and maltose.

I may, perhaps (as a practical brewer of some experience, and possessing also a simple but complete theoretical knowledge of the chemistry of brewing), be allowed to point out that the well-earned discovery is not, as M. Lyttle seems to suppose and insinuate, the manufacture of saccharine from starchy matter, a process which, as he correctly says, is fully described in standard works of considerable age, but that, by a most skilful limitation of the catalytic action of sulphuric acid (dilute), instead of completely changing the starchy matter into actual glucose, it is converted into a proportional mixture of maltose, the sugar of malt, and dextrine, the other equally important constituent of malt-worts.

The importance of this novel discovery, the credit of which is most certainly due to Messrs. Valentin and O'Sullivan, is obvious to all brewers who know by experience that thin palated beers are obtained by the excessive use of the saccharines hitherto offered to brewing firms; this result of course being due to the fact that the so-called saccharines, consisting almost entirely of grape sugar, convey to worts no characteristic of palate fulness.

Leaving it to Mr. Lyttle to explain how it comes about that he, as a chemist, does not seem to know the immense difference that exists in a brewing sense between dextrine and glucose, and how, as a reader of Mr. Valentin's paper, he fails to understand, or even admit, the novelty and importance of the discovery for manufacturing from crude starch, not a glucose, mind, but a compound containing actual malt sugar and dextrine in fixed proportions, I must make one remark about the absurd objection he raises to the use of chalk, as a neutralising agent in the manufacture of these malt substitutes.

If the syrup be left slightly acid, thus allowing a small quantity of calcic-sulphate to remain in solution, I cannot see why the public should object to the use of this syrup in the production of the beer it consumes; since the lime-salt in question, which Mr. Lyttle thinks proper to condemn on physiological grounds, is the very one which tends to give such striking character to Burton beers, and the very one which is naturally formed in beer when such preservative agents as calcic mono or bi-sulphite are employed.

Before such hasty, groundless, and unworthy remarks are again made concerning a new chemical product—new so far as its artificial formation is concerned—Mr. Lyttle ought, I imagine, to learn a little more of the theory of brewing, and a great deal more of the chemistry of sugars.—I am, &c.,

Frank Faulkner.

The Brewery, St. Helen's, Lancashire,
April 12, 1876.

MODEL DWELLINGS FOR THE RICH.

Sir,—There is one short paragraph in Mr. Chadwick's letter, printed in the *Journal* of the 31st ult., so highly important as regards the healthiness of London, that I think you will not object to reprint it if I give it here. "Blocks of these tall houses should be laid out, with sanitary precautions for the avoidance of the enclosure of deep reservoirs of stagnant and vitiated air, such as may be pointed out at the West-end of the metropolis, and for insuring the free sweep of the wind, and external ventilation."

Possibly the paragraph may not have particularly struck many readers of the letter, whence it is taken, and it would not have struck me, but that some little time ago I had painful experience of the effect of having to breathe—for a night or two only—the air of one of these "deep reservoirs of stagnant and vitiated air," and this in one of the healthiest and best sites naturally, in all London, being near the Marble Arch; but my bedroom was at the back, and though the front of the house was most cheerful and pleasant, the back looked on to an immense quadrangle formed by the backs of the several long rows of houses closely packed, and without a break of any kind, as usual in London, and the only air that came in at the window was reeking with stable smells and worse abominations. No doubt thousands, especially servants, who are not of course likely to get the best rooms, are being ruined in health from this cause without being aware of it.

Now that the importance of pure air to health is so well understood, it really is astonishing to see the folly, even in the very best neighbourhoods, where mansions are built in long continuous rows, without a break of any kind to admit "the free sweep of the wind" to blow away impurities: look, for instance, at Portland-place, or for a more modern one, at those splendid mansions in Grosvenor-place, stuck close together throughout.

I believe if London could be rebuilt with due regard to a "free sweep of air," through, and around, such as any one may see provided for in the Waterlow colonies in various parts of London, the healthiness of our grand old city would be marvellously promoted, and many would then find, to their great comfort, that it was unnecessary to be spending such a large portion of their lives in scrambling backwards and forwards to the City by railway.—I am, &c.,

H. C. White.

London, April 15th, 1876.

NOTES ON BOOKS.

Official Catalogue of the British Section of the Philadelphia Exhibition. London: Eyre and Spottiswood, 1876.

This catalogue is published in two parts; the first is the catalogue proper, the second is termed the "Exhibitors' Commercial Guide." The principal part of this is devoted to an elaborate table, giving the duties chargeable upon all articles imported into the United States. The various articles are arranged in alphabetical order, and opposite the name of each article is the rate of duty according to the American official tariff, and the duty charged in English currency. There is also a list of articles admitted duty free, almost all raw materials. The amount of information contained may be estimated from the fact that this table extends over more than 250 pages of quarto size. Besides this there is a great deal of matter likely to be useful to exhibitors and others visiting America; the laws relating to patents and trade marks are given at length; while the volume concludes with a list, giving the duties on various English articles imported into France before and after the 1855 Exhibition.

GENERAL NOTES.

Production of Silver in the whole World.—According to the most recent statistics, the production of silver in the whole world in 1800 was £7,000,000, which rose in 1850 to £8,500,000; in 1854 to £9,500,000, and in 1865 to £12,500,000. The production of this precious metal during the year 1873, is sub-divided as follows:—England and its Colonies, £2,000,000; Norway, Sweden, and Denmark, £50,000; Russia, £100,000; Austria, £320,000; Germany, £600,000; France, £400,000; Spain, £400,000; Sardinia, £100,000; Mexico, £4,000,000; Central and South America, £1,600,000; Canada, £180,000; the United States, £7,300,000, which gives a total of £17,050,000. Including the year 1873, it is estimated that the total production of silver, since the discovery of the New World by Christopher Columbus has been £143,000,000, the largest source of accession, during late years, being due to the Nevada mines.

Speed of Trains.—The following are the highest authentic instances of high railway speeds with which we are acquainted:—Brunel, with the Courier class of locomotive, ran 13 miles in 10 minutes, equal to 78 miles an hour. Mr. Patrick Stirling, of the Great Northern, took, two years back, 16 carriages 15 miles in 12 minutes, equal to 75 miles an hour. The Great Britain, Lord of the Isles, and Iron Duke, broad gauge engines on the Great Western Railway, have each run with four or five carriages from Paddington to Didcot in 47½ minutes; equal to 66 miles an hour, or an extreme running speed of 72 miles an hour; the new Midland coupled express engines running in the usual course have been timed 68, 70, and 72 miles an hour. The 10 a.m. express on the Great Northern, from Leeds, we have ourselves timed, and found to be running mile after mile at the rate of a mile in 52 seconds, or at 69·2 miles an hour. The engines used are Mr. Stirling's outside cylinder bogie express engines, the load being ten carriages.—*Engineer.*

NOTICES.

SUBSCRIPTIONS.

The Lady-day subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

APRIL 26.—"Sericiculture in Australia," by Mrs. BLADEN NEILL. The DUKE OF MANCHESTER will preside.

MAY 3.—"The Preparation of China Clay," by J. H. COLLINS, Esq., F.G.S.

MAY 10.—"A New Method of Propulsion for Street Trams," by E. H. LEVEAUX, Esq.

MAY 17.—"Railway Safety Appliances," by F. J. BRAMWELL, Esq., C.E., F.R.S.

MAY 24.—*The same continued.*

AFRICAN SECTION.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

MAY 9.—"The Languages of West Africa." By the Rev. J. H. SCHÖN.

MAY (*date not yet fixed*).—"The Commerce of the Gaboon; its History and Future Prospects." By R. B. N. WALKER, Esq.

INDIAN SECTION.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

APRIL 21.—"The Sanitary Progress of India," by Captain DOUGLAS GALTON, C.B. EDWIN CHADWICK, Esq., C.B., will preside.

MAY 5.—"Irrigation Works in India," by W. T. THORNTON, Esq., C.B.

MAY 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. GEORGE BIRDWOOD.

MAY 26.—"Thaumatodendra, or the Wonders of Trees in India," by WILLIAM TAYLER, Esq., late Commissioner of Patna.

CHEMICAL SECTION.

Friday evenings at 8 o'clock. The following arrangements have been made:—

MAY (*date not yet fixed*).—"Cinchona Alkaloids; their Sources, Production, and Use." By Dr. B. H. PAUL.

MAY 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By JOHN MORRISON, Esq., of Newcastle-on-Tyne.

CANTOR LECTURES.

Monday evenings at 8 o'clock. Third Course, "On Wool Dyeing," by GEORGE JARMAIN, Esq.

LECTURE V.—APRIL 24TH.

Logwood and other woods, and their application to the dyeing of wool and woollen fabrics (*continued*).

LECTURE VI.—MAY 1ST.

Aniline and other allied colours, and their application to the dyeing of wool and woollen and mixed fabrics.—Concluding remarks.

MEETINGS FOR THE ENSUING WEEK.

MON. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. George Jarmain, "Wool Dyeing." (Lecture V.)
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Mr. W. H. Michael, "The Working of the Sanitary Acts in Rural Districts."
Antiquaries, Burlington House, W., 2 p.m. Annual Meeting.
Institute of Actuaries, Quadrangle, King's College, W.C., 7 p.m.
Medical, 11, Chandos-street, W., 8 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Philosophical Club, Willis's Rooms, St. James's, 6 p.m. Annual Meeting.
Social Science Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. Alfred Carpenter, "The Right of the State to obtain early Information on the appearance of Epidemic or Infectious Disease in a given district—ought the Medical Attendant to be the Informer?"

TUES. ...Royal Institution, Albemarle-street, W., 3 p.m. Professor P. M. Duncan, "The Comparative Geology and former Physical Geographies of India, Australia, and South Africa."
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Mr. David Alan Stephenson, "Dhu Hearbach Lighthouse." 2. Mr. James N. Shoolbred, "Tidal Changes in the River Mersey,"
Anthropological Institute, 4, St. Martin's-place, W.C. 1. Mr. W. H. L. Ranken, "South Sea Islanders." 2. Mr. A. L. Lewis, "Some apparent Coincidences of Custom and Belief in Chaldæa and Western Europe." 3. Dr. Comrie, "Exhibitions of Weapons, Objects of Art, Dress, &c., from New Guinea." (Adjonrned discussion.)
Royal Colonial, 15, Strand, W.C., 8 p.m. The Bishop of Melbourne, "The Progress of Victoria."

WED. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mrs. Bladen Neill, "Sericiculture in Australia."
London Institution, Finsbury-circus, E.C., 12 a.m. Annual Meeting.
Geological, Burlington-house, W., 8 p.m. 1. Professor A. C. Ramsay, "The Physical History of the Dee, Wales." 2. Mr. J. W. Judd, "The Ancient Volcano of the District of Schemnitz, Hungary."
Royal Society of Literature, 4, St. Martin's-place, W.C., 4½ p.m. Annual Meeting.

THURS...Royal, Burlington House, W., 8½ p.m.
Inventors' Institute, 4, St. Martin's-place, W., 8 p.m.
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. B. Haughton, "The Spectroscope."
Royal Institution, Albemarle-street, W., 3 p.m. Professor Tyndall, "Voltaic Electricity." (Lecture I.)
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m

FRI.......Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Mr. G. J. Romanes, "Physiology of the Nervous System of Medusæ."
Quekett Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, Oxford-street, W., 8½ p.m.

SAT.......Royal Institution, Albemarle-street, W., 3 p.m. Professor W. K. Clifford, "The Present Relations of Science and Philosophy." (Lecture I.)
Physical Science Schools, South Kensington, S.W., 3 p.m.
Zoological, 11, Hanover-square, W., 1 p.m. Annual Meeting.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,223. Vol. XXIV.

FRIDAY, APRIL 28, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

HEALTH AND SEWAGE OF TOWNS.*

The Conference on this subject will take place, as already announced, on May 9th and 10th. The Right Hon. JAMES STANSFELD, M.P., will preside. A Sanitary Conference will also be held by the British Medical and the Social Science Associations on May 11th and 12th, in the Rooms of the Society of Arts. In connection with the Conference an Exhibition of Sanitary Appliances will be held. Only such apparatus will be admitted as have a distinct bearing on the subject of the Conference. Further information can be had on application to the Secretary. The Conference will meet each day at 11 a.m. and will sit till 1.30; then adjourn till 2, and sit again till 5 p.m. Arrangements will be made for those taking part in the Conference to dine together on both days, at 6 p.m. Tickets to be obtained on application, before 1 o'clock each day, at the Society's Offices.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The examination for the Scholarships founded by the Corporation of the City of London, the Sheriffs of London and Middlesex, the Common Councilmen of the Wards of Bishopsgate and Cripplegate, Viscount Newry, the Lord Mayor, the Merchant Taylors', Skinners', Fishmongers', Vintners', Clothworthers', and Saddlers' Companies; by Messrs. Rothschild and Son; the Present and Past Masters of the Skinners' Company, Mr. Charles Morley, Mr. T. Chappell, and Mr. R. D. Sassoon commenced at the Mansion-house, at 9 a.m., on Monday, the 24th inst. The musical examiners are Otto Goldsmith, Esq., John Hullah, Esq., and W. G. Cusins, Esq.; the literary examiner, the Rev. J. Richardson. The total number of candidates is upwards of 300.

The Merchant Taylors' Scholarships were competed for on Monday and Tuesday, and have been awarded to Misses Bourne, Harding, Mary Thomas, and A. L. Thomas, and Mr. Hodge. There were forty candidates.

The Mercers' Scholarships were competed for on Wednesday, and have been awarded to Misses Glen and Watson. Miss Marriot was honourably mentioned. There were eight candidates.

Mrs. David H. Stone, late Lady Mayoress, has conferred her Scholarship on Miss Warman, one of the competitors for the Society of Arts' Scholarships, whom the examiners recommended for election without further examination.

The scholarship founded by the late J. C. Sim, Esq., has been conferred on Miss Westmacott, another recommended competitor for the Society of Arts' Scholarships.

A public meeting to promote the interests of the School was held at Leeds on the 12th inst., the MAYOR in the chair. A Committee was formed, three Scholarships were promised, and it was understood that one or two others would eventually be subscribed.

A preliminary meeting was held at Chester, on the 10th inst. A Committee was formed, and arrangements made for holding a public meeting at an early date.

INDIAN SECTION.

A meeting of this Section was held on Friday, April 21st, EDWIN CHADWICK, C.B., in the chair.

The paper read was—

ON SANITARY PROGRESS IN INDIA.

By Capt. Douglas Galton, C.B., D.C.L., F.R.S., F.S.A., &c.

My connection with the Army Sanitary Commission, which dates from its formation, has made me conversant with the history of the recent sanitary progress in India; and now that attention has been so largely directed to that country, it seemed a fitting time to bring to the notice of this Society the efforts which the Indian Government has been making since the Mutiny to extend to the vast population of India the benefits of our hygienic knowledge in the prevention of disease, and to endeavour to convey some idea of the Herculean task which these efforts involve.

There is no subject connected with India which is of greater importance to the vast population of that Empire than the sanitary condition of the communities. A healthy population is an essential element in the production of national wealth. The population of India suffers from numerous diseases which are of the class termed preventible. The

* A table of returns, showing the system adopted by different towns, will be found on page 543.

climate of India intensifies the causes of these diseases, by favouring the decomposition of organic matter.

The precautions for the prevention of disease, which are essential in our temperate climate, are therefore tenfold more necessary in such a climate. Moreover, the conditions are not always uniform; India embraces many descriptions of climate, the hygienic requirements of which vary considerably. The basin of the Indus contains districts where the rainfall is sometimes as low as six inches in the year. In the basin of the Ganges the rainfall rises to 370 inches and more in the year.

For many years after the establishment of our rule in India, the conviction prevailed in England that the climate of India was necessarily fatal to Europeans, and that, whilst a large death-rate among European residents was the penalty to be paid for our occupation of India, the native population enjoyed comparative health.

The progress of sanitary inquiry and knowledge has modified both these views. The climate is no doubt less favourable to European life than the more temperate climate of Europe; but this would not account for the large death-rate amongst British troops. The real cause lay in the total disregard which prevailed of known laws for preserving health.

There was no drainage in the barracks; the refuse lay about to putrify in the hot sun, and to assist in the pollution of the water; the men were crowded together in hot and close barrack rooms, where they were kept shut up all day, to eat and sleep. They were supplied with spirits as a part of their rations, and thus encouraged to contract the habit of spirit-drinking.

The Report of the Royal Commission on the Sanitary State of the Indian Army, published in 1862, showed how grievous had been the neglect of sanitary administration in India down to that time. This report, whilst bringing into view the causes of the enormous death-rate of the army, made revelations which were almost incredible as to the sanitary condition of the natives of India. Everywhere the people were suffering from constant epidemics of fever, dysentery, cholera, and small-pox.

I cannot do better than quote Miss Nightingale's graphic words written on this subject, more than fourteen years ago:—

> "Your cities are in a condition which, in the finest temperate climate of Europe, would be—have been the cause of the Great Plague—of half the population being swept off by disease. The cities are the life destroyers, not the climate. The hill stations are becoming pestiferous from your neglect."

Sir Charles Napier, many years before, in speaking of Delhi, said:—

> "Weeds flourish, filth runs riot, and the grandest city in India has the name of being insalubrious, although there is nothing evil about it that does not appear to be of man's own creation."

Sanitary Condition of British Army in India.

As the large death-rate of the British army in India was the means of first calling attention to the question of sanitary administration, a short *resumé* of the results of the measures taken to improve the health of the army in India will form a fitting prelude to an account of the health administration of the native population.

The death-rate of the British army in India averaged in old times 69 per 1,000. The death-rate of troops serving in Great Britain in 1873 was 7·85 per 1,000. It moreover appeared from the statistics of the Bengal Presidency that, from 1830 to 1845, the deaths of the European army in Bengal averaged 67 per 1,000, of which 58 per 1,000 were from zymotic or preventible diseases, 3 per 1,000 from lung and tubercular diseases, and 6 per 1,000 from all other causes.

The Royal Commission on the sanitary state of the army in India was appointed in 1859, under the presidency of the late Lord Herbert of Lea, to investigate the causes of this death-rate. Lord Herbert was succeeded in the presidency of the commission by the Earl of Derby, who with General Greathead, Dr. Farr, and Dr. Sutherland, are the only surviving members. That Commission completed its labours in 1862. Since that time the Secretary of State for India has referred sanitary questions relating to India to the Army Sanitary Commission.

I cannot refrain at this point from pausing for a moment to render a passing tribute to Dr. J. Sutherland. Possessed of high general culture, of remarkably acute perception, of a very wide experience, and of a perfectly balanced judgment, he has been the moving mind in the proceedings of the Army Sanitary Commission since its formation. The Army Sanitary Commission has largely influenced the recent progress of sanitary administration in India. The work of this Commission is purely practical. This is indeed the only aspect of sanitary work which can properly be entertained by a Government department whose special function it is to promote measures for the preservation of health and life. The elaboration of special doctrines about disease is best left to voluntary professional investigations and discussions; whilst Government departments should record facts, and be ever on the watch for any new light which they can turn to practical benefit for the public service.

Examples of Sanitary Defects in Military Stations.

The evils brought to light by the inquiries into the sanitary condition of the troops were widespread and gigantic.

I will give a few instances, of which some are derived from information dating down to last year.

At Delhi, the troops suffered from a disease termed the "Delhi ulcer." It was found that the water from all the wells from which the troops and population derived their only supply was largely contaminated, partly from the polluted subsoil, partly from extraneous substances and dead bodies which had been thrown in.

Peshawur derived its water supply from the River Bara. The water was conveyed from the river to the station in cuts exposed all along their course to all kinds of nuisances from the native population, which thus became mere foul ditches, extending for miles within the cantonment, infecting the air and earth, as well as the water used by the troops.

At Meean Meer two wells were only 118 feet distant from cesspits from 50 to 60 feet deep,

which contained the accumulated filth of eleven years. In 1861 there was an epidemic of cholera, which destroyed $24\frac{1}{2}$ per cent. of the troops.

Murree is a sanitarium 7,000 feet above the level of the sea. It is said to be the cleanest of the Punjaub sanitaria. The water is from springs in watercourses, which serve as drains and sewers for the population. One principal water source was a tank described as situated in a watercourse, which acts as the drain for many large houses, and into which the refuse of stables, latrines, and cookhouses was discharged.

Simla, selected as a summer residence for the Governor-General, is from 6,500 to 7,000 feet above the sea. The water sources are in ravines which serve as surface drains and sewers, which are hourly liable to disgusting pollution. One source is specially described, where the water bubbles out of the rock over an area of 8 square feet, and about it there was a compost of fæcal matter, bones, and refuse, which was being gradually worn away by the current, and carried into the reservoir for distribution to the residents in the usual way, viz., by being carried away in dirty water skins.

At many stations excavations made for obtaining clay for adjacent barrack buildings were left unfilled, in which the water stagnated, and into which all sorts of filth were thrown; many of these were in close proximity to the wells.

The floors of the men's huts were often below the level of the ground, and damp with percolating sewage from drains close by. The water supply was frequently derived from a spring, the surface of the ground near which was covered with filth deposited from the neighbouring village, as the natives resort to the vicinity of streams and tanks for the purposes of nature.

These instances show some of the problems which were required to be solved. There are other and more general problems, to which I will allude further on.

Results of Remedial Measures on Health of British Army.

The improvement of the health of British troops was a simple necessity. Before the Mutiny, the number of British troops in India was comparatively small. Since the mutiny, the permanent European army amounts to about 60,000 men. If the enormous death-rate of former times had continued, the population of Great Britain could scarcely have withstood the drain upon it for recruits. Since the year 1859, gigantic efforts have consequently been made to improve the sanitary condition of Indian stations.

These efforts have had a marked success. The death-rate of the British army in India in 1874, was 13·58 per 1,000, which may be classed under—

Zymotic diseases	4·14.
Chest "	1·55.
Other "	7·89.

But the very favourable result for 1874 is due to the almost complete absence of cholera; and great as the reduction in death-rate has been, the loss from preventible diseases is still too great, and in a year of cholera epidemic would be largely increased. Moreover, the facilities of communication have caused increased recourse to be had to hill sanitaria; the invaliding has also increased, although recent investigations appear to show that, if the examination of invalids took place at the end of the cold season instead of at the end of the hot season, the weakened constitutions of the men would present a different aspect, and the increase of invaliding would not be so marked.

It is, however, evident from these various considerations that, although we have provided British troops with barracks of unsurpassed accommodation, with the most approved food and with agreeable occupations, we have not yet overcome the depressing effects which insanitary agencies outside the barracks have upon the troops. We have, as yet, only established sanitary oases for British troops in the midst of insanitary deserts.

In the question of health no one member of the community can separate his interests from those of his neighbour. Individuals, or a body of men, cannot completely isolate themselves; the air they breathe may receive contamination from neighbouring districts; the water they drink may be polluted by those around them, or their refuse water may pollute the water supply of others.

Sanitary Condition of Native Towns and Villages.

The sanitary improvement of the Indian army soon brought into notice the grievously defective sanitary state of the native towns and villages in close proximity to the cantonments. The surface of the ground in and around the villages and towns is covered with filth of every kind. The water supply is derived from streams, wells, and tanks. The streams are used as receptacles for excrement; the tanks are used for ablution and bathing. Wells were found to contain impurity derived from the foul subsoil and fouler adjacent surface. Where Persian wheels worked by animals are used for drawing out the water, the excrement of the animals generally falls back into the wells. The wells and tanks frequently form the receptacles for dead bodies; water is drawn out of wells by buckets, which allows dirt to fall in, instead of the wells being guarded from impurities, by being closed in at the top, and provided with pumps. Cattle are kept in the villages and towns in the most filthy condition, and the milch cows, for the supply of milk, and cattle and sheep intended as food, are largely fed on human excrement or horse dung.

Sanitary reports on India are received from Bengal, Bombay, Madras, Punjab, North-West Provinces, Oude, Central Provinces, Berar, British Burmah, and Native States. The reports on India all concur in showing that the neglect of sanitary laws has been universal over the whole country.

The soil in the cities, and round many villages, is loaded with nitre and salt, the chemical results of animal and vegetable refuse left to decay for many generations. The well water is impure. This is especially the case at Agra, Delhi, Benares, Lucknow, and a few years ago at Calcutta, Madras, and Bombay. In Delhi the ill-constructed under-ground drains in the portion of the city within the walls are vast cesspools, which emit noxious gases, and, there being no water supply, it would be impossible to flush the drains even if they were well constructed. A graphic description of the cleansing of some wells at Lucknow

mentions the occurrence in more than one of the wells of decomposing dead bodies.

In many of the large cities of Northern India so saline is the earth, that they are seats of saltpetre factories. With regard to the chemical process by which animal matter is transformed into these salts in factories in Germany, the following description applies exactly, with the exception that what is done in Europe for commercial purposes naturally follows, in India, a favourable combination of soil and climate with the habits of the people :—

"Vegetable and animal refuse containing nitrogen, such as the sweepings of slaughter-houses, dung, weeds, &c., is made into heaps with earth, limestone, old mortar, and ashes ; these heaps are sheltered from rain, and are moistened from time to time with urine. After several months an incrustation of nitrates forms on the surface. When sufficiently rich or ripe, the nitrified earth, as it is termed, is extracted."

It is noteworthy that in Sweden, a portion of the Government revenue is collected in the form of nitre, and almost every peasant has a saltpetre bed. If in the towns and large villages in India the nitre already in the soil could thus be turned into revenue, the additional object of purifying the soil and rendering the water drinkable would be attained. Tobacco is here generally cultivated on soil containing these salts, and is watered with the brackish water, and thus they are in part removed. And it may be observed (as the people are themselves well aware, although they do not know the reason) that this brackish water is never found in the fields, unless in naturally saline soils, but always in the heart of the towns, or in suburbs that have at some previous periods been densely peopled.

Condition of Native Dwellings.

Not only is the soil impregnated with filth, and the water supply polluted, but the dwellings of the people are of the most wretched description.

In the North-West Provinces, in the Allahabad Division, upwards of 5,000,000 people dwell in 13,557 villages. The huts are about as miserable places of residence for human beings as could be imagined. In all parts of the province they are built and repaired by those who live in them. Ill-shaped, unplastered mud walls, enclosing one little room, the floor of mud in no way raised above adjacent ground, the roof a thin grass thatch or covering of poor tiles, form the houses of millions of poor people in this country. Inside, there is positively nothing in the way of furniture, certainly nothing to tempt the poorest thief. The square opening, serving for doorway or window together, wants no door.

Even the houses of the better classes are full of sanitary defects. The Sanitary Commissioner of the North-West Provinces gives the following as the description of a native house of highly respectable appearance :—

"We walk in; beyond the threshold is the antechamber. I fine it is a latrine place but lately frequented by the inmates of the house, the results not hidden in any way, but just in a line to one side upon the earthern floor; the owner says, 'the children will do it, and it is convenient for any sweeper.' Beyond the antechamber is a small room, through which we have to pass to reach the inner court. The room is a stable, and the pony in it leaves little space to pass by, and it impossible to avoid the litter and moisture on the floor.

"The court has clean alcoves about it, used as sleeping places. Its open floor is moist, where much water has been spilt by the washing of vessels, especially about the mouth of the drain which leads out into the public way. A heap of broken timber lies to one side, a broken heap of bricks fills a corner. It is a fact that decency, cleanliness, and order, which we call comfort, has no existence in an average Indian home. A man's period of respectability is his time abroad."

In Oude, the houses, generally mud huts, are all without ventilation, usually built round an open court from which most of the rooms enter. In this court are cattle sheds, and the area is generally in a state of mire. The floors and walls of the huts are damp in rainy season. Water is drawn from open wells by all manner of vessels attached to strings; bathing, washing of clothing, and watering of cattle around the wells, cause a state of mire not remedied by any attempt at drainage.

The well, which may have had six or ten feet of water in it originally, is never cleaned out, until it gets so filled up with broken earthen pots, strings, leaves, and other rubbish, that no more water can be got out of it. Then the collection of years is excavated, generally as black as ink, this colour being due to the sulphur in the organic matters having combined with iron in the soil.

The mud for the walls of the huts is excavated from holes in their immediate vicinity. These excavations are the reservoirs of the drainage of the village. The water collected in them in these rains is used for all dirty purposes, and the village sweepings and filth of all sorts are thrown into them. The water, after seething with putrescence for some months, generally dries up in the hot season, exposing the foul mud at the bottom of the holes. This is often again used in building or repairing the walls of houses. The fields, covered with high crops, and ravines in the immediate neighbourhood, are used instead of latrines. Herds of swine do duty as scavengers, and are likewise eaten as food by a numerous body, including the Passees, who are the rural policemen and collectors of the vital statistics.

In the Punjab the villages are described as being as bad as in other parts of India. The great majority of small towns are little more than aggregations of farmsteads, the result of the insecurity of life and property which formerly prevailed, and drove the inhabitants to live near each other for mutual protection.

At Rawalpindi, where the Bishop of Calcutta recently died, it is stated that the water sources are polluted, and that most of the people of the city, especially of the lower classes, use the roofs of the houses for the ordinary purposes of nature, and neglect to clean the roofs, the refuse from which is washed down in the rainy season into the gutters, where it remains to putrify, whilst in the summer months, when all people sleep in the open air on the roofs, the stench becomes unbearable.

In the town of Madras the floors of the houses of the poorer classes are frequently below the level of floods, damp, and saturated with organic matter. The native population, as a rule, sleep on the ground. It is, however, observable that in the malarious districts of the Northern Circars, Cud-

dapah, Kurnool, &c., the people have learned by experience to sleep in a cot raised off the ground.

In contrast to these miserable pictures of the condition of Indian native dwellings, it is satisfactory to give the following extract, descriptive of the condition of the people in Burmah, as evidencing the fact that even a limited attention to sanitary laws at once produces satisfactory results:—

"Some of the conditions which occasion so much sickness and mortality in India have no counterpart in Burmah. In India the dwellings of the poorer classes are close, ill-ventilated, confined mud buildings; in Burmah they are raised from the ground, and the plank walling and bamboo and grass floors allow free ingress and egress of air. There is no lack of space, or overcrowding, and cattle are not, as a rule, kept under the same roof as their owners. No place in India can show such swarms of plump, healthy-looking children, or such vivacious, manly inhabitants as Burmah."

THE INSANITARY CONDITIONS OUTSIDE THE TOWNS AND VILLAGES.

In addition to the causes of sickness above enumerated, and the general pollution of streams and water-courses by the habits of Indian life, there are in many parts more obscure but more general agencies at work, occasioned in some cases by the neglect, in others by the direct operations of man. Malaria is engendered by a water-logged soil, due sometimes to the action of irrigation canals, sometimes to the raised banks of rivers, or to the defective means for draining large districts of country; in consequence of this, after the rainy season, large tracts are covered with stagnating ponds, from the beds of which, as they gradually dry up by the action of the sun, the decomposing organic matter breeds miasma and fevers.

VITAL STATISTICS.

At the root of the whole question of the sanitary improvement of India lay the question of an accurate registration of deaths and births, and a census of the population. Without correct information regarding the number, there can be no basis for conclusions as to the health or prosperity of a people, and the determination of the death-rate was essential for showing the points where the efforts of the sanitary reformer were most required.

CENSUS.

The census was fraught with difficulty. In some districts it was regarded with much suspicion by the people, who looked on it as the forerunner of a new tax. They concealed their children to avoid the tax. In other cases they imagined it would lead to summary measures for checking the increase of population, by their removal to other districts. In one locality they imagined the surplus population were to be blown from guns. It is, therefore, an approximation to, rather than an accurate statement of the real population. The result of the present knowledge on the subject may be briefly stated as follows:—

Divisions.	Date of Census.	Population.	Density of population per square mile.
Bengal	Early part of 1872	36,769,735	430
Bahar	" "	19,736,101	465
Orissa	" "	4,317,999	180
Assam	" "	2,207,453	63
Chota Nagpur	" "	3,825,571	87
Total of Lower Provinces	....	66,856,859	290
North-West Provinces	1872	30,769,056	380
Oudh	February, 1869	11,220,747	465
Punjab	1872	17,611,498	173
Central Provinces	1872	9,066,038	108
Berar (Haidarabad Assigned Districts)	November, 1867	2,231,565	132
British Burma	Administrative Report, 1871-72	2,562,323	27
Madras	1872	31,311,142	220
Mysore	1872	5,055,412	187
Curg	1872	168,312	84
Bombay	1872	14,042,596	110
Total	....	190,895,548	—

It was impossible to make a synchronous census. The police jurisdictions, or circles containing a certain number of villages, were generally taken as the basis for the country population, and the enumeration made by the head men of the villages. The municipalities made their own census arrangements.

The census returns are, however, very incomplete. The census for Bengal, the North-West Provinces, the Central Provinces, Bombay, Madras, and Mysore, was taken in 1872; that for the Punjab in 1868; and for Oudh in 1869. There is complete uncertainty as to the population of the rest of India.

Of the 190,895,548 of which the enumerated population consisted, about 55,000,000 were returned as agriculturists. This agricultural population is scattered through numerous villages. In Bombay there are 50,000 villages; in the Central Provinces, 35,000. The sanitary condition of these villages I have already described.

Registration of Births and Deaths.

A system of registration of deaths was generally introduced about 1864 to 1866, and a registration of births about 1870. The returns of deaths are quite worthless. Sir George Campbell, before his return to England, made a tentative reform in the system under which mortuary statistics are acquired. He saw that the acquisition of accurate statistics over the enormous area of the Lower Provinces, with their vast populations and uneducated agencies, was at present impossible. But he resolved to perfect the system on a smaller scale, over certain experimental selected areas, chosen with reference to geographical situation, so as to be accessible and easily supervised. It was arranged that the census should be taken in these areas with special care. The town areas thus chosen were usually the head-quarter stations of districts, and the country areas were limited to a moderate number of compactly-situated villages.

A wide discretion was given to the local officers in selecting agencies, and a sanitary clerk was allowed to the civil surgeons of selected stations to aid in the compilation of vital statistics. The experiment was commenced on the 1st of January, 1873. There are 101 selected areas, with a population of 1,922,608, and in most of them there has been a marked advance towards ascertaining actual facts with reference to death-rates, but the report of 1874 shows that the returns are very imperfect still. The returns of births are also imperfect.

In the North-West Provinces the registration of deaths is effected through the village police.

In the Punjab, registration of deaths was first attempted in 1865, on the purely voluntary system. In 1867, power was given to municipalites to frame bye-laws, making registration of births and deaths compulsory. Since that date, compulsory registration of births and deaths has been gradually extended to the principal towns of the province. In 1873, the number of towns in which compulsory registration was enforced was 110; in 1874 the number was increased to 124, with an aggregate population of 1,700,000. Accuracy of registration is improving, and in some towns is reliable.

Registration in rural circles is very incomplete, and it will be many years before it will be accurate; and it is said that any attempt to introduce a system of compulsory registration of births and deaths in villages in the Punjab would, under present circumstances, be unpopular, and in the absence of trustworthy agency for the enforcement of the law, lead to much corruption. The people, however, are becoming alive to the advantages of registration, for appeals are not unfrequently made in judicial cases to the police registers in proof of the exact date of the births or deaths of individuals.

The returns in the Punjab show much difference in death-rates of urban and rural circles, but there is no reason why this should be so. In small towns the crowding is not greater than in villages, while as regards paving, surface cleaning, house accommodation, and water supply, the towns are better off than the villages. Town life also appears to be more unfavourable to female than to male life, for instance:—

Registered Death-rate known per 1,000.

	Male.	Female.
1873	31 ..	34
1874	27 ..	30

This is probably owing to the large number of females who live in the unhealthy seclusion of the zenana, and are subject to the dangers of child-bearing, unmitigated by skilful medical treatment.

In the Central Provinces the vital statistics are collected through the agency of the police, but the results are not reliable.

In the Madras Presidency the registration of births was commenced in 1870, and there has been a gradual advance in the number registered year by year. In 1872, there was an increase of 15 per cent. over that of the previous year. There is a nearer approach to accuracy in the municipal towns than in the rural districts. The mortuary registration was commenced in 1866, and the increase in the number of deaths recorded is due to more efficient registration, but it is still very imperfect.

In the Bombay Presidency the registration of deaths was commenced in 1865, and there has been a regular increase in the numbers registered, which shows greater attention. But the figures hitherto collected are practically useless.

Infant Mortality.

Birth registration has only just been commenced. A vast number of births and deaths are still concealed, or never reported, in all parts of India; the rapid and unceremonious disposal of dead children and especially females, leads to easy concealment or non-registration; and indeed infanticide of female children prevailed largely over India. The crime of infanticide can only be put down by enforcing the accurate registration of all domestic events in suspected families, combined with frequent inspection of female infants by the village police. Where suspicion of infanticide exists the families or villagers are proclaimed under the provision of Act VIII. of 1870, and under regulations, subsequently issued in 1871, which enforce police supervision over proclaimed places. It is held that where the number of girls is less than 35 per cent. of the whole number of children, that there must be foul play, and a suspicion of guilt becomes justifiable; and the census returns have been utilised for the purpose of detecting the low per-centages of girls among the suspected tribes of Rájputs and Jats. The head of a proclaimed family is obliged to report all births and deaths to the police, and, if foul play is suspected, the bodies are forwarded to the civil surgeons for *post-mortem* examination. The police officers visit proclaimed villages once a month, and compare the actual numbers in each family with their registers, annual reports being furnished to the magistrates. In 1873, as many as 4,957 villages, with a population of 485,938 souls, in 25 districts, had been proclaimed as having their per-centage of girls below the prescribed limit; and the rules of repression have been applied. In 1874, there were 28 proclaimed districts.

In connection with this question it may be

mentioned that infant mortality is always large in India. One of the causes stated for the large death-rate is the frequent failure of milk in the mothers, from fever and other diseases, and the consequent endeavours to support the infants on food too solid for their stomachs, which causes convulsions, diarrhœa, dysentery, and numerous deaths.

Results shown by Vital Statistics.

Although the actual figures which result from the vital statistics are unreliable, they afford much food for comparison, nevertheless, as facts.

The marked features presented by the statistics which have been collected, exclusive of cholera deaths—to which I will presently refer—are the deaths from small-pox and the deaths from fever.

Small-pox and Vaccination.

As regards the deaths from small-pox, vaccination was not in use in India, but inoculation appears to have been largely practised in certain districts. Vaccination has been introduced by the Indian Government, but for several years it has been a very difficult matter to induce the natives to avail themselves of it. The vaccinators are spread over the whole country, and, by taking every opportunity to spread vaccination, each year produces better results. In some districts vaccinators are supplemented by ex-inoculators, but these agents are frequently found unreliable or obstructive. In some towns a money payment of two annas has been resorted to as an inducement to bring children to be vaccinated, with marked success.

In Bengal small-pox prevailed with great intensity in twelve districts not protected by the circle system of vaccination, whilst the disease was slight or very mild in character in protected districts.

In the Punjab the decrease of small-pox since the introduction of vaccination is very striking. In 1869 there were 53,195 deaths; in 1871, 25,534; in 1874, 12,026. The returns are still imperfect, but may be considered of equal value. That the decrease is due to vaccination is shown from the fact that in Umballa and districts south there is a general dislike to vaccination, and the people resort to every subterfuge to prevent their children being vaccinated. These people have lived in a wild, half-savage state for years, and cannot be expected suddenly to appreciate vaccination, whilst in the districts north of Umballa vaccination has made immense progress in the estimation of the inhabitants. The people laugh at their former fears and suspicions, and bring their children with thankfulness to be vaccinated.

	Rate of Small-Pox Mortality per 1,000.—1874.
Umballa and six districts south	2·05
Twenty-five districts north of Umballa	1·31

Thus, in the districts protected by vaccination, the mortality was little over one-half that in the unprotected districts.

The municipal committees have acted a very useful part iu helping to dispel the prejudices of the people. These bodies had been stirred up through remarks in the *Vernacular Gazette*. In many towns every child borne on the register of the previous year has been found to be vaccinated. The objection to the operation rests for the most part on mere apathy and indolence, or dislike to the trouble of seeking out vaccinators.

The medical men may exert much useful influence, as at Jagadri, in Umballa district, when a virulent outbreak of small-pox occurred, the medical men made earnest and successful efforts to spread vaccination during the progress of the epidemic, and owing to their exertions the western half of the town had almost complete immunity from the disease.

In Mooltan, the municipal committee mapped out the town into districts, and the children were collected in the compound of the house of the municipal member of the division in which vaccination was to be carried on, and thus a very small fraction of the number of children under two years old remain unvaccinated.

On the other hand, at Ferozepore, the municipal committee set themselves against vaccination, and only a few of the lowest castes submitted to it. It cannot be wondered at that the prejudices of the population should introduce difficulties at first, considering that there are municipalities in this country who object to profit by the immunity from small-pox which vaccination affords.

In accounting for an increased death-rate from small-pox in Rangoon, the Sanitary Commission says, inoculation is very extensively practised at particular seasons of the year; next to this is the recklessness with which a large number of persons expose their children, and those of other people, to the risk of contagion. The majority of the population take no precautions whatever. They will allow their children to visit houses and localities where the disease is known to prevail, but put no restraint on their mixing with others who have barely recovered from it, or will spend hours gossiping in rooms where there are sick persons, and then go home and nurse their own children in dresses which they have done all they could to saturate with the poison of small-pox or some other disease; they fill their houses with their neighbours or their children, and if the patients recover, they take them about in public conveyances, visiting public places, or send them to school, without even thinking or caring whether they may not be scattering the seeds of infection right and left. Moreover, a neglect of cleanliness is a very frequent accompaniment of bad cases of small-pox. The same dirty pillow, black with filth, is in use for months; dirty floors and beds, and filthy neglected surroundings, cause foul air, and the vitiated atmosphere makes the disease worse and more virulent than it would otherwise be.

Fever Mortality.

The most prominent feature in the return of deaths is the wide-spread prevalence of fever. Cholera, no doubt, comes periodically, and when it does come it causes an enormous death-rate, but the deaths from fever appear to be continuous.

The table on the next page shows the deaths registered in 1874 from all causes, and those registered from fevers.

Practically, therefore, out of 2,705,637 deaths, 1,644,342 are registered from fever. It is alleged in explanation of this, that it is probable that the registrars, being in many cases little conversant

Provinces.	Fevers.	All causes.
Bengal	328,721	504,980
North-Western Provinces	449,588	672,259
Punjab	190,631	316,713
Oudh	100,553	131,951
Central Provinces	118,043	174,446
Berar	26,732	60,797
British Burmah	20,137	32,937
Madras	226,220	532,902
Bombay	183,717	278,652
Total	1,644,342	2,705,637

with diseases, often attribute to fever any deaths of which the disease cause is not very apparent. But even allowing for this, the fever death-rate is enormous, and bearing in mind, that of those who suffer from fever the great majority recover, and a small proportion only—certainly not 1 in 20—die, these figures represent an enormous amount of suffering and a serious waste of the energies of the nation. The disease is favoured by the wretched habitations, the overcrowding, the low, damp floors, and too often dilapidated roofs. In many localities the soil is retentive of water, and the temperature of the soil, at a depth of three feet, rises in many parts of India to 80° and even 90°.

The Sanitary Commissioner for the Punjab remarks, that with bad natural drainage an excess of rainfall almost invariably leads to an increase of fever.

Gurgaon, which has a very insufficient escape for its surplus rainfall, is in consequence covered to a great extent with vast ponds after heavy rains. The villages in the neighbourhood of these ponds suffer terribly from fever, and prevalence of the disease varies directly as the rainfall. These ponds affect the health of the villages, both through the medium of the air and the water. In heavy rainfall, the subsoil water rises through the sewage-sodden soil in which wells are situated, and the water becomes tainted.

The station of Jacobabad lies 67 feet below the level of the Indus, from the flooding of which, and also (as is supposed), through the medium of canals, the porous soil of the country becomes saturated with water.

Twenty years ago the locality was a sandy desert, totally devoid of vegetation; but, by means of irrigation the arid waste is being converted into rich cornfields. For some years, the irrigational measures were not attended with any effects prejudicial to health.

In 1861, however, the Indus began to eat into its right bank, between Kusmore and the mouth of the Biggaree, and, escaping westward, reached the neighbourhood of Jacobabad. With the exception of two years (1867 and 1868), the floods have recurred regularly ever since. The subsoil water level has, moreover, been rising nearer and nearer the surface; in 1847, the level was 35 feet, the water is now met at ten feet from the surface; the fever at Jacobabad has very much increased.

It is, however, noteworthy that the very heavy rainfall in Sind, in 1874, did not increase the sickness from malarial fever. The Sanitary Commissioner accounts for this fact, by suggesting that large tracts of the country were under water during the time the sun's rays had the greatest power, that this restricted the development of malaria, and restricted bowel complaints; and when the winter months arrived there was still so much water and moisture on the surface that the sudden alternation of temperature between day and night was, to a considerable extent, neutralised; otherwise malaria seems to remain at its intensity, when the water, loaded with decomposing organic matter, which has flooded the country in the rainy season, is drying up.

In Madras, the Sanitary Commissioner said that whilst drought prevailed there was a diminution of fever, but that when the rains of the south-west monsoon began, and large districts were flooded, fever became very prevalent.

The effect of irrigation on fever is further shown by Mr. Planck, the Sanitary Commissioner of the North-West Provinces. The great fever mortality of 1872 took place in eight circles, all with one exception lying in a tract of country naturally ill-drained, through which the main channel of the Ganges canal passes, and irrigates. As already observed, the fever in the Punjab in the same year appeared to have been generated not so much during heavy rains as from the condition which follows them, and the remedy required is the rapid removal of the water, so as to prevent stagnation.

A marked increase in fever at Meerut is attributed to the effect of the irrigation canals. This fever is purely malarial. It is a matter of fact, that since canal irrigation was introduced, the water level has gradually risen. On the 31st of October, 1869, it was 14 feet below the surface; on the same date in 1874, it was only 9 feet 5 inches. Assuming that the measurements were taken under similar circumstances, there has thus been in five years a rise of 4 feet 7 inches. There can be no question that the water now is very much nearer the surface than it was formerly, and to this cause the increase of fever has been by many ascribed. Meerut was never well drained. The natural difficulties are great, and with a rise in the water level these difficulties must be greater than ever. It is stated, that "now the soil in low-lying places is perfectly saturated with moisture."

There are several water-logged tracts in Saharanpur and Muzaffarnagar, where the people are fever-stricken.

In numerous villages in the delta of the Ganges fever prevails endemically, from causes as much within the control of the engineer as those which caused the ague of the Essex marshes, now, fortunately, almost a thing of the past. The locality is flat and low; the soil is composed of animal and vegetable matters imperfectly decomposed; the subsoil is water-logged. The tanks and water-courses contain stagnant, putrid water, in the vicinity of dwellings. The broken ground around villages is full of holes and cesspits, and surface cleaning is unknown. The villages are enclosed with a profuse growth of jungle, in a deep, rich, uncultivated soil. The drinking water is stagnant and unwholesome.

Cultivation of the land by crops takes out of the soil the decomposing *debris*, and renders the site healthy; thus the much-dreaded Terai is again

becoming inhabited and healthy in proportion as it is cultivated; the effectual drainage of the land also renders the site healthy, provided the water runs off quickly, and provided the subsoil water is kept so far from the surface that the water does not evaporate through the damp, decomposing surface soil.

The following is an instance how the injury to the health of the district is caused by misdirected engineering operations. The Kala Nuddee, which takes its origin in the Damoodah river, and joins the Hooghly at Moogra, had its mouth closed, some thirty years ago, by a native zemindar, for the benefit of his own land; by which means the water supply, drainage, and irrigation of this district had been cut off. Thousands of people suffered from the arrangement, for the banks of the Kala Nuddee are densely populated, but the villages had few tanks, and depended for their drinking water on the stagnant and putrid pools in the bed of the Nullah, the condition of which was filthy in the extreme, cremation being practised on the banks, and the channel itself used for the reception of all the refuse of the neighbourhood. The mouth of this stream was re-opened in 1872, and a clear stream of from 40 to 80 feet wide, and 40 miles in length, provided for irrigation as well as for domestic purposes. The result has been a great decrease of sickness in the district.

The whole evidence shows that the high fever death-rate is largely due to stagnating water in the soil. The enormous value of irrigation for increasing the produce of the land is a certainty. The objections on the score of health are, generally, defective drainage, the consequent stagnation of the water, the deterioration of well water by infiltration, or the application of too much water. These are all remediable causes within the control of the engineer.

The Burdwan Fever.

These remarks would, however, be incomplete without a reference to the case of Burdwan. A malarious fever has long prevailed in the Burdwan district. In 1872 it was stated that almost every human being living in the district was suffering from it. The public officials were completely prostrated; the police, if fit for duty one day, were laid up for five or six. Households were without servants, the municipality without scavengers; the criminal tended the constable in whose custody he travelled; whole villages were prostrated, and suffering from the debilitating effect of the fever. In 1872 it was stated that the population of the town of Burdwan had decreased in the preceding years from 46,121 to 32,687 inhabitants.

The disease is described as an exaggerated and congestive form of malarious fever, most frequently of the intermittent type, generally assuming the most intense and æsthenic character in localities where the recognised predisposing causes of the disease preponderate most.

The fever is progressive, following the chief roads or means of intercommunication. It slumbers or smoulders for one, two, or three years, and then breaks out afresh, always during or towards the close of the rains. With reference to local causes, it is stated that "an overcrowded, low-lying, badly-drained filthy village was sure to be attacked, and to suffer severely." Many villages are inundated for months in the year, and a water-logged subsoil left behind. Villages "which have never been inundated, have never, as yet, suffered from the endemic fever;" and villages "situated on higher ground, with natural drainage, scanty population, good and fair water supply, and better ventilation, escaped or suffered less severely." While population was increasing, the old villages went on deteriorating every day. Every available spot was taken up for huts; extra holes were dug in order to receive filth and refuse; the air was poisoned by the emanations from a crowd of people huddled together; tanks became impure, and the water supply which was considered good for the father or grandfather was considered good for the son or grandson; bodies were buried close to the surface, or near a tank or water supply, while others were buried in the centre of the village." There followed on this condition of matters deterioration of cattle and of food, and fish disappeared. Great efforts have been made to remove the causes of disease; in 1873 the fever had much diminished, and in 1874 it had almost disappeared; but so long as conditions exist which may favour its development, there can be no certainty that it will not recur.

Cholera Mortality.

Cholera is another disease which in years of epidemic carries off large numbers. There is no country where the disease is more sudden in its invasion and more rapidly fatal than in India. There appears to be a movement of epidemic cholera which spreads from time to time over the whole of India, and travels beyond its borders developing itself most where the insanitary condition favours its development, but there also appears to be a district in India where cholera is endemic. This district, which seems to be the perennial home of cholera, is the district of the great waters, and contains within it the deltas of the Ganges, the Bramahpootra and the Mahanuddy. Cholera always exists in its endemic condition within this endemic country. It never dies out, it appears and disappears at different points, and at different seasons, and sometimes even within this area it becomes epidemic, without necessarily passing over the ordinary endemic limit. Its climatology is peculiar. The whole region is under the influence of the seaboard. It is a region of perennial moisture, from drainage of its own hills and from river outlets. Its rainfall is double that of any other province in Bengal Presidency. It receives the full force of the monsoon. Ground moisture is always within a few feet or inches of the surface. Vast tracts are under water every year, until the cessation of the monsoon and the fall of the rivers permits the ground to rise above the water. "It is with the inundation of these tracts that cholera disappears; it is with their re-appearance that cholera re-appears upon the diluvial soil, and districts adjacent, are immediately invaded by it."

The Army Sanitary Commission, impressed with the admirable field which India offered for the close study of this disease, arranged with the Government of India for a detailed inquiry, based on the collection of facts, to be made into the origin,

nature, and spread of the disease; and when this inquiry is complete much good may be anticipated from it. The year 1872 was an epidemic year. In the year 1871 Upper India had been remarkably free from cholera, but towards the end of the year there was a marked increase in the endemic area. It was epidemic in Madras and Bombay.

This outbreak of 1872 was carefully studied by Dr. Cunningham, the Sanitary Commissioner with the Government of India, and recorded in a valuable report. The facts he adduces, are that in the epidemic area, although the disease was widely diffused the proportion of places which suffered was comparatively small. He instances that in Oudh, where 6,000 deaths were registered, they occurred in 465 villages out of 2,175, and in the Central Provinces, in Nimar district, 78 villages suffered out of 588. The facts collected by Dr. Cunningham in the report, as bearing upon the epidemic of 1872, may be briefly summarised.

Cholera conferred no immunity from fever. Importation could not be traced in any one of 100 communities under observation. The general distribution of the epidemic does not accord with the idea that it was spread by man. It was not propagated along highways of communication. The disease did not travel more rapidly than it used to do when there were no railways; and there was no evidence in the event of the epidemic of 1872 to support the opinion that cholera is a contagious disease. The meteorological records were too scanty to afford ground for comment. The drainage was generally defective at the stations attacked. The theory that wherever a community is attacked violently by cholera the outbreak has been caused in the main by water contaminated with cholera discharges, is not borne out by the geographical distribution of the epidemic, or by the facts of the outbreak of 1872, and no case was recorded in this epidemic in which there is good reason to believe that cholera discharges have caused cholera.

In respect to the effect of quarantine in stopping the progress of cholera in this epidemic, Dr. Cunningham states that quarantine was tried in the hope of protecting a number of the cantonments in Upper India, that in many of them it signally failed, and that in no single instance is there any ground for believing that it was productive of any good; and he further observes that the direct evils of quarantine in stopping commerce and intercourse are great in themselves, but many indirect evils arise from it, and among these by no means the least is, that so long as men believe that they can escape from cholera by such means, they will never be fully alive to the importance of the greatest safeguard, sanitary improvement; and he adds that whatever opinion may be held on theoretical questions, the great work to be done is to perfect and extend sanitary improvements among the population.

This report deserves study, as a valuable contribution of facts regarding one epidemic.

The year 1874 was comparatively free from cholera, but yet in Bengal there were 56,876 deaths. It was worst in the hot months. The causes which originated, fostered, and propagated the cholera of this year appear to have been bad, foul, and deficient water supply; use of water from tanks and wells which had run low from consumption and evaporation, and become rife with deleterious organisms, or tainted by overflows, leakage, or percolation from sewers, cesspools, house-drains, privies, foul ditches; prolonged inundations or impeded drainage, retaining moisture and damp in the ground, and emitting noxious effluvia; malarious or vitiated air, in the vicinity of low-lying marshes, or pits and hollows, containing exposed and putrescent vegetable and animal matter; deficient ventilation; errors of diet, such as the use of new rice, decayed and putrid fish, raw fruit and vegetables, or decomposed food; congregation of large bodies of people at the famine relief centres, on pilgrim routes, or in pilgrim resorts and fairs, during months of excessive heat. As regards the question of importation or contagion in the cholera attack of 1874, it was observed that where rapid communication and comfortable modes of conveyance existed along a pilgrim road, cholera did not spread to the people generally.

At the present time thorough examinations are being carried on as to the local conditions under which outbreaks of cholera occur, viz., into the nature of the soil, the effect of the level of subsoil water, the presence of carbonic acid gas in the soil, and the influence of meteorological conditions on these matters. It may, however, be observed that Pettenkoffer's theory has not hitherto succeeded in accounting for the spread of cholera in India.

Regulations for Enforcing Sanitary Arrangements in the Vicinity of Cantonments.

When inquiries began to be specially directed to the large death-rate of the British army in India, and when the insanitary condition of the native villages and bazaars adjacent to the cantonments excited attention, the Government of India issued cantonment regulations which established committees of military, civil, medical, and engineering officers, local magistrates, and village authorities, to regulate the sanitary arrangements, so as in cantonments in some degree to protect the military from the insanitary condition of the neighbourhood.

Appointment of Commissioners for Reporting on the Sanitary Condition of the Communities.

Dr. Cunningham was appointed Sanitary Commissioner with the Government of India, to advise on sanitary matters, to report annually on the sanitary conditions of India. Besides the Sanitary Commissioner with the Government of India, there are sanitary commissioners over districts, whose duty it is to inspect localities, exercise a general superintendence, and to report annually to the Government. There are eight of these districts, viz., Punjab, North-West Provinces, Oudh, Bengal, Central Provinces, and assigned districts, Madras, Bombay, and Burmah.

The Government of India has, moreover, organised a careful inquiry into the water supply of all the military stations and of the principal towns, by means of analyses made on the spot by carefully trained officers; these continue to be carried on, so as to show the places in which improved water supply is required.

Issue of Sanitary Regulations for Fairs and Pilgrimages.

Amongst the earliest matters in connection with the civil population, which engaged the attention of the Sanitary Commissioners, was the regulation of pilgrimages. Pilgrimages and fairs in India were important foci of disease. These large assemblages are attended by hundreds of thousands of persons; as many as 250,000 or 300,000 have attended one pilgrimage. They remain encamped for many days in crowded huts. The adjacent ground and water-courses become a mass of every sort of filth; and as a consequence, a large fair or a pilgrimage generally formed the precursor of an outbreak of epidemic disease.

The Indian Government has placed these assemblies under strict sanitary supervision. Before the assembling of the multitudes the encampment is marked out, the water supplies are protected from pollution, surface cleanliness is enforced, and arrangements made for deposit in safe places of all refuse. The good results of these arrangements were illustrated in a fair at Manickpur in Oudh, attended by 125,000 persons, accompanied by at least 40,000 bullocks; cholera was prevalent in the district at the time, but there was an entire absence of cholera at the fair.

The Pooree pilgrimages to the temple of Juggernath have for long, however, been foci of disease and cholera; the following extract from the report of the Sanitary Commissioner for Bengal for 1874, affords some explanation of the dangers to health incurred by these pilgrims:—

"The fatigue and exposure, the bad or improperly cooked food, the dirty water, and the filthy resting-places, directly cause bowel congestions and cholera attacks among the Pooree pilgrims. Another, a most potent cause of cholera among the Pooree pilgrims, has recently been discovered. The magistrate, Mr. Armstrong, directed Baboo N. K. Sircar, the deputy magistrate, to visit and bring away some of the water given to the pilgrims in the inner temple of Juggernath. The Baboo reported that 'the paved floor of the inner temple is washed after each *bhog* (offering of food), and the washings carry down the filth of all human feet treading inside the temple, with relics of the food used in the offerings, such as *urnoproshad* (boiled rice), and other articles prepared with ghee, molasses, &c., spilt on the floor in being carried to and from the front of the images. The said washings run into what is popularly known as the *charnamrit khoonda*. When the cistern, then full of water, was first examined with a bamboo probe, the disturbed water sent forth noxious exhalations, the breathing of which is highly deleterious. This collection of the washings is continued from year to year. In clearing it a cartload of filth was found silted at the bottom.' This water, which was so foul and putrid as to resemble sewage rather than drinking water, containing sulphuretted hydrogen sufficient to blacken lead paper immediately it was exposed to it, is what the duped pilgrims are made to drink copiously."

Investigations into Special Forms of Indian Diseases.

In addition to the special investigations into cholera, the Government of India has organised enquiries into other forms of special diseases prevalent in India, such as leprosy, elephantiasis, and other diseases; also into poisoning by snake-bites, on which subject the valuable researches of Sir J. Fayrer have excited universal attention. The large prevalence of *trichinæ* in meat led to a special investigation into the conditions under which these are injurious in food, and it was satisfactorily shown that they invariably perish in a temperature of 160°, and consequently that well-cooked meat affords a complete guarantee against injury from these parasites.

Limits of Direct Action of Government on Sanitary Progress.

These were matters specially within the jurisdiction of the Government officials, or over which the military and police could exercise an efficient control. But the sanitary improvement of villages and towns was a matter of more difficulty, as it required the co-operation of the people themselves.

Self-governing Capabilities of Village Communities.

The village communities afford an organisation by which, up to a certain point, the sanitary regulation of the villages would be comparatively easy, if it were felt to be necessary by the village authorities, and if taken in hand by them.

The village communities consist of a cluster of homesteads, inhabited by the members of the community. Each household is governed despotically by its family chief, and the community is governed by a head man or by a council of elders. This governing body regulates the proceedings over the village lands, and the organisation is such that it can, if it so desires, secure the cleaning of the streets, the removal of refuse outside the houses, the placing of latrines for the village at an adequate distance from the houses, and regulate their use so as to prevent the fouling of the surface of the surrounding land, or of the tanks or river-courses.

But into the households themselves this organisation would not penetrate. The strict privacy maintained in the house itself is a great bar to sanitary improvement in the interior of dwellings, either in villages or in towns.

Municipal Institutions in Towns.

The Indian Government, nearly thirty years ago, endeavoured to introduce municipal government for towns. The earlier laws on this subject do not appear to have borne much fruit, but more recent laws are now developing municipal government rapidly, and afford a good basis for sanitary improvement. The three Presidency towns have long possessed municipalities. In Calcutta, the municipality consisted of a chairman and justices named by the Government, but a re-arrangement of the municipality of Calcutta has recently taken place. The municipality of Madras is mainly nominated by Government. In Bombay, the ratepayers elect half and the Government names half the corporation. These have full control over the finances and regulations of the town.

Except in the Presidency towns, municipal institutions only date from 1850. It is true that an Act was passed in 1842, empowering inhabitants of towns to form municipalities, but it proved ineffectual for the purpose, and the existing municipal institutions are based on Acts XXVI. of 1850, XX. of 1856, VI. of 1868, IV. of 1873 for the Punjab, and some provincial Acts. If the people of a town expressed a desire to that effect,

the Government was empowered to order Act XXVI. of 1850 to be put in force. A certain number of inhabitants were then appointed as commissioners for defining the taxes to be raised for the purposes of the Act, for applying them in payment of officers and servants, for the execution of works for the improvement of the town, and for other expenses. This Act is now in force in very few places, except in the Bombay Presidency. Act XX. of 1856 was passed for the maintenance of police chaukidars, and may have effect in every town to which the local government may extend it by notification. The magistrate is then to detemine the number of police to be maintained, and the sum to be annually raised, which is to be either an assessment, according to the property of the persons liable, or rate on houses and grounds, not exceeding five per cent. of their annual value.

In each town brought under the provisions of the Act, the magistrate is to appoint a punchâyat or committee, consisting of five inhabitants, whose duty it is to apportion the rate; but the police are appointed by the magistrate. The surplus, after paying the wages of the police, may be devoted to the purposes of cleaning or lighting the town, or to other improvements. Act VI. of 1868 may be extended, by Government notification, to any town, when the provisions of Act XXVI. of 1850, and XX. of 1856 are to cease to have effect. The police rate is fixed at 1·8 Rs. a year for each house; and the municipal tax is limited to 2·4 Rs. for each house. The proceeds are to constitute a town fund, under the control of the magistrate. This fund is to be applied to the support of the police, construction and maintenance of roads, the general improvement of the town, vaccination, and dispensaries. A town committee is to be formed of no less than five inhabitants, and, if necessary, subordinate ward committees. These committees are to be nominated by the magistrate, unless orders are given for their appointment in some other way, and one-third are to be officials; they are empowered to elect their own chairman, and a third of the members are to retire each year. Their duties are to consult and advise with the magistrate on the assessment and expenditure of the town funds. If the Government appoints the magistrate to be the chairman of a town committee it becomes a corporation, and the committee itself receives magisterial powers. In the Punjab all municipalities are under Act IV. of 1873. By it, the towns where it is in force are administered by a committee which must consist of five members, but which is invariably much larger. These committees are divided into three classes, with graduated powers of expenditure; those of the first-class expending the town funds on objects authorised by the Act, without control beyond a Government audit of accounts; those of the second-class only expending sums without sanction up to £200, while all proceedings of those of the third-class are subject to confirmation.

These Acts, it will be seen, render municipal institutions compulsory when the Government sees fit to introduce them to any town. The Act VI. of 1868 applies to large cities, the older Act XXVI. of 1850, to smaller towns, and Act XX. of 1856, called the Chaukidari Act, to groups of villages and very small towns.

By an Act of 1872, regulations issued in 1871, the Central Government may advance money on loans to municipalities or other corporate bodies, for the purposes of sanitary or other improvements.

The Bengal Legislative Council have passed several important Municipal Acts. The first is III. of 1864, which introduced an elaborate system of local taxation, and vested its administration in a body of commissioners, partly *ex-officio* and partly selected from the inhabitants. This body submits annual estimates of expenditure, and furnishes statements of receipts and outlay, and, with the sanction of Government, the commissioners may raise loans. The Bengal Municipal Act VI. of 1868, is for smaller towns, the number of the committees being only five, and with less power, and the occupiers being taxed instead of the owners.

The Bengal Act II. of 1874, enables the ratepayers to elect commissioners, and extends their powers, by allowing them to spend the funds on education, vaccination, and medical relief, and registration.

By the Madras Municipal Act III. of 1871, not less than three inhabitants are appointed by the Governor in Council, as commissioners, in any town brought under its operation, to carry out its purposes, to continue in office three years; and the collector is *ex-officio* commissioner in every municipal town in his district. It is provided that the Government, if thought advisable, may arrange for the election of a certain number of the commissioners by the ratepayers. The funds are to be expended on the repair and maintenance of streets and bridges, diffusion of education, and on hospitals, dispensaries, choultries, markets, tanks, and wells. The Commissioners may levy a rate on the annual value of houses and lands, a tax on arts, professions, and trades and callings, on carriages, and horses, and tolls.

In Bombay, the Municipal Act places the power of proposing municipalities in the hands of the Government, and enables the Government to group a mass of villages into one municipality, when they are not separated by more than one mile of unoccupied ground.

Action taken by Municipalities in Sanitary Matters.

The progress which has been made under these powers by the municipalities is already remarkable. In Calcutta there was formerly no conservancy; the surface of the ground was polluted with every sort of filth; cattle, fed mainly on offal, were kept in filthy hovels, in close proximity with the population; slaughter-houses were scattered over the town, without any means of disposing of the refuse. The filth of the city rotted in pestilential ditches in the midst of the population, or floated backwards and forwards with every tide in the river. The water stood at a few feet from the surface; the drinking water was unfiltered, and obtained from wells contaminated by the impurities in the subsoil, or from the river, which was not only the receptacle of the filth, but the graveyard of the city.

As I have already mentioned, until recently there has been no general registration of the deaths of the native population; but in Fort William, where the military are stationed, the mortality

during the ten years preceding 1856 averaged 102 per 1,000.

Under the agency of its municipality, Calcutta has recently received a pure water supply, and a scheme of drainage is nearly completed, by which the sewage is to be applied to irrigation. A large part of the city has already been drained; 3,201 houses were connected with the sewers in 1874, and 7,160 houses were provided with the pure water supply, exclusive of the public fountains. Much, however, remains to be done to complete the drainage system; for instance, long lengths of filthy ditches are still kept open by private native proprietors, who will not incur the cost of substituting covered drains in connection with the main sewers.

As a consequence of the improved drainage, the level of the subsoil water in Calcutta has been lowered, and it is now from 12 to 14 feet below the surface. The water supply amounts to about 6,000,000 gallons a day, but the volume of water discharged from the sewer is stated to be at least from four to six times that amount, and it would appear that a constant current of water flows through the soil, from the river to the drain, removing in its course, with the assistance of a large rainfall, which also flows through the soil, much of the former sewage pollution of the subsoil itself. The conservancy of Calcutta has been also improved, and the slaughter-houses have been removed from the town, and a municipal market has been constructed. The result of these improvements, and of others at Fort William is, that sickness in the garrison of Calcutta has been much reduced, and the death-rate in the garrison in 1873 was only 8·43 per 1,000.

There has also resulted a great diminution of the general death-rate in the town population of Calcutta, and especially of the death-rate from cholera. In the four years from 1865 to 1868, the cholera death-rate averaged 4,600 a-year (the highest being 6,823, the lowest 2,268; in 1871 it was only 800; in 1874 it was 1,680; and it is noteworthy that on the occasion of a temporary stoppage of the hydrant water, in December, 1874, an increase of cholera took place. The deaths from zymotic diseases in Calcutta, for the four years from 1865 to 1868, averaged 13,406 per annum, whilst the deaths from the same diseases in 1870 and 1871 averaged 6,875 per annum, and amounted in 1874 to 8,013. Though much has been done, much yet remains to be done; and, until all the houses are supplied with proper drainage and a proper water supply, the lives of the natives will be at the mercy of epidemic during periods of greater intensity.

The municipality of Calcutta has incurred a debt of more than £1,500,000. Its income from all sources was stated in 1874 at £450,613, and its ordinary revenue at £249,830, and its expenditure, £251,943.

The municipality of Madras have carried out an improved water supply for the town, but it has not as yet been laid on to all houses. The municipality had an income in 1874 of £51,299, and an expenditure of £48,481, exclusive of £7,384 on account of the completion of its water supply, which is now finished. The municipality of Madras have not yet effected the drainage of their town. A sewage farm has, however, been established for the reception of the sewage from the barracks, and from a small subsidiary district; and Mr. Clark, lately engineer to the Calcutta municipality, has prepared a scheme for draining the whole town.

The municipality of Bombay received £332,411, and expended £304,458, in 1874. It has executed one large work for the water supply of the town, by diverting the upper part of the Tulsi river into the Vehar lake, as the Vehar lake was not sufficient for the supply. This, however, affords only a temporary measure of relief, and a further expenditure is contemplated on another reservoir at a lower level. The drainage of the town of Bombay is much needed, and the municipality expend an enormous sum annually on a somewhat unsatisfactory system of conservancy. The solid refuse is collected by hand, removed to a distance of nine miles, and spread over the land. The liquid night-soil has till recently been conveyed in carts to tanks, and thence discharged by pumping, at favourable times of the tide, into the harbour; a large proportion of night-soil, however, finds its way into the rain-water drains, and thence by degrees into the harbour. This pollution of the harbour is a great evil. A scheme for the drainage of Bombay has, however, been settled, and the municipality—who are devoting all available funds to the water supply—will proceed with it when the water supply has been completed.

The progress in forming municipalities outside these three principal towns is shown in the following table.

	Number of municipalities.	Annual income.	Annual expenditure.	Proportion spent on conservancy or sanitary matters.
		£	£	£
Bengal	187	174,354	174,028	not known.
Madras	47	112,044	117,540	about 42,600.
Bombay	186	205,985	189,576	,, 65,000.
Punjab	128	175,030	198,860	not shown.
And	185 not formally under Municipal Act.			
North-West..	81	192,278	195,651	not shown.
Oude	19	41,909	41,854	,,
Central Provinces ..	56	68,172	52,000	,,
Burmah	45	65,563	68,794	,,
Mysore	77	35,329	33,913	,,
Ajmere	2	4,304	4,433	,,
Berar........	5	6,310	6,422	,,

It is impossible, in the limits of this paper, to give a list of all the works of sanitary improvement effected in the various districts.

Amongst the principal efforts of local municipalities may be mentioned the water supply of Peshawur, which has been improved.

At Poona, the defective water supply caused by misdirected engineering has been remedied. Formerly, *e.g.* 15 years ago, a dam was built across the river, and an engine erected to pump the water to a height sufficient to supply the city, but unfortunately, the dam was built below the city, and the water was consequently contaminated with the whole drainage of the native population. Recently, a dam has been erected 13 miles above Poona, and pure water is now brought by the Karakwasla Canal, and distributed over the city. At Nagpore, the municipality have expended £40,000 on a new

reservoir. At Cawnpore much has been done, but much is still required. The Delhi municipality have prepared a well devised scheme for the water supply of the town; but, in consequence of the large cost, a Government loan is required, and this has been applied for under the municipal Act I have mentioned.

As a general rule, there is nothing on which the people are so ready to spend the municipal taxes as on the sanitation of the town. The value of paving is understood and appreciated, for it at once increases the comfort of the people; it is an important improvement on account of the facility it affords for surface cleaning, by which also the evils of water contamination and of surface defilement are lessened. Amongst the minor sanitary measures which have been general are, the filling up of hollows and excavations near villages; the removal of brushwood and low jungle; the cleaning of wells, or filling them up, and forming new wells; setting apart some of the tanks and wells for drinking water, and closing them at the top, and providing pumps; and appropriating other tanks and wells for cattle or washing purposes; providing tanks for the reception of sewage, to prevent it going into drinking tanks; removing surface refuse; providing slaughter-houses outside the town; lighting the streets and planting trees.

Measures for Prevention of Surface Defilement.

The great evil of the surface defilement of the ground round the villages and towns by the natives for purposes of nature, has been endeavoured to be checked by the provision of public latrines, and to assist this a privy tax has been sanctioned. The dry earth system has been found to fail in India, in some places from the system in use by the natives of using ablution water. This difficulty has been overcome at Jubulpore and Cawnpore, by the plan of building separate ablution places within the latrines, the water from which is conducted to tanks outside the building. The objection to this plan is the distance the sitter has to traverse before reaching the place of ablution. It certainly would seem advisable, if water is required for the purposes of ablution within the latrine, that in the arrangements for its removal this water should be utilised to carry away the refuse at the same time to tanks, whence it could be passed on to land for irrigation.

The system of trench latrines largely prevails. Long trenches are dug, at about one foot in depth, on a spot set apart, about 200 or 300 yards from dwellings. Matting screens are placed round for decency, and the trenches gradually extended, until sufficient ground has been utilised, when they are ploughed up and the ground used for cultivation. In the wet season these cannot be used; and in sandy soil they do not answer. The men do not like the arrangement, the women hate it, they consider it an indelicate arrangement, as there can be no privacy. Moreover, the Indian plough does not penetrate more than 8 inches, consequently if the trench is too deep, the lower stratum is left unmixed with earth in a permanent cesspool, a source of future trouble. The systematised pail system in use in many English towns would appear to offer advantages for India, as it would be applicable to houses either in villages or in towns; it would ensure privacy, and would only be adopting for all Indian dwellings, a system already practically in use by Europeans in India, as well as by the higher classes of natives. In some districts difficulties in providing public latrines, or places for disposal of refuse, at a sufficient distance from the houses, have arisen from the cultivated land assessed for tax being carried up to the doors of the houses, and thus the village cannot afford to make a sacrifice of land for public purposes.

Dispensaries and Hospitals.

Although this paper is intended to discuss the prevention of disease, the *resumé* would not be complete without mentioning the large number of curative establishments which the Government assist, such as local hospitals, dispensaries, and lunatic asylums. There are nearly 800 of these various institutions largely, although not entirely, supported by the Government of India. There are also Lock Hospitals at several military stations; these are institutions for the prevention of disease, I do not, however, propose to discuss their results on the present occasion; I would only observe that a comparison between the statistics of the disease they are intended to prevent, at stations where Lock Hospitals exist, and at stations where there are no Lock Hospitals, appears to afford some ground for argument as to how far their advantages are in proportion to their cost.

Influence of Sanitary Commissioners in Educating the Native Population.

It will be seen from my previous remarks that the fringe of the question of sanitary improvement in India has only now been reached. The reports of the medical men who act as sanitary commissioners are eminently able and practical, but these commissioners are unfortunately burdened with too much labour of statistical detail. The real practical work of inspecting appears to be subordinated to the duty of preparing voluminous annual reports, abounding in statistical tables. Statistics ought to be prepared by subordinates, and to be at hand to enable the sanitary commissioner to see where his experience is most needed, but he should not be compelled to waste his time in their collection.

In the present stage of the question so far as it relates to the improvement of towns and villages, the most valuable part of the Sanitary Commissioner's functions has been to inspect and advise municipal authorities. The advantage of inspections by a Sanitary Commissioner is shown by the reports of these commissioners. The Sanitary Commissioner for the North-West Provinces (Mr. Planck) gives a curious account of an attempt he made to induce the village authorities to adopt sanitary measures, in consequence of an attack of cholera. He traced out the history of the disease. The water supply of the village was derived from two tanks. He found that the villagers who had used one of the tanks had suffered, and the others who had used the other had not suffered. He found that the tank which had been used by the sufferers was seriously polluted by the washing of lower-class natives and by fæcal matter. The village authorities, when he showed them that the disease had followed the use of the foul tank, attributed it to

the occupation of the tank by an evil spirit, and caused the villagers to discontinue its use for drinking purposes and to resort to it only for washing, and other purposes which might pollute it, and to reserve the other tank for drinking water.

The Sanitary Commissioner for the Punjab (Dr. De Renzy) states:—

"In my inspections of towns and villages, it was my custom to hold, with the native gentlemen of the place, long conversations, in which various matters of sanitary interest were discussed, attention being especially drawn to the most prominent defects of the towns under investigation at the time. In this way the subject of water-supply was discussed in all its bearings. Simple chemical demonstrations were made of the impurities of town waters, and explanation given of the manner in which the impurities reached the water, owing to the unsewered surface of the town absorbing the liquid excreta of the population and domestic animals living within its boundaries. These demonstrations led to the obvious inference of the need of surface cleanliness, and good pavements, and water-tight sewers, and the levelling of hollows and holes to save the water from contamination. The ill effects of air fouled by putrid emanations from decomposing animal and vegetable matter were described; the use of statistics for the purpose of gauging the sanitary condition of a place was explained, and statistical illustrations of the reduction of death-rates, by means of sanitary improvements, afforded, in order to counteract the fatalistic idea, so obstructive to sanitary progress, that sickness and death are events entirely and absolutely beyond human control. When discussing this subject of death-rates, I took occasion to examine the birth and death registers, and in doing so to point out errors, to apply tests, to ascertain how far the registers were reliable, and to urge upon the municipal committees the great importance and value of such records. The utilisation of sewage was another subject which I had frequent occasion to refer to, and also the value of vaccination was a frequent subject of discussion. In short, my inspections had, to a great extent, an educational character. Surrounded by large crowds of people, I encouraged them to ask questions, and to make objections, and to raise difficulties which I endeavoured to remove. The effect of these discussions has been, in many cases, to make the people conscious of the existence of grave remediable evils, which had previously escaped their notice, and if not, to establish a general conviction of the need of sanitary improvement; at least to dispose the minds of the people to consider the subject dispassionately, and with some sense of its vast practical importance to their health and comfort.

By efforts such as these the people of India will be gradually educated in sanitary matters; but this alone cannot solve the great problem of the prevention of disease in India.

Necessity of Sanitary Training for Indian Engineers.

After the Sanitary Commissioner has pointed out the causes of the disease, and the remedial measures to be applied, it requires the intervention of sanitary engineering; for on the practical knowledge of the engineer depends the application of hygiene to each individual case as it arises. In this respect in India there is a large void to be filled.

Every medical officer who enters the army is required, before he is commissioned, to make a special study of hygiene at the admirable Medical School which Lord Herbert established at Netley; and which has attained such a high state of efficiency under Dr. Longmore and the late Dr. Parkes.

At the School of Military Engineering at Chatham a course of lectures is given annually to the officers of Royal Engineers, on hygiene and sanitary engineering alternately, but this is not a systematic training in sanitary engineering.

At Cooper's-hill, which is the training college for civil engineers for India, no very systematic sanitary training was at first adopted; it is, however, stated in a recent report from the India-office, that it is intended in future to carry out the study of sanitary science there in a more systematic manner than has hitherto been done.

The sanitary problem in India requires a special study, that it may be adapted to the climate and the habits of the people. The principles of sanitary science are the same everywhere, but the application of these principles is controlled by the surrounding circumstances of each particular case. In the few instances to which I have alluded, out of the many measures of sanitary improvement on which money has been spent in India, it will have been seen that errors have, on more than one occasion, resulted from a want of knowledge of hygienic science in the constructors of these works. This led to waste of money in the execution of the works, as well as to waste by the injured health of the community. I mention this, not as a matter of blame for the past, because sanitary science was not then so well understood as it now is, but I mention it as a matter of experience, which should form a guide for the future.

The sanitary officer points out the causes of disease, either hidden or apparent; the engineer has to devise the arrangements for their removal. The detailed improvement of even village conservancy alone concerns the welfare of far more than 50,000,000 people; it involves an enormous expenditure, and errors or useless cost in the details of the arrangements will entail a vast unnecessary tax on the community. Moreover, in developing large Government works of irrigation or canalisation, the public health requires that drainage, or the rapid removal of the water, should proceed hand in hand with irrigation, and that the engineer engaged in such works should possess a thorough understanding of the principles of sanitary science. There are also parts of India from which it is the mission of the engineer to extirpate fever, and it is probable that he may succeed eventually in abolishing what is termed the endemic home of cholera.

The municipalities and the villages will have to provide large sums of money for these works of sanitary improvement. Unless this money is spent on an intelligent system, much is certain to be spent in an unadvisable manner, and much to be wasted; sanitary progress will then be delayed, if not discredited. On these grounds improved and systematic training in sanitary engineering is required for all engineer officers, either military or civil, who proceed to India. Moreover the engineering element must be brought into its proper position in the department of sanitary supervision; and therefore, side by side with the medical officers, *i.e.*, the sanitary commissioners, who point out the defects, engineers duly conversant with sanitary questions should advise on the details of the works necessary to obviate the defects, and no important work should be carried out by any municipality without carefully prepared plans and estimates.

Additional Legislation Required.

The first step in the sanitary improvement of India was taken by the appointment of Sanitary Commissioners to inquire and report. A further step has been taken by committing to the native municipalities the duty of effecting sanitary improvements in their towns. The social and religious customs of the people would prevent the Government from interfering with the causes of disease which exist inside the houses. The education of the people in the appreciation of the value of sanitary arrangements will alone solve this difficulty.

But, as we have now ample evidence, from the valuable reports of the Sanitary Commissioners, of the general measures of conservancy that are required, and as we know that the more enlightened of the natives are desirous of sanitary improvements, the time appears to have come when legislation may safely step in, and make it compulsory on the municipalities to adopt some general measures to promote the public health, at least so far as concerns surface cleansing, and to prevent the pollution of the supplies of water for drinking.

Conclusion.

The brief sketch of the subject, which, the time at my disposal this evening has enabled me to give, is barely sufficient to convey even a mere outline of its importance, or to put before you the vast changes in social and domestic life in India, which sanitary progress will entail.

Although my intention has been to confine my observations to the sanitary progress of India, the nature of the subject has compelled me to enter into collateral questions of great interest in regard to the political and social condition of the people. I have, for instance, alluded to the introduction and rapid spread of municipal institutions in Indian cities during the last few years; institutions introduced by the Government into India, with the object of enabling the people to govern themselves in matters relating to the management of the towns. These institutions will infallibly lead to great results in time to come.

The condition of the towns and villages of India is similar to that which caused the abandonment by their populations of many cities of high fame in ancient times; now mere deserts. The task which the Government of India has set itself to perform is to arrest the physical decay of the people by the removal of the deteriorating conditions. The sanitary progress which has been made in the country during the last ten years has no parallel in the history of the world; yet, each step of forward progress has only shown more clearly the vast work which remains to be done.

The enormous amount of preventible diseases which I have shown to exist in India represents a corresponding loss to the community, even in a mere financial point of view. The loss by fever alone is quite appalling. There are above 1,600,000 registered deaths from fever; but for each death there are at least twenty cases of attacks of fever, which do not terminate fatally, but which weaken the sufferer, and reduce or destroy his capacity for work; and thus the registered fever death-rate represents a debilitated working population of probably nearly 30,000,000. Moreover, the large fever death-rate also represents a large amount of defective drainage and defective agriculture; thus the loss in production from this cause, added to the direct loss of the labour abstracted by the debilitated state of a large portion of the labouring classes, is the measure of the loss to India from the insanitary condition which produces fever.

To this loss must be added that of the perpetually recurring cholera epidemics, fostered by dirt, by bad water, and by other removeable causes; this loss of productive human life is the cholera-tax, paid by India, for its neglect of the laws of health. The tax-assessor and the tax-collector are in this case one and the same, and cannot be put off.

In order to arrest this enormous waste of the national health and of the national wealth it is necessary to remove the sources of contamination of the air, the soil, and the water, and to provide pure water for drinking, in almost every town and village in India. Of these matters some depend upon the action of the people themselves; others depend to a great extent upon the action of the Government.

In conclusion, therefore, whilst I would urge the Government of India to remove those causes of disease which are dependent upon the operations of their own officers, and to continue by every means in their power to impress upon the native communities their duties and responsibilities in this matter, I would call on the natives of India, and especially on those Indian gentlemen who have done so much in many ways to benefit their country, to come forward and help to remove from India the causes of disease and death which I have enumerated, by spreading among their fellow-countrymen a knowledge of the laws of health.

These causes of disease weigh equally on European and on native; but whilst they rob the native of his health, and, may be, of his life, they also abstract from the people of India a large portion of its labour, they reduce the productiveness of its soil, and they help to keep the great Indian Empire in a chronic state of poverty, although it is situated in one of the most productive regions of the earth.

DISCUSSION.

Dr. Boycott had listened with very great pleasure to the paper by so distinguished an officer of the engineering corps, and thoroughly agreed with the remarks made as to the importance of attending to the education of engineers in sanitary matters. Amongst the medical profession these matters had been thoroughly studied, and they had already done considerable work in improving the condition of health in India during the last thirty years. Still, however, there remained a great deal to be done with regard to the education of all classes in respect of sanitary measures, for even this country was not in a very satisfactory condition in that respect. In Bombay and Calcutta great mistakes had been made with regard to water supply, and he did not think a greater curse could be introduced into India than the English system of water supply and water closets. Englishmen, when they went to India, carried their cleanly habits with them, and of all the houses he had ever seen, or of the hospitals, he had never seen any to equal those of India. In an Englishman's house in India there was not the slightest nuisance, either in or about it, and the same with regard to the hospitals; most of them were as perfect in sanitary arrange-

ments as any he had never seen. He had heard that it had been said by Miss Nightingale what a dreadful thing it was to think that in India there was not a water-closet in the houses, but he considered, on the contrary, it was the greatest blessing they had no such things; therefore, before any large sanitary measures were introduced into India, it was necessary that engineers and sanitary officers should be well instructed in the conditions of the country before they commenced making alterations. The levels of many of the towns were such that it would require the skill of the whole engineering corps to carry out an English system of drainage with anything like success.

Dr. Burn, having had some 32 years' experience in India, said there was no doubt that the state of the country, with regard to sanitary arrangements, was capable of being vastly improved. At the same time, there were many things which would put this country to shame. Captain Galton had mentioned the fact that the people drank water from the tanks in which they bathed, but in London we did a great deal worse, for we drank the Thames water, which was nothing but a common sewer, quite as bad as any tank he ever saw in India. No allusion was made in the paper to the position of European cantonments in India in reference to the prevailing winds; they were but two, the land wind and the sea breeze, which he looked upon as a vital point, though it had been entirely neglected. In Western India the principal cantonments had been laid out in the worst possible way. For instance, at Poonah, where he had had many a battle with the authorities on sanitary matters, the cantonments were made to face to the east, according, he believed, to the views of the clergy, but that was the worst position which could have been chosen, because for six months of the year it was exposed to the land winds charged with malaria, whereas if it had faced to the west it would have received the magnificent sea breeze. Not only so, but all the nuisance from the camp was carried out and placed between it and the sea; and still worse, they had taken the drinking water from the river below Poonah, a city of some 20,000 inhabitants. Many years ago he pointed out to the Commander-in-Chief the frightful character of the arrangements, but found it almost impossible to get his suggestions attended to. At that time one could not get military officers to understand sanitary arrangements for a camp. However, after having made some very strong remarks, which led to an interview with Sir Henry Somerset, at which he was at first treated with a considerable amount of *hauteur*, he was at length allowed to take a portion of the camp and put it into a healthy condition. He was somewhat laughed at by the officers of the Staff, and consequently requested that his work should be judged of, not by the Staff, but by the men, and the result was, that after his alterations had been made, the men said it was like living in paradise, compared to what they had been accustomed to. All the cantonments in India ought to be regulated by a knowledge of the prevailing winds, because they had a very powerful effect upon the health of the troops. The native villages also required very great improvement. When he was in the Civil Service at Kaira, in Ghuzerat, which was a walled town, he collected the statistics of births and deaths with some care, and they were published in a journal in Calcutta. The custom there was to keep all their manure in the village in front of their doors, but he induced them to alter it, and to carry out all the refuse every morning, and deposit it outside the gateways, where it could be used for agricultural purposes when required. This caused a great improvement in the health of the town, and no doubt if it had been viewed in the proper light, and carried out further, there would have been a great change, but it was impossible to make people understand the value of such measures all at once, and even now, as Captain Galton mentioned, this difficulty was not removed.

Mr. Andrew Cassels said, when he first went to Bombay, in 1873, they were entirely dependent on tanks for water for every purpose, and in the dry season these were generally so low that the water was frightfully unwholesome. The stench from the Mohammedan burying grounds was sickening, and the filth in the native town was indescribable. In those days they might truly be said to carry their lives in their hands, for cholera and disease of every kind constantly prevailed. A great improvement had now been made, and health in Bombay was almost as secure as in London. He could bear witness from his own knowledge to the great efforts the Government was making in every direction to show the advantage of sanitary reform, by spending money and doing all it possibly could to teach the people of India. Indeed, amongst the many good things England had done for India, he believed this was the most important. With regard to fever, he might say that every disease that was not clearly recognised was put down to fever. With regard to the census, he might mention that the Government was already making arrangements for the next census, which could not come off for five or six years.

Mr. Sen, as a native of India, desired to express his sincere thanks to Captain Galton for the interest he had taken in India. The sanitary improvement of the country was a gigantic work, as would be seen when it was recollected that India was nearly half as large as the whole of Europe. It must also be remembered that India was a very poor country, poorer even than Ireland, and, therefore, in this work the Government would have immense difficulties to encounter. It might be possible to introduce sanitary improvements in presidency towns like Calcutta, Bombay, and Madras; but whether it would succeed in doing so in villages and the country generally was a great problem. The prejudices of the people must be taken into consideration, and they were, as a race, very conservative. Whatever they were told to do, or not to do, by the Government, they thought was ordered from some selfish motive; and this feeling would be very difficult to overcome. As far as he knew, the European quarters of the large towns were pretty well looked after, but he feared little attempt had been made to improve the native quarters, except, perhaps, a little at Calcutta. He had heard a great deal about the army, and the health of the army, but for the population in general very little appeared to have been done.

The Chairman said:—As I have been of late individualised for the purpose of reactionary attacks on the principles advanced in the sanitary report, and in the reports and papers of the first General Board of Health, upon which the leading principles of the measures set forth in the paper read have been mainly based, I may be allowed to be individualised to some extent for their defence. Now, in the early reports and papers to which I refer, will be found, as respects England, statements of the chief sanitary defaults which have been described as affecting India in greater magnitude; but there will also be found in those papers expositions of remedial principles, and of long tried and successful applications of them that are applicable to the east as well as to the west. Take for example, the types of marsh malaria, and especially of irrigations. You will find noted instances of irrigations here by the method of submersion, which by sanitary defaults of supersaturated soils, create rot in sheep and ague in men. Irrigations in India have been conducted, with the like sanitary defaults, of the creation, by supersaturation, of marsh surfaces on a greater scale, acted upon by a more powerful sun, and followed by magnified evils, amongst which have been this one—that the course of a great trunk line of irrigation has been marked by the size of the spleen of the natives living in proximity to the works. In the expositions referred to will be found the remedies to this:—Subsoil drainage, so as to lower the natural water

tables, and augment the receptivity of the soil for regulated applications of water, with manure in doses, avoiding supersaturation, and apportioned to the absorbing powers of the vegetation, as well as of the soils. Examples of such remedial works in England were presented, as operating on naturally supersaturated soils and marsh surfaces, with the results of augmentation of vegetable production, and of health in men, as well as of cattle, and in the banishment almost of ague, as the work proceeded, and the use only of ounces of Peruvian bark, where pounds were previously needed. In respect to the application of these principles to India and the tropics, I got an example examined of what a sanitarian had effected in Algeria by the sanitary works on a malarious tract, which it had been found necessary to occupy for strategic purposes, where three three sets of colonists had been cleared away, and three sets of soldiers had been decimated. By proper drainage of the subsoil, by suitable cultivation, and by fresh supplies of water properly distributed, the marsh conditions were removed, and the death-rate of the French soldiers was reduced to 12 in a thousand, or a third less than that prevalent amongst the French army at Rome; while the birth-rate of the children was elevated above the death-rate, and as healthy a crop of children reared as any in France. It was the declaration of Mr. Robert Ellis, the then chairman of the Sanitary Commission of Madras, who was one of the commission who examined the case, that the example was equally applicable to cantonments and camps in India. An Indian gentleman has to-night expressed what is a common belief amongst those who are ill-informed on sanitary subjects, "That the Indian population are too poor to bear the expense of sanitary works," that is to say that they are too poor to bear the lower expense of the removal of the greatest and most expensive causes of their poverty; too poor to bear a cheap increase of their strength and productive power; too poor to bear the cheap reduction of years of premature disability and helplessness; too poor, for example, in respect to one item of sanitation, an improved supply of water into their cities, carried into their houses direct, even by steam power, direct and constantly, pure, cool, and fresh, at an expense greatly below that of the poorest hand labour that can be found. If the water supply of this metropolis were to be taken as a type, with the works of eight separate companies, and of eight separate establishments, and directorates, and of cisternage in all private and the poorest homes, necessitated by the intermittent supplies, altogether about threefold expense, and if there were only to be lump charges on occupiers or short owners for new permanent works, as is common here at present; there might indeed be ground for his apprehensions. A distinguished medical practitioner in India ventured to express the hope to-night that the water-closet will not be introduced into Indian cities, that is to say, if he knew and could have consulted examples of correct sanitary engineering, he hopes that the means of removing excreta, and removing it at once in suspension in water, from beneath the sites of houses and cities before it can enter into advanced stages of decomposition, before sewers and stagnant cesspool gases can be evolved, before it can be deteriorated as manure by putridity; and that this unseen innocuous removal may not be effected there as well as here, at a rate of charge greatly below any means existing of removal by tub or by hand. He speaks of the inferior cleanliness of the house of the Hindoo gentleman. No doubt the Hindoo gentleman with his service of sweepers and tub men, who has removed far away from the precincts of his mansion in the morning all the excreta of the night, before decomposition could advance, will have the advantage of an English gentleman in a mansion in Belgravia, or even of the occupiers of new Government offices in Downing-street, where excreta are discharged into, and frequently detained in, ill-constructed drains, and thence into large sewers of deposit, extended cesspools, which were characterised in the Sanitary Report (1862) as bulbs of retorts, generating noxious gases, of which retorts the house drains were the necks, leading the gaseous products into the habitations, imperfectly defended by every species of traps. In those early sanitary papers will be found the grounds for the statement, that you may test the competency of sanitary science by the nose; test the competency of the architect by foul smells in habitations; and test the competency of the engineer and the local administration by the smells from sewers in the streets, and of sewer gases in houses. In India, with the progress of sanitary science, it may be expected to be the test of the rule of cities; of which I remember seeing in the diary of a lady travelling there at night, that she knew when they came to one by being awakened by the stink. I have heard the cleanliness of barracks in India effected by the tub system, defended as the perfection of sanitation. No doubt it is comparatively good, but all modifications of the tub system are offensive in their working, and immensely more expensive, even with the cheapest of Indian labour, as was shown in respect to barracks, and demonstrated in a report as respects Bombay, in a report of Major Tulloch of the Engineers, now one of the engineering inspectors under the Local Government Board. These principles have had sufficient verification, in a number of towns, where the works were laid out on the principles promulgated under the first General Board of Health, and three houses and three towns were drained with self-cleansing drains and sewers, at an expense heretofore incurred for works which were little more than extended cesspools; and these works though rudimentary and improvable have been attended by the results of reductions of general death-rates by one-third. What, however, I think most of, in the way of example, is the reduction of the children's death-rates in one district, orphan institutions and half-time schools, to one-third of the death-rates of children common to middle and lower classes; and what I should especially prize for India, is the example of the death-rate of an orphan asylum of children of British parents at Calcutta, reduced to seven in a thousand, or little more than half the children's death-rate at home. What, too, is to be noted as most encouraging is, that the removal of bad sanitary conditions from old urban districts—which were invariably the seats of physically depressed populations—is now being markedly followed in England by improved types of children; and, it may be declared, improved sanitary rule, wheresoever it is made completely prevalent, will certainly be so followed, more conspicuously in India. But it is due that I should note the verification of sanitary principles in their particular application to military forces. Curative service having failed to avert the loss of our first army in the Crimea, urgent representations were made to the Government on the need of the application of specially preventive, or sanitary, service for the protection of the reinforced or second army. I, for one, wrote an expository paper on the subject for Lord Palmerston. The Commission sent out included the foremost of our staff of officers of the first General Board of Health, schooled for several years previously in its principles; Dr. Sutherland, Dr. H. Gavin, and Mr. Robert Rawlinson, for whose introduction to the public service I may claim credit. Dr. Gavin was killed by an accident, and his place was subsequently filled by Dr. Milroy. The Commission was powerfully aided by the pervading spirit of Miss Florence Nightingale. It must suffice to say of its work that the Minister of War, Lord Dalhousie, declared in Parliament that to the principles applied by their labours it was owing that the second army was preserved and returned in a better state of health than even the army at home had previously enjoyed. Dr. Sutherland and Mr. Robert Rawlinson have continued their services as members of the Army Sanitary Commission. Of Dr. Sutherland's labours I can endorse what has been justly said, and may say

much more of them than has been said in the paper. It were just also to note the distinguished service of Mr. Robert Rawlinson in the practical application of correct sanitary principles to engineering works. The outcome of the application of sanitary principles to the home army, as influenced by that Commission, has been a decrease in the death-rate from 17 to 7, or by 10 per 1,000. In India, as you have heard, the reduction accomplished has been from a death-rate of 69 to one under 16 per 1,000, which is equal to a saving of 3,500 of mean force annually for the Indian army. These are the first examples in the world's history of sanitary science having been applied separately, distinctly from curative science, to the preservation of military force, and I think it must be acknowledged that on the whole the disciples of the new science have, so far as they have been allowed, well justified their mission. But by a conspiracy of sinister interests in Parliament, the first General Board of Health was discontinued unwarrantably, of which the House really knew nothing; and that vote was held to be a disapproval of their principles of action; its course of practical sanitation was, to a great extent, abandoned, and civil death-rates, which ought to have been reduced, have been, as a consequence, maintained or augmented. The practical means of reducing them, as set forth in our rules and regulations of the duties of local officers of health, were set aside for mere generalities, which are now found to be mere evasions of practical sanitary action. A committee of the British Medical Association have lately reprinted our regulations for circulation and voluntary adoption, and medical journals have treated their abrogation as a great evil. A reactionary course, that has threatened interference with the course of sanitation in India, has been in directing attention to personal contagion as the chief means of preventing the spread of disease, by the re-enforcement of quarantines, the working of which we had examined and upon that examination had declared them to be useless and mischievous, even upon the hypothesis on which they were maintained. In the illustration of the different doctrines and of the courses of action upon them, I may mention, that on my first sanitary inquiries, on occasions of severe visitations of typhus fever in towns and villages, I found people—medical men as well as others—overlooking the stagnant marshes and cesspools, and disregarding the evolution of the foul gases amidst which they were living, maintaining positively that the disease had been imported by tramps;—for had not the first outbreak been in the common lodging house? —which was true, but it was also true, that the common lodging house was more overcrowded and in a worse sanitary condition than ordinary dwellings, and was just the place in which, on current sanitary principles, any such pestilence might be expected to appear. The remedy, however, then held to be was just the same as in the plague, and now in the cholera, a *cordon sanitaire* against the beggars, "stamping" out the disease by burning the clothes of the infected, and so on. Now, by the sanitary course taken under Lord Shaftesbury's Act, when properly executed, the "stamping" out has been effective by the drainage of the common lodging houses, by the introduction of pure supplies of water, by the introduction of the water closet, for the immediate removal of all fouled waste water and excreta, by ventilation, and by the prevention of overcrowding, and by cleaned bedding. By these means, common lodging houses instead of being the first, are the last to be attacked, and are in a sanitary condition and exemption from epidemic visitations which contrast strongly with the conditions of the wage classes and their dwellings. The like has been the course in India, where it has been held to be an undoubted fact there, as well as here, that epidemics, and especially the cholera, were carried solely by human communications, as by pilgrims. Is not its first development displayed at the great fairs in India where they assemble? Truly so. But those vast fairs are fairs of vast filth, of vast overcrowding, of bad feeding, of depression, and susceptibility, from weakness from these causes. The operations first conducted against these causes at a great fair at Congeum, by Mr. Robert Ellis, of Madras, were by the enforcement of cleanliness, by supplies of pure water, by pure and sufficient supplies of food, by the prevention of overcrowding, by separation. By such means the regular outbreaks of cholera, then and since, have been "stamped out" at those fairs, and the people now hold them with the same immunity from such epidemics that the tramps have here in well regulated common lodging-houses—the disease continuing its ravages on the unregulated and ill-conditioned dwellings of the stationary wage classes of the population. Of the reactionary doctrines which have impeded sanitation at home, and would impede it in India, is one that it is the primary business of a public administrative authority to investigate the causes of disease. In my report on the sanitary condition of the labouring population of Great Britain, I deprecated any occupation of the executive authority, with inquiries as to the cause of disease, and with controversies upon them, as befitting only colleges for speculative research,—as being irrelevant to executive administrative action, and as being obstructive of it. I endeavoured to illustrate my objection popularly in this wise. We know that the heads of children at certain stages are strangely infested with animalcules. Now researches as to how they came there, whether by contagion from head to head, and how they were germinated and propagated, might be fitting subjects for professional research by scientific entomologists,—but ought not to stay the administrative action of the small tooth comb, or delay preventive sanitation by the application of soap and water. If this be so as regards matters that are seen and known, how much more is the occupation of a public administration, as lately agitated with things that are unknown, and really imagined, as with the "germ" theories of the propagation of disease, by which the course of practical sanitation has of late been been much delayed and obstructed. Of these germs Dr. Richardson, our able president of the Health Section of the Association for the promotion of Social Science, has said in his recent work on Modern disease: —"Recently speculation has run high on what has been called the germ theory, which has supposed each specific poisonous particle to be a living germ, that can be multiplied in the body indefinitely. But no one has ever seen a germ, and no one has ventured to define between the germ of typhus and the germ of small-pox, or of any other specific disorder. Moreover, no one has ventured to explain why the living germs once commenced to propagate in the body should not continue to propagate, until in every case they should kill their victim. For my part I can see no basis for the germ theory, as applied to the spreading diseases, except a barren analogy that these diseases may originate like plants or animals. This argument, purely defensive, explains none of the manifold phenomena which mark the character and course of spreading diseases." Whatever we may have sent to India in the principles of sanitation and prevention, India, through excellent observers of masses of facts on a large scale, has sent us important corroborations of all our first conclusions as to the transmission and dealing with cholera, as well as other epidemics. It was laid down by reactionaries, for example, as respects the cholera, "that the rapidity of its transmission is in correspondence with the rapidity of human communication." The rapidity of communication has been vastly increased by steam and by railways, but, lo! it is beheld the movement of disease has no correspondence with it whatsoever. It has been held that the disease is chiefly spread by human excreta, but it is found to traverse wastes where the only excreta would be of the tiger, or of wild animals. It was held that deserts were barriers to its transmission. It is now known that it passes over these barriers regularly from their evidence. Every adverse contagionist hypothesis has been overturned by

massive facts, and recently a declaration has been put forth that quarantines are worse than useless, but without the grace of an acknowledgment that this is what we had proved 30 years ago in our report on quarantine. These strivings for new courses have, for the purposes of practical administration, collapsed, without the attainment of a single new solid conclusion, or a new practical administrative conclusion, so far as I am aware, that is accepted as an addition to applied sanitary science; without one single instance of a city relieved by it, or a considerable reduction of a death-rate effected by it. A comparative examination of the results of the two administrations is due to the public as well as individuals. I have submitted to the Indian department that what might well be done for India would be, to have careful and authentic examinations made of sanitary works, and varied applications of the same principle to show what does do and does not do, and what modifications experience has proved to be requisite. This would be a means to great economies in sanitary works. The present Chief Secretary of State for India is stated to have said, when he was previously in office, that so far as he could see, sanitation was an ingenious mode of spending money. Whether he said so or not, it might fairly have been said, from his point of view; with a preoccupied and distracted attention he was probably then only enabled to see the succession to the first General Board of Health of a double expenditure on officers with death-rates maintained, or increased as they have been within the two last decades, which ought to have been, and I undertake to say could have been reduced, had the constitution and action of the Board been maintained, as was due to its first successes. But if he could have seen or known of the reduction of expenses which it effected, of three houses and three towns, drained well at an expense of draining one ill—of old death-rates reduced by one-third;—of children's death-rates in public institutions, former fever nests, reduced to less than one-third of the children's death-rate in this country; and indeed of reductions of British children's death-rates one-half in Calcutta;—if he will look at an army saved by sanitation in the Crimea—if he could look at what had been done, and is doing, within the direct province of his administration and duty in India; if he will regard these, the reduction of the army death-rate from 69 to 16 per thousand, a rate of saving of 3,000 to 500 men of our present force, the saving of the cost of at least £100 per man;—and if he will see the evidence of the production of the like economy of civil force—he will see for India, as well as elsewhere, in sound practical sanitation, an ingenious means of saving money. Sanitary science rightly consulted in right instances, and rightly applied, will be found to be the most paying as well as the most saving of all expenditure upon physically depressed populations ever hitherto administered by any Government. Let us hope that the present Government administration may advance beyond the common and seemingly safe but really unsafe past policy in India, as respects the civil population of economising the means of economy, as I call it, and will vindicate the declaration of the Premier *sanitas sanitatum omnia sanitatas*. To this policy in duty every support is due, and will no doubt be most cordially given by distinguished sanitary officers in India, as well as by all sanitarians in this country. The Chairman then proposed a vote of thanks to Captain Galton for his paper, which was passed unanimously.

TWENTIETH ORDINARY MEETING.

Wednesday, April 26th; The Duke of Manchester in the chair.

The following candidates were proposed for election as members of the Society:—

Prevost, Edward W., Queenwood College, Hants.
Rose, Frederic Robert, 9, St. Paul's-churchyard, E.C.
Saure, Dr. E. Cassel.
Schauer, Louis Joseph, 171, Rue de Vaugirard, Paris.
Stevens, John Henry, Birmingham.
Wallace, R. W., Chemical Works, Battersea-park, S.W.

The following candidates were balloted for and duly elected members of the Society:—

Baldock, John Henry, F.L.S., F.C.S., South Norwood, S.E.
Jetter, J. F. L., 4, Amyand-road, Twickenham.
Luck, Thomas F., 24, Walbrook, E.C.
Macnie, John, Gas Works, Londonderry.
Payne, Alfred, Ettingshall, Wolverhampton.
Phipps, Richard, Spencer-parade, Northampton.
Tidman, Edward, Middlesborough, Yorkshire.
Wadeson, James, Goswell-house, Windsor.
Woodall, William, Burslem.

The paper read was—

SILK-GROWING: ITS PROSPECTS AND ITS WANTS.

By Mrs. Bladen Neill.

It will be expected that I should, in the first place, explain to you the general object which has not only occupied my time and energies for several years past, but which now encourages me to hope for your attention for a short time this evening, and in doing so I will endeavour to make my story as short as it would be reasonable to expect from a lady, who has, to some extent, got you at her mercy by bringing you together within this room. The object in view is, then, to aid in the enlargement of the silk-growing industry in Australia and New Zealand, not only for the advantage of the colonies themselves, but with the view of adding to the sources from which the English manufacturers draw their supply of silk, and also to provide such means of new employment for women, and particularly for poor educated women, as may be properly connected with silk-growing. The origin and history of our present silk-growing movement in Australia would, in detail, take up too much of your time.

No account of the silk culture in Australia would be complete without a tribute of praise to the unwearied and scientific labours of Mr. Charles Brady, of Anthony Tweed River, New South Wales, who has devoted his life to the study and improvement of silk culture. We owe to him the means of producing successive and daily hatchings at pleasure, as well as the introduction into Australia of the best races of silkworms known—these will, doubtless, in due time produce. He probably knows more about silkworms than any man living. Nor should the labours of Mr. Coote, in Queensland, be omitted. Adelaide also, through Mr. Davenport's influence, is doing what it can to foster this enterprise; while Western Australia, under its energetic chief secretary, Mr. Barlee, has established a government silk farm, with a Macclesfield man at the head of it. Mr. Barlee is present, and will probably give an account of his own colony. At home the work has been greatly forwarded by the kindly aid of Mr. David Chadwick, M.P. for Macclesfield, and Mr. B. F. Cobb, late the Secretary of the Silk Supply Association.

One very important result has been obtained through Mr. Kelly's devoted attention to the Aus-

tralian grain. Since it was landed at Venice last May, many distinguished foreigners considered it would be impossible to reverse the seasons, or to keep back the grain beyond the usual hatching season, but Signor Ferrari's successful education in September last proved that the colonies could send to Europe grain that would hatch in the autumn, and the same grain, under proper treatment, could be made to hatch out successfully this spring. A small sample was sent to me early in the month, and from every egg I obtained a worm, proving the success of the experiment. One hundred ounces of this grain will be tried near Verona this season, and in June a small experiment will be made in England. I believe it will be the first time that grain eighteen months old has been hatched in Europe, though I obtained fine cocoons in Australia from some fully as old.

But I may shortly mention that, several years ago, while on board one of the steamers of the P. and O. Company, I had the fortune to meet with a French gentleman, who was on his way to Japan to purchase silkworm eggs, or "grain." At that time the silk-growing industries of the south of Europe were suffering greatly from the diseased state of the "grain," and a tremendous impetus was thus given to the importation from Japan of healthy grain, to supply the silk growers of Italy and France.

The Frenchman had made several enterprising journeys to various countries in search of healthy grain, and in the course of his wanderings he had visited some parts of Australia, and he expressed a very strong opinion that the cultivation of the mulberry and the growing of silk ought to do very well there. The experiment had certainly been tried in several parts of Australia long before I determined to take it up, but it had not been worked out to the point of making it become a national industry; and it was this latter view which the suggestions of my French *compagnon de voyage* led me to attempt. All the world knew that Japan had developed an enormous and most profitable trade in the export of silkworm eggs to Europe, and I could not see why the British colonies should not do the same. I subsequently started a plantation of mulberry trees on my own property on the Murray River in New South Wales, and in course of time a number of ladies in Melbourne and other parts of Victoria, encouraged by my success, formed the "Victorian Ladies' Sericicultural Company, Limited." In connection with this company I made a journey to the silk growing districts of southern Europe, and through my instrumentality the famous race of silkworms cultivated by M. Roland, of Orbe, was introduced into Australia. It is unnecessary for my present purpose to detail the method adopted by M. Roland in his celebrated magnanerie; suffice it to say that the effect of his system has resulted, for many years past, in the production of a race of silkworms which has remained healthy while the breeds of other silk growers in the south of Europe have for years suffered terribly from the disease to which the silkworm is liable. Thus we have been fortunate, in Australia, to secure the introduction of the best known system of treating the silkworm, so as to get a healthy and vigorous race, and this may fairly be credited to me as a valuable commercial result.

The best kinds of mulberry trees have been introduced into Australia in larger quantities than formerly was the case, and the planting of the trees has, through the agency of our company, been widely spread throughout the colonies to which I refer.

We have established a silk farm and plantation at Mount Alexander, about 70 miles from Melbourne, and have obtained a Government grant of 1,000 acres of land there for this purpose. We have also opened up in Italy an assured market for as many cocoons and silkworm eggs as our means may enable us to grow, and among the results already achieved in this movement I look upon the Italian market as a very great step indeed, because it is the evidence of local prejudices against our produce having been overcome in Italy, and of the good opinion of acute and critical judges in that country having been secured. I have already published in the *Journal of the Society of Arts* the certificates from Italian experts which substantiate these remarks, and I have the original certificates in my possession, which thus conclusively prove that the quality of the Australian cocoons and "grain" is so high as to justify us in trying to extend the industry which produces them. Good business prospects are thus open to us in Italy—the largest silk market in the world—but we want capital to enable us to take full advantage of such an opening. With regard to the Italian market for Australian grain, I may mention that offers have been made for colonial grain at from 20 to 30 francs per ounce; whereas good Japanese grain (if, indeed, it can now be obtained sound at all) only fetches 15 to 25 francs per ounce. Now, as our colonial grain is sound, I have thus shown a good practical reason for cultivating the Italian market for this article. But I do not propose to begin with an export trade in grain; it will be sufficient to begin by developing our export of cocoons to Italy, where the trained labour of that country will prepare the silk for our English buyers. I have always thought, and I am still strongly of opinion, that in course of time our own women and girls, and particularly those of the educated classes, will be able to undertake even the reeling and other processes of the silk business, which for centuries have been a speciality in Italy and the South of France; but, although I should like to see this attempted at once in England on a large scale, I do not here propose it. We must be content to let the thing grow.

But it is not only in Italy that our Australian silk produce has earned high commendation. Various articles of clothing, stuff, and woven fabrics have been made for experimental purposes here in England. Samples of some of these goods are now shown to you on the table before me; and I take this opportunity to ask our noble Chairman to accept, as a specimen of our work, a pair of socks, made by gentlewomen who are working with me, out of silk "refuse" from the sunny land of Victoria.

Some of the manufactured goods of which I now exhibit samples have been kindly worked up from our silk by Messrs. Brocklehurst, and Messrs. Potts, Wright, and Co., of Macclesfield, and I take this opportunity of acknowledging the deep gratitude of myself and my lady-coadjutors for the assistance we have received from these gentlemen. I think I may say that the specimens of Australian silk which I have submitted to Macclesfield houses of business have been highly commended; but, as I am told by hard-headed masculine friends that I must not state anything without proof, I will read the following letter to myself from Messrs. Potts, Wright, and Co.:—

"Macclesfield, February 11, 1876.

"We have the pleasure to forward, by this post, half a dozen scarves made from the silk you left here for that purpose. The silk worked in the most satisfactory manner. The short reel wound the best, but both were good, and we silk consumers should be glad to see tons of it imported into the old country."

I may also mention, and I do so with much pleasure, that the Chamber of Commerce at Macclesfield gave me much encouragement on the occasion of my recent visit to that place; and I have since then been informed that that chamber is about to issue a recommendation to all the chambers of commerce in Australia, setting forth the desirability of encouraging the further plantation of mulberry trees in that country, with the view to the better development of silk production. I also saw how much farmers would benefit if they could supplement their returns through the labour of their wives and children, who have plenty of spare time on their hands in Australia. When I am asked for results from my recent exertions in England, I think it will be almost in itself sufficient to point to this proof of the estimation in which our present movement is held by the accredited representatives of the silk trade of Macclesfield, and I hope it will be influentially taken up.

I think I have said enough to show that this business has in it the making of a solid thing. Thus far, what has been done has been effected with much struggling and difficulty by a handful of women, and with very insufficient means. We believe that it must be carried through on a large scale, and we want the assistance of practical men and money. We want, above all, to largely increase our mulberry plantations in Australia, and we are open to enter into any reasonable undertaking to indemnify those who may advance the capital required for the purpose. So far as I am able to understand matters of this nature, the most feasible scheme appears to be to raise a company here, with, say, 50,000 shares of £1 each, the price of the shares being intentionally kept as small as possible to enable women to join in the enterprise, because we always keep prominently in view the fact that the rearing of silk-worms, even on a large commercial scale, is eminently a woman's work, without reckoning the various collateral industries which we hope may eventually grow out of it, in working up the refuse silk in various forms. The leaf season lasts in many parts nearly ten months, in others eight and nine months. Numerous educations can be made annually, which will largely increase the profits. The limits of the time allowed to me here will, I fear, prevent me from going into the details of the commercial aspect of such a company as I propose, but I have with me, in writing, a calculation based upon experience of the cost of silk culture in Australia, and of the estimated labour profits. The very important question of labour remains only to be mentioned, and it may, perhaps, surprise you all to hear that an education of 12 ounces of grain (eggs) with the rapid Cavalloni system, can be made at considerably less cost in Australia than in Italy, and I say this from practical experience, having resided on a large estate near Verona last season, where I studied the cost of every thing connected with silk growing. I could not have had a better master than Signor Ferrari, upon whose estates silk is so largely cultivated; his reputation for what is considered very high farming indeed, is widespread, his vineyards being perfect pictures of beauty. Numbers came to inspect this really show property, and most grateful am I to Signor Ferrari for having enabled me to master all the details, by which, I trust, still further to increase the silk fever which is now raging in all the Colonies, including New Zealand, where there is a gentleman I hear who has silk on the brain nearly as much as I have.

I shall be happy to go into these matters with any ladies or gentlemen who wish to join in the work before us, and the secretary, Mr. Le Neve Foster, will, no doubt, with his usual kindness, receive the names of any intending supporters. I will now only detain you by expressing a hope that I have succeeded in laying before you a general sketch of what we want to do, of what we have already done, and of how we propose to carry the work through to a practical and successful termination.

An Australian silk growers' depôt has been started at 7, Charles-street, Grosvenor-square. This depôt will be a boon to small silk growers, who will thus be able to dispose of their produce to the best possible advantage. Useful articles, such as socks, stockings, &c., made by gentlewomen, will be sold, and ladies are invited to visit the depôt, where also they can obtain full particulars of the Victorian Ladies' Association.

DISCUSSION.

Sir Antonio Brady had the greatest pleasure in bearing testimony to the indomitable energy and zeal of Mrs. Neill. It was a holy cause she had taken up, and he was delighted to hear that she was going to admit the "lords of creation" to some little share in it, because, until she could put this question on a commercial basis, she would not accomplish the ends she had in view. He believed skilled labour could be better obtained from educated ladies than from Italian or any other peasantry in the world, and therefore he had great faith in the undertaking, if conducted on commercial principles. A few days ago Mrs. Neill gave him some worms which had been prematurely hatched, and he was happy to say that, having fed them in an orchid house on the leaves of the *Morus alba*, of which he had saved a few in pots a few years ago, they were thriving wonderfully well, and he should soon be able to return them at full growth. In a box on the table there were some wonderful cocoons, which were exhibited in the Paris exhibition, when, as far as he could judge, the people of Lyons were very envious of them, for they certainly had nothing which could compare with them. He had to thank Mrs. Neill for the testimony she had borne to the efforts of his brother during the last twenty years to promote the silk culture in Australia; though he had not met with the commercial success which was to be expected for a new industry, because people did not yet believe in it, but he had the finest race of silkworms in the world, having obtained worms from all parts of Europe and Asia, some of which were sent him through the kindness of Mr. Cobb. Mrs. Neill had also given a just tribute of praise to M. Roland, who was a philosopher who had gone back to nature for nature's laws. The silkworms had been deteriorated by being bred in close hovels, and by interbreeding over and over again until they got diseased. M. Roland had not attempted to cure the disease, but to prevent it; he fed the worms in the open air, let them spin in the trees, and left the eggs exposed to the winter snows of the Alps, so that only the strong and healthy ones survived. He bred from them by selection, following Mr. Darwin's theory, and the result had been a most magnificent race; and it was from some of these eggs that Mrs. Neill had obtained such great success. If half a dozen gentlemen would only put themselves in communication with Mrs. Neill, and assist her in getting up

a company with limited liability, there would not be any difficulty in raising the capital, for she would soon get the support her well directed efforts deserved. He had had the pleasure of introducing Mrs. Neill to the Peninsular and Oriental Company, whose liberality she had borne testimony to, and who had placed their ice wells at his disposal also for sending out eggs, and had done all they could to assist the enterprise, in the interest as well of the colonies and of the mother country as of their own trade. He would only add that he should be happy to afford any information in his power to any gentleman desirous of obtaining it, and he had been in correspondence with some of the best authorities on this subject for many years.

Mr. H. W. Freeland said they were all deeply indebted to Mrs. Neill for a very interesting paper, and must all sympathise with her in the desire which she had so eloquently expressed to be able to solve one of the great problems of the day, the means of procuring honourable and profitable employment for women who were somewhat above the degree of servitude. They must also sympathise with her efforts to improve the production of healthy grain and the quality of the cocoons; but it was only in a regular commercial way that any efforts of this kind could ever be conducted so as to be permanently successful. On the present occasion he did not wish to be the prophet of evil, and would only say, as he had said when presiding over a similar meeting at Brighton, that no doubt plenty of ladies and gentlemen would be found willing to help, but he hoped no one to whom the money they might put down was an object of importance would be induced to enter into the undertaking so long as it remained in its purely experimental stage. It was, no doubt, possible, either here or in Australia, to expedite the processes of nature by the production of grain or cocoons under glass, and you might manufacture stockings worthy to be worn by the noble Chairman, but the question was whether you could do so at a cost which would ensure a commercial result. He had relatives who had produced a certain quantity of healthy grain, and no doubt it could be done all over the country, and would form a nice recreation for young people, and it might be consigned to Mrs. Neill, and then exported to Australia or other countries where the regeneration of the silkworm was a matter of pressing necessity. He thought the proposed company also was well worthy the attention of those who could spare a few pounds for the purpose, and he should be very glad to assist. He understood the present Lord Lyttleton had supplied mulberry leaves for some experiments, and he had with him a letter from the late Lord Lyttleton, which he received from him some years ago, in answer to some inquiries directed to this very question, which he would read:—

"Feb. 6th, 1870, 12, Grosvenor-square.

"Sir,—In reply to your letter, I beg to state that my experiment could not fairly be said to fail, though I dropped it.

"I began it in about 1848 (if I remember rightly) to amuse my daughter.

"I imported the plants from a celebrated firm in Provence, and also from nursery grounds in Piedmont; but I cannot remember the names of the suppliers, and have no paper here to refer to. No doubt the white mulberry was amongst the plants in large proportions, but the plants selected for me by an experienced cultivator, now dead, were of various kinds. I forget their denominations. The eggs were sent to me in tin boxes, partly from Provence, partly from Piedmont. The silkworms came out and prospered: very few died. The diseased ones were carefully thrown away. For about six weeks they were kept on ledges, in a warm room, heated and watched night and day. Not being able to sell the cocoons as they do in France, I had to make the silk. I bought a machine, and had a special person, a foreigner, to reel the silk. A small portion of it I sent to the late Mr. Radcliffe, a silk merchant, of Coventry. His report was that it was cleaner and finer than any he got from abroad, and he would buy any amount I could raise. I then had thoughts of making the experiment on a large scale (hitherto I had planted about an acre with some slips), but at that time I lost my daughter.

"The experiment, being associated with her, became painful to me and ended. I had no one in my village who took sufficient interest in it to make its success probable. I thought of it no more. My impression of it is that it could only pay if undertaken on a large scale, several acres planted, the superintendence of some female who would take great pleasure in it, and experienced aids in watching and reeling, who for the first year should be hired from abroad.

"The expense of the process otherwise is not great, children for six weeks bringing the mulberry leaves. Care must be taken in selecting plants that come out in early succession, and a few glass frames for potting in case the worms precede the leaf. A calculation was given to me by which the gross product was estimated at forty-five pounds an acre. I should think this greatly above the mark in England, unless in the warmest parts, but I should be inclined to think that after the first three years there might be an average net return of fifteen pounds per acre, which would rapidly increase.

"The first three years there would be a great deal of cost in buying plants, in hiring foreigners, &c. After that time our own villagers would have the work. I think it cost me about £115 to buy the plants for an acre, but no doubt they might be bought cheaper.

"I should observe that a few years ago I transplanted some of the trees, and in that process they all died. Those I have left on the old ground, which has a south aspect and a good loam soil, appear still flourishing.

"Yours obediently,

"(Signed) "Lyttleton."

He believed these were the plants which the present Lord Lyttleton had handed over to Mrs. Neill for the experiments, which he earnestly hoped would succeed. All these things involved some outlay in the beginning, but the sum asked was so small, that in a rich country like England it could easily be raised, even if only for a philanthropic experiment. The effort to find useful employment for women, would in this country never want sympathy, and he believed would never ask in vain for support.

Mr. W. C. Brocklehurst (M.P. for Macclesfield) would like to make a few remarks on this question from a practical point of view, being largely engaged in the silk manufacture. He should be happy at any time to carry out any suggestions made by Mrs. Neill. It was well known that the silk manufacture was introduced into this country by Protestant refugees from France, who settled in Spitalfields, and afterwards spread to Macclesfield, Congleton, Derby, Manchester, and other places. Up to 1860 the trade was very flourishing, but then, in consequence of Mr. Cobden's French treaty, the protective duties were abolished, smuggled silks were no longer in fashion, and what was of more consequence, the trade became much depressed, though he must confess at the same time that the treaty was very beneficial to the country at large. About the same time, however, there appeared that mysterious silkworm disease of which no one know the nature, and for which there was no remedy. The effect was to diminish the supply of silk, and therefore the silk trade in England had not been so flourishing as it was prior to 1860; though according to the census of 1861 there were still more than 100,000 persons directly engaged in it. With the energy of the manufacturers and the patient industry of the workpeople the damage done by the abolition of the duty had been partially overcome, but they had still to contend with the disease

over which they seemed to have no power, It was therefore very encouraging to him, as a manufacturer, to hear that there was in Australia a means of overcoming this evil, as silk could be produced there at a low cost and of superior quality. He had tested practically the specimens brought forward by Mrs. Neill, and had seen letters from different people connected with the trade, in which they said that this silk was as good as, if not better than, the best silk produced in Europe in its most palmy days. He found on referring to the Blue Books, that in 1861 the import of silk was 8,710,000 lbs., of which 4,096,000 lbs. were re-exported, leaving 4,600,000 lbs. for home consumption, whilst in 1874 the import had fallen to 5,911,000 lbs., of which 2,741,000 lbs. were re-exported, leaving only 3,170,000 lbs. for home consumption. Of course, it became a serious question how this falling off was to be remedied, and he could only say that the best method seemed to be by encouraging in every possible way the production in Australia. He did not say the cocoons produced could be brought here to be reeled, because probably the cost of labour would be too high, but they might be sent to France and Italy for that purpose, and afterwards manufactured in England. Another important point was the deterioration in the quality. The reelers in India, China, and Japan had taken advantage of the scarcity, and had endeavoured to produce quantity rather than quality, so that at the present moment there was no good silk to be had, but only bad European and worse Asiatic, the consequence of which was that ladies complained that silk dresses did not wear nearly so well as they used to; they turned to other fabrics, and silk to a great extent had gone out of fashion. If they could get good silk from Australia, it would be the means of bringing the trade back again, and they would again see ladies walking in silk attire, in which he thought they looked better than in anything else. Owing to this deterioration also there had been malpractices introduced into the manufacture and dyeing of silk, and a lady's dress would consist of one-fourth its weight of silk and three-fourths of something else, which in the course of a few weeks' wear caused it to come to pieces. The next question was, how were they to get this Australian silk; and though he had listened with great interest to Mrs. Neill's remarks, he had not heard any very practical suggestions on this head. However, he thought if that lady would condescend to accept the aid of three or four practical men, it might easily be accomplished. A company might be formed in this country connected with the Governments in the colonies, and the cocoons and seed might be sent to Italy, to France, and even to Broussa in Asia, where it might be reeled, and the "dead bodies," which were in reality the refuse, might very well be brought here and worked up profitably by those ladies of whom Mrs. Neill had spoken so feelingly. The idea was that a company should be formed with a capital of £50,000, of which one fourth should be called up, and this would be amply sufficient for the experiment. Mr. Clayton, the manager of the Government silk farm in Western Australia, wrote to say that the Government had placed in his hand sufficient funds to carry on the operations, and that the Colonial Secretary, the Hon. Mr. Barlee, had promised a reward of £500 to the person who produced the first bale of silk in that colony. He could not but be struck with the fact that Western Australia should be so far ahead of Victoria in this matter, seeing that the latter colony had imports from this country of £16,953,000, and exports £15,441,000, whilst the imports and exports of the former were only £367,408, and £398,000 respectively, and the population was only 24,000, against 731,000 in Victoria. He believed the time would come when these colonies would find it to their interest to produce silk as much as to devote themselves to the production of wool, which was now such an important article of export.

Lord Alfred Churchill believed the day was not far distant when there would be hundreds of thousands of spindles in England spinning Australian silk, and they would then look back to the present evening as one of the greatest importance, and of the most happy augury for the trade of this country; but in order to do this, the commercial element must be separated from the philanthropic. He entirely agreed with all Mrs. Neill had said as to the desirability of aiding the ladies of this country, but that was a separate question, and must not be looked upon as the reason for supporting silk culture in Australia. The way to promote this culture commercially would be for those engaged in it to grow as much as they could and send it over, when it would, no doubt, be purchased at its full value; and when it was known that so much per acre could be realised by it, silk culture would thrive as that of wool had done. It was not more than a generation since sheep were introduced into Australia; the country was found suitable for them, and now 50 millions of lbs. of wool were exported annually. He believed Australia was peculiarly adapted for producing silk, though it was twenty years since he was there, but he had always thought that if the proper food for the silkworms could be introduced, the thing would be accomplished. There were several kinds of mulberry, but one was specially adapted to the silkworm, and rapidly brought them to maturity. And not only so, but the worms came to maturity at the same time the leaf was fit for consumption. The reason why silk culture did not succeed in England was, that the worms came to maturity before the leaf, but in Australia, on the contrary, they were both ready at the same time, and this ensured the success they desired. He begged to conclude by proposing a cordial vote of thanks to Mrs. Neill.

The Chairman, after complimenting Mrs. Neill on her eloquent address, said he had been lately in correspondence with Mr. Wilson, proprietor of the *Melbourne Argus*, on the subject of Australian wine, which that gentleman prophesied would before long become of as great importance as wool. Now, Mrs. Neill had remarked that where the vine flourished the mulberry would also, and, therefore, he saw no reason why the silk culture should not succeed, if conducted with energy and zeal, aided by such practical commercial experience as gentlemen like Mr. Brocklehurst could give. That gentleman had referred to the deteriorated quality of silk in the present day, and he might mention that he lately saw, at Hardwick-hall, in Derbyshire, a satin cloak which looked perfectly new, but which he was assured was worn by Bess of Hardwick, who built Hardwick-hall, for the reception of Queen Elizabeth. If there were any truth in that tradition, the material must have been of a far more durable quality than any that was made now. With regard to the proposed company, he rather doubted the policy of calling up only 5s. per share on £1 shares, leaving a liability of three times the amount paid; but that was a detail which might be reconsidered. It seemed very desirable that such a company should be formed, and he should be very willing, if Mr. Brocklehurst would give the company the benefit of his business experience, to join it, if his doing so would at all tend to its success. Mrs. Neill had mentioned her office, but had not stated where it was, which perhaps she would do in replying.

The vote of thanks having been passed unanimously,

Mrs. Neill, in responding, said it was almost impossible for her, after six years of labour in this cause, to believe she had really succeeded at last. Even in Australia she had found it very difficult to make people believe in the silkworm, but she had persevered, and though often voted a bore she had made many friends. She had been much indebted to the Peninsular and Oriental Company, to Sir Antonio Brady, and others for assistance in carrying out her enterprise. She was glad to know also the mulberry was being cultivated at the Cape, and at Natal, with the governor of which colony, Sir Henry

Bulwer, she had lately had the good fortune to travel. Signor Ferrari also had been most kind in his assistance. She felt rewarded now for her exertions, and could not express the gratitude she felt for having been permitted to express the opinions she had on this great question. She had always felt that if she ever had an opportunity of speaking in England she would be supported by the generous and warm-hearted. She had always loved this country except for its climate, and she only wished Englishmen could have a little of the bright sun of Australia, and thought those who felt sick and weary would be all the better for a trip to that colony. The office of the society was at 7, Charles-street, Grosvenor-square, where she had herself reeled some skeins of silk which would soon be made into ribbon at Coventry. She hoped indeed, that ladies would be able to undertake the reeling, for it presented no insuperable difficulties.

HEALTH AND SEWAGE OF TOWNS.

TABLE SHOWING THE SYSTEM OF SEWAGE TREATMENT, FROM RETURNS FURNISHED UP TO THE 28TH APRIL, 1875, FOR THE INFORMATION OF THE CONFERENCE ON THE 9TH MAY.

Names.	Population	Mortality per 1,000, 1875.	Dry System.	Water-carried System.
Aberdeen	88,189	22·5	Ash-pit and dry ash-closet	Irrigation, or drained direct into rivers Don and Dee.
Abergavenny	4,803	25·6	Not any	Filtration.
Aberystwith	6,920	23·2	Midden	Drained into the harbour.
Abingdon	5,809	..	....	Drained into river Thames.
Arundel	2,956	14	Midden to small extent	Drained direct into tidal river Arun; cesspools.
Ashton-under-Lyne	33,417	33·7	Ash-pit and pail	Drained direct into river Tame.
Bacup	18,500	24	Ash-pit; pail system on trial	Filtration.
Baldock	2,030	22·6	Midden to small extent	Filtration.
Banbury	11,718	19·66	Not any	Irrigation.
Barnsley	23,020	26·88	Midden and ash-closet	Drained direct into river Dearn.
Bath	52,542	24·9	Earth-closet in rural district	Drained direct into river Avon.
Berwick-upon-Tweed	13,198	23·5	Midden to small extent	Drained direct into river Tweed.
Bewdley	3,017	19	....	....
Bilston	25,000	22·6	Midden	Drained direct into river.
Birmingham	343,787	26·34	Midden, pail, and ash-tub	Lime precipitation.
Blackburn	78,600	26	Pail to a large extent	Subsidence and irrigation.
Bodmin	4,672	..	Midden	Irrigation.
Bolton	82,854	26	Midden and ash-pit	Precipitation.
Boston	15,576	22	Ash-closet to small extent	Drained direct into tidal haven.
Bowness	1,450	17	Not any	Filtration.
Bridport	7,666	17·07	Midden	Drained direct into two small streams; cesspools.
Bristol	182,524	29·7	Not any	Drained direct into tidal river Avon.
Burnley	40,858	28	Pail, modified midden, and earthenware tank	Drained direct into river Pendle.
Burton-on-Trent	24,874	23·15	Midden and ash-pit	Lime precipitation.
Cambridge	30,078	13	Midden and ash-pit, earth closet.	Drained direct into river Cam and cesspools.
Canterbury	20,962	24·4	Not any	Precipitation and filtration.
Cardiff	73,000	21·26	Midden and ash-pit	Drained direct into Bristol Channel.
Carlisle	31,049	29·2	Midden	Drained direct into river Eden.
Carmarthen	10,488	23·1	Midden to small extent	Drained direct into tidal river Towy.
Carnarvon	9,788	32·79	Not any	Drained direct into Menai Straits.
Chelmsford	9,318	21·64	Not any	Irrigation.
Cheltenham	41,923	19·5	Not any	Subsidence.
Chester	35,257	23·45	Midden	Lime precipitation.
Chichester	8,500	20·7	Midden	Cesspools.
Cleethorpes	2,200	15·45	Pail	Filtration.
Clitheroe	8,208	26	Midden	Not any.
Colchester	28,000	18·75	Midden	Drained direct into river Colne.
Cottingham	5,000	16	Midden	Subsidence.
Coventry	37,670	21·4	Midden to small extent	Filtration and Precipitation.
Crewe	20.000	20·7	Midden	Irrigation.
Croydon	63,000	21·71	....	Irrigation and filtration.
Dartmouth	5,338	20	Midden	Drained direct into the harbour.
Derby	49,795	27	Midden and tub-closet	Drained direct into river Derwent.
Devizes	6,840	22·9	Midden to very small extent	Irrigation.
Doncaster	18,758	22·5	Ash pit	Irrigation.

Names.	Population	Mortality per 1,000 1875.	Dry System.	Water-carried System.
Droitwich	3,538	17·4	Not any	Drained direct into canal or river; dead wells.
Dudley	43,782	25·2	Ash-pit	Catch-pits, and drained direct into rivers Stour and Tarne.
Durham	14,460	22	Midden to a great extent	Drained direct into river Wear.
East Stonehouse	14,585	28·37	Not any	Drained direct into sea.
Epsom	6,276	17·8	Not any	Subsidence and irrigation; cesspools.
Eton	3,500	..	Not any	Irrigation.
Flint	4,269	21	Midden to small extent	Drained direct into estuary of river Dee.
Folkestone	12,694	19	Not any	Drained direct into the sea.
Glasgow	491,846	28·59	Midden, pail-closet, and ash-pit	Drained direct into river Clyde.
Gravesend	21,265	21·39	Not any	Cesspools.
Great Malvern	5,693	9·03	Not any	Irrigation.
Great Yarmouth	41,819	23·02	Midden to large extent	Drained direct into tidal river Yare.
Hanley	39,976	25	Midden and pail	Drained direct into river Trent.
Hanwell Asylum	2,000	..	Not any	Filtration and irrigation.
Harborne	5,105	21	Midden	Filtration; lime precipitation.
Harrogate	6,655	21·6	Midden to small extent	Irrigation.
Hastings	33,000	17	Not any	Drained direct into the sea.
Hereford	18,000	21	Not any	Drained direct into river Wye.
Hertford	7,169	22·7	Not any	Precipitation and filtration.
Hexham	5,331	34·75	Midden, ash-pit	Filtration and precipitation.
Honiton	3,464	25·6	Midden, ash-pit	Drained direct into river Otter.
Hoole	1,720	..	Midden	Irrigation.
Horsham	5,300	22	Midden	....
Ipswich	42,839	22·7	Midden, pail-closet	Drained direct into river Orwell.
Jarrow	18,115	24·1	Midden	Drained direct into river Tyne.
Kendal	13,455	20	Midden	Irrigation and downward intermittant filtration.
Kidderminster	19,463	21·5	Ash-pit	Irrigation.
King's Lynn	17,163	21·8	Ash-closet	Drained direct into river Ouse, and cesspools.
Kingston-upon-Hull	137,000	27·33	Midden	Drained direct into estuary of Humber.
Leamington	20,917	18·9	Ash-pit	Irrigation.
Leeds	291,000	26·4	Midden and pail	Precipitation.
Leicester	95,084	26·02	Midden, ash-pit, and pail	Precipitation by lime.
Lincoln	26,766	22	Midden	Drained direct into river Witham.
Litchurch	11,087	..	Midden	Filtration.
Liverpool	493,405	27·5	Midden and ash-pit	Drained direct into river Mersey.
Longton	19,747	31·5	....	....
Louth	10,500	21·24	Ash-closet	Drained direct into river Lud.
Macclesfield	35,571	26	Ash pit	Drained direct into river Bollin.
Maldon	5,297	20	Not any	Drained direct into river Blackwater and cesspools.
Malvern Link	2,000	11·5	Midden	Irrigation.
Manchester	351,189	28·4	Pail and ash-pit	Drained direct into river Irwell.
Margate	11,956	..	Not any	Cesspools.
Marlborough	3,660	..	....	Drained direct into river Kennet; cesspools.
Merthyr Tydfil	51,891	21	Not any	Irrigation.
Newark	12,187	26·6	Midden	Drained direct into river Trent.
Newport (Mon.)	29,018	22	Not any	Drained direct into river Usk.
Northampton	41,270	..	Not any	Irrigation.
Norwich	80,382	23	Midden to small extent	Drained direct into river Hensom, and irrigation.
Nottingham	86,262	27·8	Midden, ash-pit, and tub-closet	Drained direct into river Trent.
Oldham	88,609	30	Ash-pit and pan	Drained direct into rivers Irk, Medlock, and Beale.
Ormskirk	6,127	30	Midden	Irrigation.
Oswestry	7,308	20	Midden to very small extent	Filtration.
Oxford	32,477	22	Midden	Drained direct into rivers Thames and Cherwell.
Pembroke (urban district)	13,704	24·4	Midden and ash-pit	Cesspools.
Penryn	3,636	30·2	Midden	....
Penzance	10,414	21	Not any	Drained direct into sea.
Peterborough	18,000	19·38	Midden to small extent	Drained direct into river Nen.
Plymouth	71,667	..	Not any	Drained direct into sea.
Portsmouth	113,569	19·5	Midden	Drained direct into sea.
Reigate	15,916	15·1	Not any	Irrigation.
Rochdale	67.590	24·10	Midden, ash-pit, and pail	Drained direct into river Roche.
Rochester	18,552	19·72	....	....

Names.	Population	Mortality per 1,000, 1875.	Dry System.	Water-carried System.
Ryde	11,234	14	Not any	Drained direct into sea.
Saffron Walden	5,717	20·6	Ash-closet, midden	Filtration and subsidence; cesspools.
Salford	124,805	31·78	Midden and pail	Drained direct into river Irwell.
Salisbury	12,903	24·3	Not any	Drained direct into river Avon.
Sandown, I. of Wight	2,350	16	Not any	Precipitation and deodorisation.
Sandwich	3,050	..	Midden and pail	Cesspools.
Shrewsbury	23,300	20·8	Midden	Drained direct into river Severn; cesspools.
Southwold	2,155	12·06	Not any	Dead wells.
South Shields	45,336	24·8	Midden, ash-pit	Drained direct into river Tyne.
Stalybridge	21,092	25·3	Midden	Drained direct into river Tame.
Stoke-upon-Trent	16,000	19·09	Midden	Irrigation.
Stroud	7,082	23	A few ash pits	Filtration and precipitation.
Sudbury	6,900	18·9	Goux	Drained direct into river Stour; cesspools.
Sunderland	103,000	22·4	Ash-pit	Drained direct into sea and tidal river Wear.
Swinton & Pendlebury	18,000	17·7	Ash-pit to a large extent	Filtration and irrigation.
Tenterden	3,669	26·71	Midden; a few earth-closets	Cesspools.
Tewkesbury	5,409	24	Not any	Filtration.
Totnes	4,073	..	Midden	Drained direct into river Dart.
Tottenham	23,500	..	Not any	Precipitation.
Truro	10,899	..	Midden	Drained direct into the sea.
Tunbridge Wells	19,410	16	Not any	Irrigation.
Tynemouth	38,960	22·64	Midden to a large extent	Drained direct into estuary of Tyne.
Uxbridge	7,497	21·4	Not any	Filtration.
Wallingford	2,972	18	....	....
Walton-on-the-Hill	4,391	16	Midden and dry earth	Precipitation and irrigation.
Warwick	11,001	19·1	....	Irrigation.
Watford	7,461	20	Not any	Precipitation, filtration, and irrigation.
Wellingborough	9,385	16·4	A few earth-closets	Filtration.
Welshpool	7,318	22	Not any	Drained direct into river Severn.
Wigan	42,000	32·1	Midden	Drained direct into river Douglas.
Winchester	17,003	19·51	Midden and earth-closet	Drained direct into river Itchin; cesspools.
Windermere	909	19	Midden	Subsidence.
Wisbech	9,362	23·71	Midden	Cesspools.
Woking Prison	1,750	..	Earth-closet	Precipitation and irrigation.
Wolverhampton	68,279	25·2	Midden, ash-pit, and pail	Irrigation and downward filtration.
Worcester	33,226	25·58	Midden; earth-closet	Drained direct into river Severn.
Worksop	10,410	..	Ash pit	Subsidence and filtration.
Wrexham	8,537	25·6	Midden	Irrigation; cesspools.
York	43,796	23	Midden and ash-pit	Drained direct into river Foss.

THAMES WATER FOR DRINKING.

In the House of Commons on Monday, **Sir C. Dilke** asked the Secretary of State for the Home Department whether, during the present Session of Parliament, any measure would be introduced which would prevent towns from pouring their sewage into the Thames above the point at which the supply of water to London for drinking purposes was drawn.

Mr. Sclater-Booth said—There is no intention of bringing in any Bill having the special object indicated in the question, but a Pollution of Rivers Bill is in preparation, as the hon. baronet and the House are already aware. The Thames Conservancy Act, passed some years ago, provides for the purification of that river, so far as sewage is concerned, by the agency of the Conservators, whose jurisdiction extends up to Cricklade. They have exercised their powers and put pressure on the authorities with useful though necessarily with slow results, and the Local Government Board have sanctioned the expenditure of large sums of money for the construction of works having for their object the purification of the river. Out of 12 or 15 towns between Cricklade and Hampton, the following of the more important cases may be specified:—At Oxford, upwards of £100,000 is being expended; at Abingdon, £20,000; at Reading, £150,000 at Eton, £25,000; at Windsor, £30,000. Most of the works in these instances are in a forward state,—some, I believe, completed or approaching completion.

OBITUARY.

Lord Lyttelton's death took place on Thursday, the 20th inst. He was born March 31, 1817, and was educated at Eton, and afterwards entered Trinity College, Cambridge, where he was Chancellor's Medallist and Senior Classic in 1838, when he was bracketed with Dr. Vaughan (Master of the Temple, and late Head Master of Harrow), and was made LL.D. in 1862. His great attainments, especially as a Greek scholar, are well known. He was Under-Secretary of State for the Colonies from February to July, 1846, having previously unsuccessfully contested the election of High Steward of Cambridge University in 1840. His Lordship was appointed Principal of Queen's College, Birmingham, in 1845. Among other distinctions for his learned acquirements, he was made an Hon. D.C.L. at Oxford in 1870. The late Lord was created a Privy Councillor in 1869, and the same year was made a Knight Commander of the Order of St. Michael and St. George. He had been a Fellow of the Royal Society

since 1840, and was a Fellow of Eton College, and one of the governing body, and Lord Lieutenant and Custos Rotulorum of the county of Worcester. The latest official appointment his Lordship held was that of Chief Commissioner of the Endowed Schools, an office he relinquished the year before last, on that Commission being amalgamated with the Charity Commission. The late Lord Lyttelton was High Steward of Bewdley, and succeeded his father in the barony in April, 1837. He was an officer in the Worcestershire Yeomanry Cavalry. Lord Lyttelton became a member of the Society in 1860, and on several occasions presided at meetings of the Society, as well as, on one occasion, at its Educational Conference.

NOTICES.

SUBSCRIPTIONS.

The Lady-day subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

May 3.—"The Preparation of China Clay," by J. H. Collins, Esq., F.G.S.

May 10.—"A New Method of Propulsion for Street Trams," by E. H. Leveaux, Esq. E. Chadwick, Esq., C.B., will preside.

May 17.—"Railway Safety Appliances," by F. J. Bramwell, Esq., C.E., F.R.S.

May 24.—*The same continued.*

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

May 9.—"The Commerce of the Gaboon," by R. B. N. Walker, Esq.

May (*date not yet fixed*).—"The Development of Central Africa," by Edward Hutchinson, Esq., Lay-Secretary of the Church Missionary Society.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

May 5.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

May 26.—"Thaumatodendra, or the Wonders of Trees in India," by William Tayler, Esq., late Commissioner of Patna.

Chemical Section.

Friday evenings at 8 o'clock. The following arrangements have been made:—

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne.

Cantor Lectures.

Monday evenings at 8 o'clock. Third Course, "On Wool Dyeing," by George Jarmain, Esq.

Lecture VI.—May 1st.

Aniline and other allied colours, and their application to the dyeing of wool and woollen and mixed fabrics.—Concluding remarks.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Cantor Lectures.) Mr. George Jarmain, "Wool Dyeing." (Lecture VI.)
Farmers' Club, Salisbury-square, E.C., 5½ p.m. Mr. J. K. Fowler, "The Administration of the Poor-law, especially in reference to Out-door Relief."
Royal Institution, Albemarle-street, W., 2 p.m. Annual Meeting.
Society of Engineers, 6, Westminster-chambers, 7½ p.m. 1. Mr. A. H. C. Trewman, "Flues and Ventilation." 2. Mr. J. W. Pearse, "The Ventilation of Buildings."
Royal United Service Institution, Whitehall-yard, 3 p.m. Rev. E. L. Berthon, "Collapsing Boats for Saving Life at Sea, also for Naval and Military Purposes."
British Architects, 9, Conduit-street, W., 8 p.m. Annual Meeting.
Victoria Institute, 8, Adelphi-terrace, W.C., 8 p.m. Professor Challis, "Metaphysics of Scripture."
Social Science Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. Clair J. Grece, "On the Wasteful Expenditure of Legislative effort upon an adhesion to the ancient effects of Prorogation."

Tues. ...Royal Institution, Albemarle-street, W., 3 p.m. Professor P. M. Duncan, "The Comparative Geology and former Physical Geographies of India, Australia, and South Africa." (Lecture II.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on "The River Mersey." 2. Mr. W. H. Wheeler, "Fascine Works at the Outfalls of the Fen Rivers."
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.
Biblical Archæology, 9, Conduit-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 1 p.m. 1. Mr. George Busk, "On the Palæontology of the Fossiliferous Caves of Gibraltar." 2. Prof. Garrod, "On the Internal Anatomy of the Colies" (*Colius*).

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. Mr. J. H. Collins, "Preparation of China Clay."
Microscopical, King's College, W.C., 8 p.m. Dr. J. J. Woodward, "On the Markings of the Body-scale of the English Gnat and the American Mosquito."
Archæological Association, 32, Sackville-street, W., 4½ p.m. Annual Meeting.
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.
Entomological, 11, Chandos-street, W., 7 p.m.

Thurs...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Dr. Cobbold, "Trematoda of Gangetic Dolphins." 2. Mr. W. T. Thiselton Dyer, "The genus *Hoodia.*" 3. Mr. W. Duppa Crotch, "Migration and Habits of Norwegian Lemming." 4. Rev. M. J. Berkeley, "Fungi of Kerguelen Pland."
Chemical, Burlington House, W., 8 p.m.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Professor Tyndall, "Voltaic Electricity." (Lecture II.)
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Mr. W. T. Thornton, "Irrigation Works in India."
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m., Prof. Gladstone, "Methods of Chemical Decomposition illustrated by Water."
Geologists' Association, University College, W.C., 8. p.m.
Philological, University College, W.C., 8 p.m.
Archæological Institution, 16, New Burlington-street, W., 4 p.m.

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Mr. Henry Woodward, "Crustaceæ."
Foremen Engineers (at the House of the Society of Arts), 7 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,224. Vol. XXIV.

FRIDAY, MAY 5, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The examination for the Scholarships founded by the Corporation of the City of London, the Sheriffs of London and Middlesex, the Common Councilmen of the Wards of Bishopsgate and Cripplegate, Viscount Newry, the Lord Mayor, the Merchant Taylors', Skinners', Fishmongers', Vintners', Clothworkers', and Saddlers' Companies; by Messrs. Rothschild and Son; the Present and Past Masters of the Skinners' Company, Mr. Charles Morley, Mr. T. Chappell, and Mr. R. D. Sassoon commenced at the Mansion-house, at 9 a.m., on Monday, the 24th April. The musical examiners are Otto Goldschmidt, Esq., John Hullah, Esq., and W. G. Cusins, Esq.; the literary examiner, the Rev. J. Richardson. The total number of candidates is upwards of 300.

The Scholarships founded by the Wards of Bishopsgate and Cripplegate, by T. Chappell, Esq., and by the Sheriffs of London and Middlesex, were competed for on Thursday, the 27th April, and have been awarded respectively to Miss M. E. Hughes, Mr. E. T. Sweeting, Mr. E. G. A. Fowles, and Miss E. B. Gibson. The total number of candidates was 33.

The Scholarships endowed by the Lord Mayor, Viscount Newry, and Mr. Charles Morley, were competed for on Friday, 28th April, and have been awarded respectively to Misses Cox, Roche, and Marriott. There were 19 candidates.

The Scholarships endowed by the Fishmongers', Saddlers', and Skinners' Companies were competed for on Monday and Tuesday, the 1st and 2nd inst., and have been awarded to Misses Pidcock, Webbe, and S. E. Hudson, and to Mr. Balfour. The total number of candidates was 35.

The two Scholarships founded by the Messrs. Rothschild, were competed for on Wednesday, the 3rd inst., and have been awarded to Miss Grace E. Maile and Mr. Sidley. There were 17 candidates.

The ten Scholarships founded by the Corporation of the City of London will be competed for at the Fishmongers' Hall, during the week ending the 13th May. There are 150 candidates.

HEALTH AND SEWAGE OF TOWNS.

The Conference on this subject will take place, as already announced, on May 9th and 10th. The Right Hon. James Stansfeld, M.P., will preside. The Conference will meet each day at 11 a.m., and will sit till 1.30, then adjourn till 2, and sit again till 5 p.m., and again at 8 p.m., if necessary. The following is the programme of proceedings.

Tuesday, 11 a.m.—Opening of the proceedings by the Chairman. Papers and discussions on—

1st. Water-carried Sewage.
- *a.* Sewage Farms, with or without precipitation or subsidence, profit and loss.
- *b.* Effluent waters.
  - Subsidence.
  - Precipitation.
  - Filtration.
- *c.* Possibility of producing an effluent harmless to health.

2nd. Disposal of Sludge.

3rd. Discharge of Sewage into Sea.

4th. Dry Systems.
- Pails, Pans, Boxes, Earth, Ash, and other Closets; their influence on health, cost, &c.

5th. Foreign Systems.
- Liernur and other systems, and the suggestions they offer.

Wednesday, 11 a.m.—Proceedings will be resumed. Papers and Discussions continued.

The invitations have been issued to Mayors, Town Clerks, Medical Officers of Health, and Town Surveyors.

Members of the Society will be admitted on signing their names.

On Thursday a visit will be paid to the Main Drainage Works, at Crossness.

Arrangements have been made for Representatives and others to dine together at the "Criterion" Restaurant at 6 o'clock each day. Tickets, 5s. each without wine, may be obtained at the Society's office on the morning of each day. To secure places, application must be made to the Secretary on or before Monday, the 8th May.

The following is a summary of the returns furnished to the Committee by the various towns. They are intended to show the manner in which the sewage is dealt with in each locality, the cost, and other particulars, as far as they have been obtainable. For purposes of comparison, the population, and the death-rate, when procurable, have been added:—

Aberdeen.—Population, 88,189; mortality 22·5—Water-carried sewage contains very little manufacturing refuse; a limited quantity of the sewage is used for irrigating about 44 acres of land, the remainder is drained direct into the River Dee; water-closet system in use in about 5,500 houses. Total cost of construction for sewers up to end of

1874, as reduced by sinking fund, £55,631; annual outlay for maintenance, £522, exclusive of salaries and general charges; this expenditure is principally for cleaning and flushing. The irrigation farm has been in existence for six years with good results.

Nine hundred ash-pits, 1,200 private and 22 public dry-closets in use. Every family is obliged to have a dust-box, in which is collected all refuse, ashes, &c.; this box is carried to the street every morning, and picked up by carts sent round for the purpose; the contents of the public closets, as well as that of the few remaining private dry-closets and ash-pits, are removed at the same time, and the whole afterwards mixed together and sold to the farmers. Gross cost of carting manure from streets in 1875, £2,833 15s. 7½d.; receipts, manure, £3,113 16s. 3d; rent of irrigation farm, at £5 per acre, £220; cost of scavenging, £5,009 9s. 9d. The present system of night soil disposal answers well, but, owing to the number of water-closets now in use, is not profitable. No injunctions have been granted against the locality.

ABINGDON.—Population, 5,809.—Water-carried sewage is at present drained direct into the River Thames. Sewage works have been commenced on a system of the combination of Mr. J. Bailey Denton's intermittent downward filtration and irrigation. The sewage is proposed to be carried to the land and then pumped up and distributed, existing sewers are to be retained for surface and rain water, sewage proper only is to be admitted into the new sewers. This system of course necessitates water-closets.

ABERGAVENNY.—Population, 4,803; mortality, 25·6.—Water-carried sewage does not contain any manufacturing refuse, is drained into tanks, filtered; effluent water discharged into adjoining stream Kibby, and the residue dried and sold as manure at 3s. 6d. per ton; ashes are occasionally mixed with the soil from the sewage tanks to assist in drying it; about 500 water-closets in use. System in action since 1866. Total cost of construction for sewers up to end of 1874, £6,000; annual outlay for maintenance under £30; net cost for dealing with the sewage in 1875, about £25. The Abergavenny Improvement Commissioners remark "that more summary powers are required to deal with nuisances, ruinous and unhealthy buildings, and noxious trades," and suggest "alterations in the law and in the local government," with this object.

ABERYSTWITH.—Population, 6,920; mortality, 23·2.—Water-carried sewage does not contain any manufacturing refuse, drained direct into the harbour, and from thence into the sea; 495 water-closets in use, this number will be greatly increased during the present year consequent upon extension of sewage works. Total cost of construction for sewers up to end of 1874, £3,450; annual outlay for maintenance, £120.

Night soil from middens mixed with ashes, and removed at cost of occupiers; receipts to town for night soil in 1875, £1; cost of scavenging for the year ending 31st August 1875, £313.

ALTON.—Population, 4,092; mortality, 17.—Sewage drained into tanks; effluent water after subsidence discharged into River Wey; sludge used for manure; cesspools in use with about one-third of the inhabitants; system in action about 13 years. Total cost of construction for sewers up to end of 1874, £6,115.

ALTRINCHAM.—Population, 8,478; mortality, 20.—Water-carried sewage does not contain any manufacturing refuse; treatment, direct irrigation of land; system in action about five years; about 250 water-closets in use. Total cost of construction for sewers up to end of 1874, about £9,000; net cost of dealing with sewage in 1875, £135, loss in working of sewage farm.

About 1,800 ash-pits and middens in use, some open and others covered in; ashes mixed with night soil, used by farmers. Gross cost of disposing of night soil in 1875, £100.

ARUNDEL.—Population, 2,956; mortality, 14.—Water-carried sewage does not contain any manufacturing refuse, is discharged direct into strong tidal river Arun. Cesspool drainage still in use in many houses, night soil mixed with earth and spread upon the land.

ASHTON-UNDER-LYNE.—Population, 33,417; mortality, 33·7.—Water-carried sewage contains manufacturing refuse; drained direct into River Tame; about 300 water-closets in use.

Ash-pits about 5,000, and pails 300; products collected and mixed with contents of ash-pits sold to farmers. Gross cost of disposing of night soil in 1875, £3,389 8s. 3d.; receipts, £474; cost of scavenging, £818 5s. 9d.

BACUP.—Population, 18,500; mortality, 24.—Water-carried sewage does not contain any manufacturing refuse, is passed through tanks charged with coke and charcoal, and after filtration effluent water discharged into River Irwell; 150 water-closets in use; treatment in action about nine years. Total cost of construction for sewers up to end of 1874, about £19,000; annual outlay for maintenance about £60; net cost of dealing with sewage in 1875, £60.

About 900 covered ash-pits in use, 20 pail-closets on trial, about two-thirds of total quantity of night soil mixed with ashes; soil given to farmers. Gross cost of disposing of night soil in 1875, about £300; receipts, nil; cost of scavenging, about £700. The return from this locality remarks on the necessity of early information being given of infectious diseases, also more summary method of dealing with nuisances during prevalence of epidemics.

BALDOCK.—Population, 2,030; mortality, 22·6.—Water-carried sewage contains refuse from breweries and malt works; drained into tanks at outfall, strained, and deposited, the effluent water filtered through about half an acre of land. Water-closet system almost universally adopted; about 200 in use. Total cost of construction for sewers up to end of 1874, £2,804 18s. 10½d.; annual outlay for maintenance about £250; cost of dealing with sewage in 1875, £244. System in action about two years.

Very little night soil to be dealt with; soil, mixed either with earth or lime, used for manure; gross cost of disposing of night soil in 1875, *nil;* receipts, £5; cost of scavenging, *nil.* An action in respect of sewage against the locality ten years since, was compromised at a cost of £280; no injunctions granted.

Banbury.—Population, 11,718; mortality, 19·66. —Sewage contains a small amount of manufacturing refuse; tanks which were formerly used for deodorisation, &c., are at the outlet of sewers, into these tanks both the solid and liquid sewage is drained; subsidence then takes place, strainers used to keep back floating substances; liquid pumped to farm of 138 acres, about a mile distant; deposit in tanks generally mixed with the town sweepings, &c., and sold for manure; water-closets in universal use. Total cost of construction for sewers up to end of 1874, about £6,000; cost of maintenance about £5. Filtration process tried, also deodorisation, 1st, with carbolic acid and lime, and 2nd, with perchloride of iron and lime, but utterly failed; about eight years ago the present irrigation system was adopted and is a great success. Farm of 238 acres with farm buildings and house purchased by Local Board for £23,500, farm buildings and 100 acres not under irrigation let at £3 10s. per acre, remaining 138 acres utilised for sewage farm. Receipts in 1875 from sales of crops in sewage farm £1,450, for deposit in tanks £30, total £1,480. Payments for same period, irrigation labour, including engine drivers salary, £202, labour emptying tanks £41, coal, seed, oil, &c., £225, manager's salary £45, total £513. Legal proceedings pending for a number of years previous to the adoption of irrigation.

Barnsley.—Population, 23,020; mortality, 26·88.—Water-carried sewage contains refuse from dye-works; drained direct into River Dearne; about 350 water-closets in use. Total cost of construction for sewers up to end of 1874, £11,329 16s. 6d. Plans have been prepared by Mr. Bailey Denton for dealing with the sewage by intermittent downward filtration and irrigation; contracts on point of being let.

About 1,000 middens and 500 ash-closets in use; night soil mixed with ashes sold to farmers. Cost in wages for disposing of night soil in 1875, £780 10s. 9d.; receipts £373 17s. 4d. (viz., night-soil, £322 8s. 2d., and street-sweepings, £51 9s. 2d.) The total loss on the sanitary purposes account was in 1875, including salaries, £2,911. One injunction now in force to cease turning unpurified sewage into the River Dearne, £1,468 has already been expended in legal proceedings. The medical officer of health remarks no system has been proved thoroughly satisfactory; in dry seasons all the night soil can be disposed of easily to farmers, in wet ones there is great difficulty in getting rid of it; and also that the bad management of children by poorer mothers, as well as the Chancery injunction which prevents the making of any new sewers, are obstacles to the progress of improvement in the sanitary condition of the locality.

Bath.—Population, 52,542; mortality, 24·9.—Water-carried sewage does not contain any manufacturing refuse, is discharged direct into River Avon; water-closets on an average to every house. Upwards of 8,000 in use. Total cost of construction for sewers up the end of 1874, £37,818 5s. 1d.

In a rural part of the borough, difficult to drain, earth-closet system introduced with great success.

Berwick-upon-Tweed.—Population, 13,198; mortality, 23·5.—Water-carried sewage does not contain manufacturing refuse, is discharged direct into tidal river a few hundred yards from its mouth; 931 water-closets in use in town; adjoining villages of Tweedmouth and Spital, which are within this district, without any system. Cost of construction of sewers to the end of 1874, £6,181 19s. 3d.; annual outlay for maintenance, about £100.

About 50 middens in use; night soil taken away by farmers; cost of scavenging, about £630.

Bewdley.—Population, 3,017; mortality, 19.—The borough, from its position, tolerably well drained; no special method of dealing with the sewage.

Bilston.—Population, 25,000; mortality, 22·6. —Water-carried sewage is drained direct into the river; only about 20 water-closets in use; total cost of construction for sewers up to end of 1874, £13,000; annual outlay for maintenance about £200.

About 2,000 middens in use; night soil not mixed with ashes; collected by "The New Town Manure Company;" manufactured into a marketable manure. Gross cost of disposing of night soil in 1875, £400, paid to above-named company under contract; this method has been found to be the best manner of disposing of night soil for this locality.

Birmingham.—Population, 343,787; mortality, 26·34.—Water-carried sewage contains a considerable quantity of manufacturing refuse. The sewage from nearly the whole of the borough, amounting to about 12,000,000 gallons daily in dry weather, is conveyed by two mains to the outlet near Saltley, where the sewage works are situated; a third of a mile above such works cream of lime is added, about 13 tons of lime being used daily. The sewage is passed alternately into two sets of tanks averaging 330 feet in length by 90 feet in width, in which the bulk of the heavier matters in suspension are deposited; it passes from thence into 4 sets of tanks, each containing 4 compartments of 150 feet in length by 50 feet in width, where further deposition takes place, and then passes in a clarified state into the River Tame. Preparation is being made for purifying a considerable portion of the clarified effluent by filtration through land belonging to the corporation at Saltley; about 350 yards cube of sludge are arrested daily, a small portion of the sewage only is used for irrigation. About 8,000 water-closets in use; total cost of construction for sewers up to end of 1874, about £250,000, outlay for maintenance only nominal; about £1,500 per annum is expended in cleansing and flushing sewers, this amount is included in scavenging account; net cost of dealing with sewage in 1875, £12,710. The above treatment has been in operation for the last three years, and has been found to be the most successful method of preventing pollution of river; with the lime treatment is generally obtained a clarified effluent, and it is believed that by its adoption a very much smaller quantity of land will be required to ensure purification.

19,000 middens, 3,977 ash-tubs, and 9,184 pail closets on the Rochdale system, with some modifications; night soil mixed with ashes, part is sold to farmers, the remainder is deposited at depôts in the country. Ashes, when collected, are screened, the fine ash is mixed with the

contents of excreta vessels, the mixture is then sold to farmers as manure. Gross cost of dealing with night soil in 1875, £35,301; receipts, £5,795; estimated expenditure for the year 1876 for scavenging, repairing, and watering the streets, £50,250, of which amount £15,500 is for stone for macadamising purposes. The Rochdale system has been found to be, in this locality, the best method of disposing of night soil. The ultra-reverence for vested interests which influences Parliament, and led to the rejection of the Birmingham Sewage Bill of 1872, impedes the progress of sanitary improvement. Upwards of £10,000 expended in legal proceedings in respect of sewage; two injunctions have been granted, one restricting the Corporation from accumulating the sewage at Gravelly-hill, or depositing it, or disposing of it in tanks or reservoirs, or disposing or dealing with the sewage in such manner as to be a nuisance. The other injunction, that which refers to the great bulk of the sewage, was to restrain the Corporation from dealing with it so as to pollute the River Tame, so as to render it injurious to the health of the persons adjoining its course, or so as that it may be offensive and unfit for use or injurious to health when it passes through the grounds of the plaintiff, Sir C. B. Adderley. No complaints, however, have lately been made by any of the relators with respect to the proceedings of the Corporation.

Report of the Sewage Inquiry Committee, 1871, states: "There are in Birmingham 3,884 premises, containing 7,065 water-closets, accommodating about 20,000 persons; and 70,000 houses connected with 19,551 privies and middens, accommodating about 325,000 persons; of these middens or ash-pits nearly 14,000 are drained into the sewers.

Mr. J. Netten Radcliffe's report for 1874, states:—"Pail system introduced May, 1873; at present time 2,700 pail closets in use; pails changed weekly; manure made from mixed excrement and fine coal-ash, sells at £5 per cart-load of from 24 to 25 tons; 27,644 middensteads and ash-pits cleansed in 1873; 163,142 loads of soil removed; cost £24,000, less £3,500 received for sale of part of removed material; estimated cost of working pail system in the borough, including interest on capital account and depreciation, would not exceed cost of present night soil scavenging by more than £2,000, while receipts from sale of manufactured manure and rough ashes would realise probably £18,000, without including cost of manufacture."

Blackburn.—Population, 78,600; mortality, 26.—Water-carried sewage does not contain any manufacturing refuse; treatment, retention of solid matter in settling tanks; effluent water used for irrigation; system in action three years. Total cost of construction for sewers up to end of 1874, £125,000; annual outlay for maintenance £768 10s.

Pail system in general use, 15,770 pails; ashes mixed with night soil after collection and sold to highest bidder; gross cost of disposing of night soil in 1875, £5,641; receipts, £773 17s. 5d.; scavenging, £2,098 15s. 2d. A sum of £20,000 has been expended in resisting injunction and claims for damage to property by pollution of river. One injunction granted by Vice-Chancellor and upheld by Lord Chancellor.

Bodmin.—Population, 4,672.—Water-carried sewage does not contain any manufacturing refuse; treatment, direct irrigation of grass land; 250 water-closets in use, number increasing. Total cost of construction for sewers up to end of 1874, £1,283; net cost of dealing with sewage in 1875, *nil*.

Night soil from middens tipped on to ash-heaps. Cost of scavenging, £34 per annum.

Bolton.—Population, 82,854; mortality, 26.—Water-carried sewage contains refuse from dye works, cotton manufactories, and ironworks, &c., is dealt with by the precipitation process; materials employed, fine ash, lime, refuse carbon, and iron salts; about 500 water-closets in use. The present precipitation process has been in operation two years, for the two previous years the A B C process was used, but abandoned on account of the cost. Total cost of construction for sewers up to end of 1874, £60,000; annual outlay for maintenance, £300; net cost of dealing with sewage in 1875, £1,000; present treatment successful in preventing pollution of river.

Middens and ash-pits in use, 700; night soil sold to farmers in its raw state; net cost of cleaning middens and ash-pits for the year ending 30th June, 1875, £4,493 17s. 11d.; receipts for night soil, exclusive of carriage, £1,023 14s. 6d.; street sweepings, £376 18s.; and slaughter-house offal, £141 18s. 3d.; scavenging, cleansing, and watering streets, removal of slaughter-house offal, £2,622 4s. 2d.

Boston.—Population, 15,576; mortality, 22.—Water-carried sewage does not contain manufacturing refuse; is discharged direct into the tidal haven; 265 water-closets in use.

100 ash-closets in use about three years; night soil removed weekly by scavengers.

Bowness (on Windermere).—Population, 1,450; mortality, 17.—Sewage does not contain any manufacturing refuse; drained into tanks, liquids passed through filters into the lake, solids used as manure; water-closets used by all the houses. Total cost of construction for sewers up to March, 1874, £1,211 6s. 7d.; net cost of dealing with the sewage from March, 1874, to March, 1875, £263.

Bridport.—Population, 7,666; mortality, 17·07.—A system of drainage is now being carried out, but not yet completed. Cesspools and vaults, and badly-constructed drains, emptying into two small rivers nearly surrounding the town, has been the system in use hitherto.

Bristol.—Population, 182,524; mortality, 29.7.—Sewage and manufacturing refuse discharged into tidal River Avon; water-closets in general use, lower classes using privies with gas traps, no public ones. Total cost of construction for sewers up to end of 1874, £168,000; annual outlay for maintenance *nil*.

Mr. J. Netten Radcliffe's report for 1874 states:—"Inhabited houses 27,536; privies in use flushed by hand. Inspectors appointed by the Corporation to inspect or cleanse them at weekly or shorter intervals, as required. Rain-water pipes and yard drains are made to communicate with ejects, so as to secure the flushing action."

Burnley.—Population, 40,858; mortality, 28.—Water-carried sewage contains manufacturing refuse; and drained direct into River Pendle; 630 water-closets are in use. In 1875, a sum of £27,576 was spent in construction of sewers; the filtration and precipitation system is about to be adopted.

Night soil is removed in covered carts to grass

lands; 95 pails, 1,200 earthenware, and 5,543 masonry tanks covered over, in use; 190 mixed cesspits; ashes and night soil are kept separate; the night soil is sold to farmers, and ashes tipped. Gross cost of disposing of night soil in 1875, £951 4s. 6d. (done by contract). One injunction was obtained against the locality, in respect to sewage, and £800 has been spent in legal proceedings. The medical officer of health mentions as the most important points for consideration, the advisability of giving more summary power over the filthy; removing jurisdiction over workshops from factory inspector; putting it out of the power of local authorities to dismiss sanitary inspector when he is acting for the public good against local interests, and making it compulsory to give information of infectious fevers to sanitary authority.

BURTON-ON-TRENT.—Population, 24,874; mortality, 23·15.—Water-carried sewage contains manufacturing refuse; is dealt with by lime precipitation; 232 water-closets in use. Annual outlay for maintenance about £300. System of lime precipitation not sufficiently long at work to be able to state if successful.

2,219 privies, and 1,575 ash-pits, principally in connection therewith; night soil mixed with ashes and sold to farmers. Gross cost of disposing of night soil for year ending March 31st, 1876, about £1,100; receipts for same period about £180; cost of scavenging for ditto about £900. Removal and sale found to be best method of disposing of night soil.

CAMBRIDGE.—Population, 30,078; mortality, 13.—Water-carried sewage; drained into River Cam at different outlets, many of which are within the borough area. In a new district cesspools in use; water-closets in general use.

Moule's dry-earth system in use at three of the colleges, a few middens and ash-pits in a new part of town; night soil, in some cases mixed with ashes, used with street refuse for manure. Difficulty experienced in providing an efficient water-carriage system of sewage in a district where a proper sewer gradient cannot be obtained. Sewage question now under consideration of the authorities.

CANTERBURY.—Population, 20,962; mortality, 24·4 or 23·13, excluding 19 deaths brought into city.—Sewage contains manufacturing refuse from dye and soap works; about 3,000 water-closets in use; dealt with by means of precipitating tanks and large filtering beds of gravel; system, fairly successful in preventing pollution of river, in action about three years. Total cost of construction for sewers up to end of 1874, £1,800; annual outlay about £150 for wages at sewage work; cost of scavenging in 1875, £296 8s. 11d.

CARDIFF.—Population, as extended under Cardiff Improvement Act, 1875, 73,000; mortality, 21·26—Water-carried sewage contains very little manufacturing refuse; drained direct into Bristol Channel; about 12,000 water-closets in use. Total cost of construction for sewers up to end of 1874, £70,000; annual outlay for maintenance, £400.

About 800 middens and ash-pits in the western part of the district, when sewered, will be converted into water-closets; each house is provided with a small receptacle for ashes and refuse, which is brought to the front daily, and removed by the scavenger between 7 a.m. and 3 p.m.; cost of street and house scavenging, including watering, £400 per annum. The western portion of the district is now being sewered, and with an outfall into river Taff, thence into the Bristol Channel.

CARLISLE.—Population, 31,049; mortality, 29·2.—Water-carried sewage does not contain any manufacturing refuse; is drained direct into the River Eden; 2,750 water-closets in use. Total cost of construction for sewers up to end of 1874, about £30,000; outlay in 1875 for maintenance, £700; this includes extensions. Net cost of dealing with sewage in 1875, £964 17s. 11d. A system of irrigation on about 100 acres was carried on for some twelve years with a portion of the sewage treated with carbolate of lime; rental of land soon rose from £4 to £7; now abandoned about two years, stated by lessee on account of rise in coal, as small steam-engine was required for pumping.

Middens in use to small extent, gradually diminishing; night soil mixed with ashes and sold; cost of scavenging in 1875, £1,043 9s. 6d. Medical Officer of Health remarks that he is by legal arrangement so placed as to be fettered by those who uphold largely commercial interests, ignoring the value of public health.

CARMARTHEN.—Population, 10,448; mortality, 23·1.—Water-carried sewage does not contain manufacturing refuse; is discharged direct into tidal river Towy; 1,138 water-closets in use. Total cost of construction for sewers from 1853 to 1874, £7,000. Total cost of ditto in 1875, £5,000. Seventy-two privies in use.

CARNARVON.—Population, 9,788; mortality, 32·79 (this high rate of mortality caused by 72 deaths during epidemic of scarlet fever).—Sewage does not contain any manufacturing refuse; drained direct into tidal waters of the Menai Straits; water-closets in general use. Total cost of construction for sewers up to end of 1874, £4,000; annual outlay for maintenance, £20; cost of scavenging in 1875, £225.

CHELMSFORD.—Population, 9,318; mortality, 21·64.—Sewage does not contain any manufacturing refuse; pumped up into the land for irrigation, being first roughly screened at the point of delivery; about 1,600 water-closets in use. Total cost of construction for sewers up to end of 1874 about £12,000; annual outlay for maintenance about £300; net cost of dealing with sewage in 1875, £300; a return of £35 per annum for the sewage pumped. System in action about 10 years. Cost of scavenging £150 per annum. No injunctions have been granted against the locality, but £200 was expended in legal proceedings some 20 years ago, when the sewage was discharged direct into the river.

CHELTENHAM.—Population, 41,923; mortality, 19·5.—Sewage does not contain manufacturing refuse; is dealt with by subsidence, separation of sludge and irrigation of liquid sewage on grass lands, sludge mixed with ashes and sold for manure; about 10,000 water-closets in use. The above method has been found to be the best way of disposing of the night soil, in respect of cleanliness and profit.

Chester.—Population, 35,257; mortality, 23·45.—Water-carried sewage is drained into tanks; treatment, lime precipitation, partial subsidence, and effluent water, discharged into tidal river; from 600 to 700 water-closets in use; treatment in action six months. Total cost of construction for intercepting sewers and outfall works, £22,000; cost of existing drains, made some years, unknown; estimated entire cost for additional drains and work already completed, £50,000.

A few middens in use; ashes mixed with night soil, and sold to farmers. Gross cost of disposing of night soil, so far as done by the Corporation, £772 5s. 10d.; receipts, £198 12s.; cost of scavenging, £710 per annum.

Chichester. — Population, 8,500; mortality, 20·7.—Water-carried sewage does not contain any manufacturing refuse; the surface water is carried off in drains, and sewage proper drained into cesspits; water-closets in general use.

Night soil from middens removed at occupier's cost, about 30s. for each removal; used on land by farmers. This system has been found to be the best method of disposing of night soil in the locality. Cost of scavenging and watering, including the removal of house refuse, sweeping the streets, &c., £465 10s. per annum.

Cleethorpes.—Population, 2,200; mortality, 15·45.—Water-carried sewage does not contain any manufacturing refuse; drained into three intercepting filtering tanks; effluent water carried a mile-and-half from the town; about 50 water-closets in use; total cost of construction for sewers up to end of 1874, about £2,500; annual outlay for maintenance, about £10, system in action five years; apparently answers satisfactorily in preventing pollution of river, effluent water fairly clear.

Pail system in use at most houses, single pail for ashes and night soil; scavenged nightly from 9 p.m. to 5 a.m.; annual cost of scavenging, £150, paid to scavengers in addition to night soil, &c., collected.

Clitheroe. — Population, 8,208; mortality, 26.—At present time no works of sewage, but the Council are contemplating dealing with the sewage on the irrigation system. Night soil is now mixed with ashes and used on land, the gross cost of disposing of which was in 1875, £294, including scavenging, against receipts, £53.

Colchester.—Population, 25,000; mortality, 18·75.—Water-carried sewage does not contain any manufacturing refuse; drained direct into river Colne; a large number of water-closets in use. Scheme for disposal of sewage now under consideration.

Night soil from middens mixed with ashes, carted away partly by the sanitary authority and partly by farmers; cost of scavenging £700 per annum.

Cottingham.—Population, 5,000; mortality, 16.—Water-carried sewage does not contain any manufacturing refuse; drained into settling pits; effluent water overflowing into Beek; deposit when pits are cleaned out used for manure; about 35 water-closets in use. Total cost of construction for sewers up to end of 1874, £8,400; annual outlay *nil*; cost of dealing with sewage in 1875 *nil*; result of present system not altogether satisfactory in preventing pollution of river.

Midden system in use, night soil mixed with ashes, used for manure for market gardens; cost of scavenging, about £100 per annum. A system for the drainage of the entire district is now being carried out, and when finished, the entire sewage will be discharged into the River Humber, near the western boundary of the district of Hull. The entire cost by such time is estimated at about £20,000.

Coventry.—Population, 37,670; mortality, 21·4.—Water-carried sewage contains water refuse from silk dye works. The sewage is subjected to four processes, viz.:—1st, strained; 2nd, chemically treated and precipitated; 3, effluent water filtered; 4, precipitate or sludge, dried and disposed of. Treatment in action, two years; process successful; 5,000 water-closets; total cost for construction of sewers up to end of 1864, £35,000; annual outlay for maintenance, £20.

A few middens in use; night soil mixed with ashes and sold to farmers at 1s. per cubic yard. Gross cost of disposing of night soil in 1875, £980; receipts for sale of ditto, £104; cost of scavenging, £684.

Crewe.—Population, 20,000; mortality, 20·7.—Water-carried sewage contains manufacturing refuse; sewers drained into covered tanks, from whence it is pumped upon the land for irrigation of sewage farm; about 60 water-closets in use.

About 3,867 middens; night soil mixed with ashes, and used on the sewage farm; gross cost of disposing of night soil in 1875, £927 12s. 11½d. Cost of scavenging, £386 9s. One injunction filed against the Crewe Local Board in the matter of sewage, and £1,050 has been expended in legal proceedings.

Croydon.—Population, 63,000; mortality 21·71, this has been materially raised by an epidemic of typhoid, consequent upon an intermittent water supply, the average for the past ten years having been 18.—Water-carried sewage does not contain any manufacturing refuse, is filtered so as to separate the paper, rags, &c., and then employed for irrigation of farm; about 11,000 water-closets in use. Total cost of construction for sewers up to end of 1874, including renewals and reconstructions, from great increase of population, &c., £77,000; annual outlay for maintenance was, a few years ago, £600, now £1,100, gradually increasing with a yearly increasing area, this includes wages of sewer men engaged in flushing, and cost of water; net cost incurred by the parish in dealing with sewage in the year ending Lady-day, 1875, £2,367, equal to a rate of 1½d. in the £. System in action 16 years; successful in preventing pollution of river. Twenty-two Moser's closets in use; product is sold with sewage manure from the filter-house, at 2s. 6d. per load. Gross cost of disposing of night soil in 1875 about £30; cost of scavenging, collection of ashes and house refuse, about £2,000 per annum; street sweeping, £1,850 in 1875. It is stated that the great obstacle to sanitary improvement is the great waste of water, and consequent liability to pollution, because local boards have not the power which companies possess in dealing with the fittings. Previous to the formation of the sewage farm, in 1860, numerous

injunctions were obtained, and great costs incurred, since that time nothing has been expended on law proceedings.

DARTMOUTH.—Population, 5,338; mortality, 20.—Water-carried sewage contains manufacturing refuse, drained direct into harbour below low water mark. Total cost of construction for sewers up to end of 1874, £1,565 3s. 11d.; annual outlay *nil;* net cost of disposing of sewage in 1875, £57 0s. 2d.

Middens in use, night soil mixed with ashes, carted away daily by the town scavenger, who receives soil for labour of scavenging. Method now in use found best for disposing of night soil.

DERBY.—Population, 49,795; mortality, 27·4.—Water-carried sewage contains a small quantity of manufacturing refuse, is drained into River Derwent; about 2,600 water-closets. Total cost of construction for sewers up to end of 1874, £13,000,

In use 2,635 privies, and 1,024 tub-closets; night soil removed by scavengers to depôts away from the town, mixed with ashes and manure, and sold to farmers. Gross cost of disposing of night soil in 1875, £2,069 8s. 5d.; receipts, £596 13s. 5d.; cost of scavenging, £1,825 16s. 8d. The inhabitants appear to be in favour of tub system. Consider water carriage most desirable system; attribute partial failure to water-closets, imperfect and unventilated sewers, unventilated house drains, and imperfect traps, and the ignorance of the sanitary officers and the poorer classes.

DEVIZES.—Population, 6,840; mortality, 22·9.—Water-carried sewage drained into meadows some distance from town; treatment downward filtration; water-closets in general use. Total cost of construction for sewers up to end of 1874, £2,311 10s., annual outlay for maintenance, *nil.*

Not more than six middens in use; soil used on land. Cost of scavenging in 1875, £181. Present system considered best method of disposing of night soil in this locality. The medical officer states the absence of water supply impedes progress of improvement in the sanitary condition of the locality, and that the only water supply which exists at present is obtained from wells.

DEVONPORT.—Population, 49,449; mortality, 18.—Water-carried sewage drained direct into the sea below low-water mark; water-closets in general use. A few privies still remain, but this system is gradually disappearing.

DONCASTER.—Population, 18,758; mortality, 22·5.—Scarcely any manufacturing refuse in water-carried sewage, the whole of which is pumped up for irrigation of sewage farm three miles distant; about 500 water-closets in use; farm let by the corporation at £800 per annum rental; annual outlay for maintenance about £450, for coals, wages, enginemen, &c., exclusive of interest on capital. Total cost of construction for sewers up to end of 1874 exceeds £20,000. System successful; cost, about 30s. a head of the inhabitants.

Ash-pits in use; the pail, tub, and box systems would not be tolerated; night soil, after being mixed with ashes, sold to farmers at 1s. per ton. Gross cost of disposing of night soil about £500 per annum; receipts, about £100. System considered best method of disposing of night soil. One injunction obtained some years ago; sewage was then discharged into River Don, previous to present system being adopted. Medical officer states that he expects to further reduce death-rate.

DROITWICH.—Population, 3,538; mortality, 17·4.—Water-carried sewage contains salt, drained direct to river or canal; sewers in very bad state, owing to the peculiarities of the soil, foundations of streets always falling in; 24 water-closets in use, all bad, with no ventilation.

Night soil kept in pits till the nuisance is unhealthy, then carted away, if any farmer can be got to take it. The medical officer of health states that the want of knowledge and vested interest have hitherto prevented any improvement in the sanitary condition of the locality. A complete scheme of drainage and waterworks is being prepared, in view of which the town has been surveyed by Mr. Richard, C.E., who proposes the separate system and irrigation, old drains to be used for surface-water, sinkage of streets to be remedied by employing pipes in short lengths, with ball and socket joints.

DUDLEY.—Population, 43,782; mortality, 25·2.—There is but little water-carried sewage, this does not contain manufacturing refuse; drained into Rivers Stour and Tame; about 100 water-closets in use, these drain into catch-pits, and then into a brook. Net cost of dealing with sewage in 1875, £272.

Ash-pits in general use; contents carted away to a depôt and left. Gross cost of disposing of night soil in 1875, £1,764 17s. 5d.; cost of scavenging, £1,979 1s. 11d.; this amount includes the cost of scavenging and all the labour required in repairing the streets and roads of the borough. In some parts of the borough mining operations prevent any improvement in the sanitary condition of the locality, which cannot be effectually remedied until the mines are worked out. A general system of sewerage of the whole borough is about to be carried out, the engineer's report and plans and estimates for which are now under consideration of the town council.

DURHAM.—Population, 14,460; mortality, 22.—Water-carried sewage contains very little manufacturing refuse; is drained direct into River Wear; about 900 water-closets in use. Total cost of construction for sewers up to end of 1874, £5,500; annual outlay for maintenance small.

About three-quarters of the inhabitants use middens; pail system employed in connection with one large factory. Ashes mixed with night soil; soil carted away when ash-pits are full. Gross cost of disposing of night soil and ashes from September 1874, to September 1875 (part of plant bought) £1,139 15s. 2d., receipts for same period, £153 18s. 7d. The want of power to prevent the accumulations at river side considered an obstacle to improvement in the sanitary condition of the locality; suggested formation of a board to control river above tidal flow.

EAST STONEHOUSE.—Population, 14,585; mortality, inclusive of Royal Naval Hospital, 28·37, exclusive 22·87.—Sewage does not contain any manufacturing refuse; drained direct into sea at low-water level; water-closets in general use. Total cost of construction for sewers up to end of 1874, £5,200; annual outlay for maintenance, under £5; with the scavenging, a profit is made of

£40 per annum. Return mentions a difficulty experienced in obliging landlords to provide an adequate and safe storage for water, especially in houses let in tenements, an obstacle to sanitary improvement.

EPSOM.—Population, 6,276; mortality, 17·8.—Water-carried sewage does not contain any manufacturing refuse; about three-quarters of it is dealt with by subsidence, separation of sludge, and irrigation of liquid sewage on land; sludge collected weekly, mixed with ashes, and made into manure. Above treatment in use five years. Approximate cost of construction for sewers up to end of 1874, £8,000; average annual outlay for maintenance, £38. Remaining part of sewage drained into cesspools, earth-closets are being introduced.

ETON.—Population, 3,500; mortality, 20·7.—Sewage does not contain any manufacturing refuse; is dealt with by irrigation of land on the separate system, viz., the exclusion of all surface and storm waters from that of sewage proper. Water-closets in general use. System in action six years. Total cost of construction for sewers in 1874, £20,000, including 50 acres freehold land; annual outlay for maintenance £341; profit from working farm about £120, equal to a rent of £3 per acre. The expense and difficulty of closing polluted wells which people persist in using in spite of warning, is still an obstacle to improvement of the sanitary condition of the locality.

FLINT.—Population, 4,269; mortality, 21.—Water-carried sewage does not contain any manufacturing refuse, is drained into estuary of the River Dee; about 25 water-closets in use. Total cost of construction for sewers up to end of 1874, £1,250.

Ashes mixed with night soil, and sold to farmers. Several methods for the disposal of night soil under consideration of the sanitary committee, but none have as yet been adopted.

It is stated in the return received that the inhabitants consist almost exclusively of the working classes, who are engaged in the large chemical works and collieries in the neighbourhood, and it is extremely difficult to get them to adopt any modern improvements. There is a great deal of overcrowding. Proprietors of works object to build cottages, and the people have been accustomed to pay such low rents that it does not pay private individuals to build.

FOLKESTONE.—Population, 12,694; mortality, 19.—All sewage drained direct into the sea; water-closets in universal use; total cost of construction for sewers up to end of 1874, about £7,500, annual outlay for maintenance, £75, cost of scavenging, £300.

GLASGOW. — Population, 491,846; mortality, 28·59.—Water-carried sewage contains a considerable amount of manufacturing refuse, which, however, is greatly purified by precipitation at most of the manufactories, before being allowed to flow into the sewers; is then drained direct into River Clyde; in 1873 there were 32,000 water-closets in use.

Ash-pits (for ashes only), 6,083; middens, 1,287; pail-closets, 4,365 in use in 1873; ashes are mixed with the night soil, and sold to farmers. Gross cost of disposing of night soil in 1875, £50,323 12s. 1d.; receipts, £26,364 4s.; cost of scavenging, £11,734 13s. 9d. Return states that there is great necessity for a uniform sanitary controller, at present under different jurisdictions, most prejudicial to progress of improvement in sanitary condition of the locality, and recommends that the local authority have a consulting voice in the planning and erection of new buildings, &c., and that sanitary matters and building speculations should be legislated under one head.

Mr. J. Netten Radcliffe's report (1874) states:—"Pails in use are galvanised cylindrical vessels, calculated each to serve ten families; ash-pits attached to pail-closets, which also receive considerable quantity of excremental matters. Scavengers are paid by the ton, this induces the men to imperfectly cleanse receptacles."

GREAT MALVERN.—Population, 5,693; mortality, 9·03.—Sewage does not contain any manufacturing refuse; at present, it is disposed of on grass land unprepared, but it is intended to adopt the intermittent downward filtration scheme and irrigation proper. Water-closets in general use. Total cost of construction for sewers up to end of 1874, £11,680; annual outlay for maintenance, about £35; cost of manual labour in 1875 for applying sewage to land, £60. No dry system in use.

GREAT YARMOUTH.—Population, 41,819; mortality, 23·02.—Water-carried sewage does not contain any manufacturing refuse; is drained direct into River Yare.

Privies in use to a large extent; ashes mixed with night soil collected by the authorities, and disposed of to farmers. The medical officer states that he considers it desirable to enlarge the urban jurisdiction.

GRAVESEND.—Population, 21,265; mortality, 21·39.—Sewage does not contain manufacturing refuse; is drained into cesspools; not allowed to enter storm-water drains, which discharge into the River Thames.

Night soil disposed of to farmers. Scarcely any disease occurs that can by any means be traced to want of proper means of removal of excreta; particularly free from serious epidemic outbreaks, and outbreaks of any sort seldom become formidable.

GUILDFORD.—Population, 9,105; mortality, 18·33.—Sewage drained into cesspools; contents used by market gardeners or farmers; proper iron carts are provided by the sanitary authority for its conveyance from the cesspools, which is done at the cost of occupiers. In some cases the sewage proper is allowed to enter the surface-water drains.

HANLEY.—Population, 39,976; mortality, 25.—Water-carried sewage contains refuse from paper-mills, potteries, and iron and coal mines; is at present drained direct into the River Trent; water-closets estimated at 500. Total cost of construction for sewers up to end of 1874, £13,000; works now in progress, total estimated cost, £50,000; annual outlay for maintenance about £300. The question of sewage disposal is now under consideration by the authorities.

About 600 middens, and more than 1,100 galvanised iron pails in use; night soil sold to farmers, and exported into Cheshire by a contractor. Gross cost of disposing of night soil in 1875, £1,367 12s. 9d.;

receipts, £153 9s. 6d.; scavenging, £599 7s. This is for street sweeping. The galvanised iron pail system has been found to be the best method for the disposal of night soil. Medical officer of health considers that all roads should be in charge of the Corporation, as at present there is a great difficulty in getting the turnpike trustees to repair them in the tramway of the Borough.

Hanwell Asylum.—Population, 2,000.—Sewage treated by filtration through coarse gravel, &c.; fluid portion partly disinfected by a solution of lime and carbolic acid; pumped into tanks and used for irrigating the land; upwards of 200 water-closets in use; system in action 12 years; patients, labour employed. The lands irrigated are immediately around the asylum, but no illness has ever been ascribed to this treatment of sewage.

Harborne.—Population, 5,105; mortality, 21·—Water-carried sewage does not contain any manufacturing refuse; drained into tanks; treated partly by a process of upward filtration through gravel, coke, and charcoal, and partly by the lime process; the effluent water discharged into a small stream which runs into the River Rea. Total cost of construction for sewers up to the end of 1874, £2,500, inclusive of £450 for cost of land for erection of tanks; net cost of dealing with sewage in 1875, £130.

Middens in use; ashes mixed with night soil; supplied to farmers and market gardeners free of charge. Gross cost of disposing of night soil in 1875, £25; receipts, *nil*. Cost of scavenging, £140.

Harrogate. — Population, 6,655; mortality, 21·6, inclusive of visitors; 17·7, exclusive.—Water-carried sewage does not contain any manufacturing refuse; treatment, wide irrigation, in action seven years; 1,200 water-closets in use. Total cost of construction for sewers up to end of 1874, £16,000; annual outlay for maintenance, £75. Cost of dealing with sewage in 1875, £382; system found successful in preventing the pollution of rivers.

Middens in use; night soil removed by farmers at the expense of the occupiers of houses, as Commissioners object to employ carts or contract for same. Cost of scavenging in 1875, £300. One injunction granted against the locality; cost of legal proceedings, about £8,500. Medical officer of health states, as an obstacle to sanitary improvement, that lodging-house keepers maintain strict secrecy about infectious diseases; houses overcrowded during season; and considers it advisable for notice of infectious diseases in a watering-place being given to the medical officer, under penalty, as well as a means of isolation of such cases; also the yearly appointment of medical officer prevents honest performance of his duties, as, acting rightly, he is sure to give offence to some, and, should opponents prove influential on the Board, is removed; suggests the necessity of medical officers having some reasonable independence of Local Boards of Health.

Hastings.—Population, 33,000; mortality, 17.—Water-carried sewage does not contain any manufacturing refuse; drained direct into the sea; water-closets in universal use. Total cost of construction for sewers up to end of 1874, about £53,000. Ashes are disposed of by contract; ash-pits to every house; receipts for ashes, about £500 per annum.

Hereford.—Population, 18,000; mortality, 21.—Sewage all drained direct into the River Wye; about 2,000 water-closets in use. Total cost of construction for sewers up to end of 1874, £17,000; annual outlay, £300; net cost of dealing with sewage in 1875, £247. This method has been found in this locality the best for disposal of the night soil.

Hertford.—Population, 7,169; mortality, 22·7.—Water-carried sewage contains refuse from breweries; is dealt with by the phosphate sewage process, precipitation and filtration; treatment in action two years, successful in the prevention of pollution to river. Total cost of construction to the locality for sewers up to the end of 1874, £2,000; by the New River Company £28,000 has been expended, and the company allow the Corporation £600 a year for dealing with the sewage. The annual outlay for maintenance under phosphate process £200, against £450 expended under the lime process in use between 1858 and 1873. Water-closets are in general use; middens, ash-pits, &c., not allowed. Net cost of dealing with the sewage in 1875, £200. The medical officer of health remarks that the existence of urban authorities in an extensive rural district, who are allowed independent action, impedes very materially improvement in these urban localities, and suggests amalgamation.

Hexham.—Population, 5,331; mortality, 34·75.—Water-carried sewage contains refuse from tan yards; treatment filtration and precipitation in tanks, effluent water drained into River Tyne; sludge used for manure; water-closets in general use; total cost of construction for sewers up to end of 1874, estimated at £16,000.

Middens in use; contents mixed with ashes; often not removed until after overflowing for some time. The officer of health, in his report to the Hexham Urban Sanitary Authority, January 3rd, 1876, after calling attention to his first quarterly report, in which he had pointed out the principal nuisances that tend to cause the excessive high death-rate in Hexham, indicated the remedies to be applied, and urged the speedy action of the Board, states:—"The high death-rate significant as it is of gross mismanagement, does not represent all the mischief arising from the foul state of the town. Long continued sickness and slow lingering disease prevailed among the inhabitants of every locality, rendered unhealthy by filth and neglect."

Honiton.—Population, 3,464; mortality, 25·6.—The small amount of water-carried sewage that exists is drained direct into River Otter; very few water-closets in use; cost of construction for sewers very small.

Middens and ash-pits in general use; ashes, in some cases mixed with night soil, sold to farmers; gross receipts cannot be obtained; cost of scavenging, £20 per annum. A plan has now been approved of by the Town Council, and submitted to the Local Government Board, which will meet the sanitary requirements of the borough.

Hoole. — Population, 1,720. — Water-carried sewage does not contain any manufacturing refuse; treatment, irrigation and filtration; system in action eleven years. Total cost of construction for sewers up to end of 1874, £4,855 17s. 10d.; average

annual outlay for maintenance of sewers only, £10 10s.

Contents of middens mixed with ashes and carted away by farmers at cost of occupiers; cost of scavenging £12 per annum.

HORSHAM.—Population, 5,300; mortality, 22.—No method yet adopted with the water-carried sewage; about one-third of the houses have water-closets.

Middens in general use, dry-earth system used in a few cases; night soil removed in carts to the fields around the town; paid by private contract.

HULL.—

Mr. J. Netten Radcliffe's report, 1874, states:—"Collection of night soil carried on by contract; contractor, in addition to receiving the material he collects, is paid from 2s. to 3s. yearly for each house in his district (in 1869, this payment was from 1s. to 1s. 6d.); 30,977 houses enumerated for this collection in 1873."

IPSWICH.—Population, 42,839; mortality, 22·7.—Water-carried sewage does not contain any manufacturing refuse; drained direct into River Orwell, and carried away by the ebb-tide; about 800 water-closets in use. Total cost of construction for sewers cannot be well estimated, as they have been constructed at different times; annual outlay for maintenance about £600; net cost of dealing with sewage in 1875, £600.

Middens, and about 40 pail-closets in use, these latter "Gibbon's and Greene's Manchester," and "Morrell's" systems as an experiment; night soil removed by farmers and sanitary authority; deposited at the manure yard mixed with ashes, sold at 4s. a load; gross cost of disposing of night soil in 1875, £228; receipts, £100; cost of street scavenging, £900 per annum. Considered that cinder shifting pail-closets would be most profitable and least offensive, provided the sanitary authority would undertake the systematic removal to one or more depôts.

JARROW.—Population, 18,115; mortality, 24·1.—Water-carried sewage contains refuse from alkali works; drained direct into River Tyne; only about 50 water-closets in use.

Midden system the only one generally adopted, and is described as being as bad as it can be. 3,000 middens in use; ashes mixed with night soil; contents of middens carted away when full to the depôt, and there accumulate, except the very small proportion which is taken by the farmers for manure. Gross cost of disposing of night soil in 1875, £917,143, receipts £20; cost of scavenging, £530 14s.; general disinclination to change stated as impeding sanitary improvement.

KENDAL.—Population, 13,455; mortality, 20.—Water-carried sewage contains a considerable amount of refuse from dye works, tanneries, &c.; treatment downward intermittent filtration through the soil and by irrigation, rough deposition in a tank previous to being applied to land and filtration areas; about 500 water-closets in use. Total cost of construction for sewers up to end of 1874, about £20,000; annual outlay for maintenance of sewers only from £25 to £30. System successful in preventing pollution of river; in action three years.

About 1,200 middens in use, mostly of old form; ashes in some cases mixed with the night soil; night soil sold or given to farmers and removed at cost of occupiers, as the urban sanitary authority do not dispose of it; the above is considered to be the best method for disposing of night soil for this locality; cost of scavenging £360 per annum. Return states as an impediment to the sanitary improvement of the locality; urban sanitary authority have not sufficient powers; Public Health Act leaves this matter entirely to the discretion of the justices, who are often owners of property in a most unsanitary state, and therefore adverse to ordering expensive works, though they are proved to be requisite. About £700 have been expended in legal proceedings with respect to sewage. No injunctions granted.

KIDDERMINSTER.—Population, 19,463; mortality, 21·5.—Water-carried sewage contains refuse from dye works, is dealt with by irrigation of sewage farm. Total cost of construction for sewers up to end of 1874, £58,009 15s. 2d.; outlay for maintenance in 1874, £543 3s. 3d.; net cost of dealing with sewage in 1875, £975 9s. 4d. Cost of sewage farm, £16,000; soil of a hungry sandy nature, with gravel under it, is let at £3 per acre. Cost of waterworks, which has a good supply from an artesian well, £23,427.

There are in use about 1,300 ash-pits; night soil sold to market gardeners. Gross cost of disposing of night soil in 1875, £139 13s. 11d.; receipts, £139 13s. 11d.

KINGSTON-UPON-HULL.—Population, 137,000; mortality, 27·33.—Water-carried sewage drained direct into an estuary of the Humber; water-closets used only in the houses of the better classes.

Privies in general use; the subject of night soil collection is at present under consideration; present system said to be in every way bad; a deputation, consisting of town clerk, medical officer, and surveyor, were recently sent to Liverpool, Manchester, and Leeds, on this subject; their report recommended a modification of the Manchester system.

Mr. J. Netten Radcliffe's report for 1874 states:—"The system in general use is a modification of the midden closet, with frequency of scavenging."

KING'S LYNN.—Population, 17,163; mortality, 21·8.—Water-carried sewage drained direct into River Ouse, or cesspools. A considerable number of water-closets in use.

A large number of box-privies, into which ashes are thrown, in use; boxes emptied by scavengers weekly; contents sold to farmers. With regard to cleanliness the water-closet method has been found to be the best.

LEAMINGTON.—Population, 20,917; mortality, 18·9.—Sewage does not contain any manufacturing refuse; is pumped on to the farm of the Earl of Warwick for irrigation of land, all sewage from the borough having been conceded to the Earl for a term of thirty years; about 4,000 water-closets; system in universal use. Total cost of construction for sewers up to end of 1874, about £30,000; annual outlay for maintenance, about £250 (wages and materials); net cost of dealing with sewage in 1875, £430 3s. 9d.

Almost all houses supplied with either a dry ash-pit or ash-box for ashes and house refuse; scavenging department under control of borough surveyor; ash-pits and boxes

emptied periodically; cost of scavenging in 1875, £787 9s. 10d. An injunction was obtained against the late Local Board to restrain them from discharging the effluent water from the sewage into the River Leam, as at that time the whole of the sewage was treated by the "lime process," precipitation and filtration, the cost amounting to over £2,000. Great difficulty is experienced in getting rid of the ashes collected, farmers will not buy them, as they are not mixed with night soil. The whole of them would be given away by the council for the fetching. A serious difficulty must arise in the course of time in disposing of the great accumulation of ashes.

LEEDS.—Population, 291,000; mortality, 26·4.—Water-carried sewage contains a large quantity of manufacturing refuse from dyeworks, tanneries, &c.; very difficult to treat successfully; now dealt with by precipitation under the Native Guano Company's process; treatment in action between two and three years, at intervals. About 6,300 water-closets. Total cost of construction for sewers up to end of 1874 about £280,000, and about £60,000 for outfall works. Other processes are being tried, to endeavour to find the cheapest efficient process. The process of the Native Guano Company, and that of the Leeds Clarifying and Purification of Sewage Company, have both proved to be successful in preventing the pollution of rivers, but not commercially. Rawson's process makes also an apparently good effluent.

15,598 middens, and about 6,000 pails in use; night soil mixed with ashes and sold as manure. Gross cost of disposing of night soil in 1875 about £26,000; receipts, about £7,000. Cost of scavenging, about £10,800. One injunction obtained, restraining authorities from discharging sewage into River Aire until the same has been purified and deodorised so as not to be a nuisance nor injurious to public health.

Mr. J. Netten Radcliffe's report, 1874, states:—"That about 1-16th of the population employed the pail system, separate pails for excrement and dry house refuse; about 3-16ths the common privy, with midden-stead, no public provision for their being cleansed; and that not more than six weeks' filth will probably be permitted to accumulate among the remaining 12-16ths."

LEICESTER. — Population, 95,084; mortality, 26·02.—Water-carried sewage contains refuse from dye and soap works; treatment, precipitation by lime; 6,500 water-closets in use. Total cost of construction for sewers up to end of 1874, £41,000; annual outlay for maintenance, about £1,500; net cost of dealing with sewage in 1875, £2,032 17s. 9d.; system in action twenty-two years; not successful in preventing pollution of river Soar.

3,500 middens, 3,660 ash-pits, and 3,000 pail-closets in use; ashes mixed with night soil and sold as manure; gross cost of disposing of night soil in 1875, £7,036 17s. 1d.; receipts, £3,367 5s. 7d.; cost of scavenging, £851 10s. 2d. The pail system has been found in this locality to be the best means of disposing of the night soil. Outlying villages object to contamination of river by effluent sewage water. It is suggested that irrigation and downward filtration on elevated districts would obviate this difficulty.

LINCOLN.—Population, 26,766; mortality, 22.—No works of sewerage in operation in the city; 500 water-closets in use, discharged into the River Witham. Night soil from privies, &c., collected and given to farmers. Cost of scavenging £1,700 per annum.

LITCHURCH. — Population, 11,087. —Water-carried sewage contains hardly any manufacturing refuse; filtered through coarse gravel, and finally charcoal; about 100 water-closets in use; treatment in action about four years; annual outlay for maintenance, £50.

Midden system in use; night soil mixed with ashes, carted to depôt and sold to farmers; gross cost of disposing of night soil in 1875, about £350. Has been found to be the best method of disposing of night soil in this locality.

LIVERPOOL.—Population, 493,405; mortality, 27·5.—Water-carried sewage contains manufacturing refuse; is drained direct into River Mersey; although a company was formed in 1866 to apply the sewage to the irrigation of a sandy district north of the town, a pumping engine was erected and pipes laid, but nothing has been done for about three years. About 70,000 water-closets in use by almost four-fifths of the inhabitants. Since the Liverpool Sanitary Act, 1846, came into operation, about £600,000 has been expended in sewage works; average outlay for maintenance, £3,000. The pollution of the Mersey, which is very wide and swift, is comparatively slight, and with the exception of the above-named company no steps have been taken to abate it.

In 1871, 15,171 middens (since decreased), 17,480 ash-pits (since largely increased), and 3,760 trough water-closets with galvanised iron receptacles for ashes and dust. Net cost of scavenging in 1875, including collection and disposal of night soil, house refuse, &c., was £67,138 (an exceptionally heavy year); net receipts, 1874, on sale of product of scavenging, £6,654. These methods have been found in the locality to be the best method of disposing of night soil.

LONGTON.—Population, 19,747.—Water-carriage system about to be adopted, under plans prepared by Mr. Baldwin Latham, works in progress.

LOUTH.—Population, 10,500; mortality, 21·24.—Water-carried sewage contains a small amount of refuse from asphalte, candle, and soap works; is drained direct into the River Lud. 362 water-closets in use, equal to 12 per cent. of the houses. Total cost of construction for sewers up to end of 1874, about £6,000; annual outlay for maintenance, *nil;* net cost of dealing with sewage in 1875, *nil.*

There are 2,350 ash-pits, the night soil from which is collected by scavengers, and stored at the depôt outside the town, where it is sold to farmers; receipts for sale of night soil from September 1874, to September 1875, £129 5s. 9d. Omitting profit, the use of a small water-tight pit under the privy seat (earthenware pans or otherwise), and ashes either thrown in, or to pass down a shoot to the soil, has been found in this locality the best method of disposing of the night soil. Several engineers have been consulted as to an improved drainage, and keeping the sewage out of the river; but no steps have been taken to carry out any new plan.

MACCLESFIELD.—Population, 35,571; mortality, 26.—No general system of drainage has been completed; sewage drained direct into the River Bollin; water-closets only to a limited number in the best houses, have been discouraged until provision is made for the disposal of the sewage.

Ash-pits in use, contents removed by farmers. Gross cost of disposing of night soil in 1875, £799 2s. 2d., receipts £214 10s. 11d. Cost of scavenging, £836 10s. 9d. Medical officer of health states in his report, December, 1874, 3,044 houses thoroughly well drained; 5,199 houses unprovided with a proper system of drainage, these he divides into two classes, viz., 3,217 in which the drains are too shallow and defective in other ways, and 1,972 without any pretensions to any system of drainage, and the sewage allowed to flow on the surface of the ground; Out-door closet accommodation as a rule defective and insufficient; the older closets being built upon wrong principles; ash middens too large and badly built. In closets being built these defects are remedied.

MALDON.—Population, 5,297; mortality 20.—Water-carried sewage discharged into River Blackwater. Soil from water-closets, &c., principally led into cesspools, which are emptied by the farmers; system in use a number of years. Cost of construction for sewers comparatively trifling, no regular system of sewage having been yet adopted; annual outlay for maintenance small; net cost of dealing with sewage in 1875 very small so far as the authorities are concerned. The force of the tide is usually so great that practically no inconvenience or danger to health has arisen from the sewage matter being allowed to to flow into the river, but steps are being taken to prevent an increase in the quantity.

MALVERN LINK.—Population, 2,000; mortality, 11·5.—Water-carried sewage does not contain any manufacturing refuse; treatment, irrigation of 20 acres of land after filtration; 100 water-closets in use. Total cost of construction for sewers up to end of 1874, £2,000; annual outlay for maintenance about £95. System successful in preventing polution of rivers.

Ashes mixed with night soil and refuse of cesspools; removed by farmers; has been found to be the best method of disposing of night soil.

MANCHESTER.—Population, 351,189; mortality, 28·4.—Water-carried sewage contains manufacturing refuse, drained direct into the rivers; estimated number of water-closets in use, 10,000.

About 20,000 tub-closets and 23,000 Lancashire middens in use; night soil mixed with ashes; a portion is made into concentrated manure, and the remainder sold as common night soil. Net cost of disposing of night soil in 1875, after deducting receipts, £22,839 2s. 7d.; scavenging, £22,151 7s. 11d. The tub system has been found to be the best method of disposal of night soil.

The Health Committee has now made arrangements with the "Universal Charcoal and Sewage Company, Limited," for the use of its system of carbonising the refuse, &c., by which it is reduced in bulk 50 per cent. before admixture with the night soil, which it is stated is by the addition of the charcoal so obtained rendered perfectly inodorous and inocuous.

Mr. J. Netten Radcliffe's report for 1874 states:—"That the corporation have established a frequent systematic removal of excremental and household refuse, and are substituting movable receptacles for middensteads; system already applied to 6,000 of the 67,000 houses of the city, being extended to the rest at the rate of 5,000 annually. Most significant testimony was given to the benefit of the change by some householders; the change, moreover, has affected beneficially the value of cottage property, and tenants are quite willing to give 3d. more rent weekly, since the reconstruction of the privies."

MARGATE.—Population, 11,956.—All sewage drained into cesspools; when full, fresh ones generally dug; water-closets almost universal; annual outlay for maintenance supposed to exceed that of a sewers' rate.

MARLBOROUGH.—Population, 3,660.—Sewage drained direct into River Kennet; cesspools in general use.

MERTHYR TYDFIL.—Population, 51,891; mortality, 21.—Sewage does not contain any manufacturing refuse; strained through layers of cinders in tanks, and effluent water used for irrigating land; treatment in action five years; about 4,000 water-closets in use; total cost of construction up to end of 1874, for sewers and sewage works, including purchase of 272 acres of land, £97,000 (72 acres in addition held under lease); annual outlay for maintenance of sewage works, £400; cost of material for straining tanks and labour; application of sewage to the farm £447 0s. 6d.; system found successful in preventing pollution of rivers; cost of scavenging in 1875, £2,023 6s. 7d. One injunction granted; cost of legal proceedings in respect of sewage, £10,675 19s. 11d.

NEWARK.—Population, 12,187; mortality, 26·6.—Water-carried sewage contains a large quantity of refuse water from maltings, drained direct into River Trent. About 600 water-closets in use; total cost of construction for sewers up to end of 1874, £3,700. Annual outlay for maintenance and cost of dealing with sewage, *nil.*

About 650 middens in use; ashes mixed with night soil after collection and sold to farmers; receipts for sale of night soil in 1875, £150; cost of scavenging, £550.

NEWPORT (MONMOUTHSHIRE).—Population, 29,018; mortality, 22. Sewage contains a small amount of manufacturing refuse; is drained direct into tidal river Usk. No cesspools are allowed; all water-closets, &c., drained direct into sewers. Town well sewered, and has a constant supply of excellent water. Typhoid but little known, and epidemics of cholera have passed harmlessly by.

NORWICH.—Population, 80,382; mortality, 23.—Water-carried sewage contains refuse from breweries, mustard, and starch works; treated partially by irrigation, but the scheme is not yet fully developed; greater part of sewage at present discharged direct into River Wensom; about 3,500 water-closets in use. Total cost of construction for sewers up to end of 1874, about £150,000; annual outlay for maintenance, about £10,000 for the past three or four years; net cost of dealing with sewage in 1875, about £11,500.

Middens in use to a large extent; ashes mixed with night soil, removed by contract; gross cost of disposing of night soil in 1875, £1,500; receipts, *nil;* cost of scavenging, including cleansing

highways, £10,663. It is stated that this system acts very well, but is at a great outlay. Two injunctions granted, one to prevent the pollution of river, and the other to prevent pollution of a well, the Parliamentary and other costs of which will not reach £2,000.

NORTHAMPTON.—Population, 41,270.—Water-carried sewage contains refuse from tanneries; treatment irrigation; it is drained into tanks, and thence to sewage farm, four miles distant. Attempts were made for several years to purify the sewage by chemical means and by filtration, without success. About 7,000 water-closets in use. The sewering of the town has been gradually accomplished during the last thirty years, at a cost to the town of about £28,000; all new streets, at the cost of the owners, probably £6,000 more; net cost of dealing with sewage in 1875, about £2,300; cost of scavenging, £1,000 per annum. It is stated in the returns from this locality that "the want of an intelligible code of sanitary laws, in drawing up of which town surveyors should have a voice," impedes improvement in the sanitary condition of the locality. Two injunctions have been granted, costing the locality directly and indirectly from £12,000 to £15,000. The return also mentions the desirability of some authority being established, which (in case of injunctions being threatened or obtained) shall have power to consider and approve of the proposed remedial measures or plans, such approval to act as an idemnity against future attacks in the same direction. This would give local bodies encouragement to carry out works which the want of some security makes them now hesitate to undertake. In the case of this town they have been compelled to obtain an act to acquire land by compulsion, for a farm; the purchase and laying out of which has cost £75,000, and is only just completed.

NOTTINGHAM.—Population, 86,262; mortality, 27·8.—Water-carried sewage contains manufacturing refuse; drained direct into River Trent; question of sewage utilisation under consideration. About 3,000 water-closets in use. Total cost of construction of sewers up to end of 1874, about £80,000; annual outlay for maintenance, about £100. No register kept of middens and ash-pits, probably about 6,000 in use; tub-closets, 3,766; night soil collected and sold to farmers under the direction of the officers of the corporation. Gross cost of disposing of night soil in 1875, for cleansing privies and ash-pits, £5,981 1s. 4d.; for tub-closets, £1,791 12s. 4d.; for purchase of horses and plant, £815 5s. 4d.; and for repairs, £560 11s. 3d.; total £9,148 10s. 3d.; receipts, £4,284 19s. 8d.; cost of scavenging, £2,300. System in present use not objectionable in a sanitary sense, financially an annual loss. It is hoped, however, that when present works are completed, expenses will be reduced.

Mr. J. Netten Radcliffe's report for 1874 states:—"Number of pail-closets 2,510, serving for the use of 4,516 houses. This form of closet is now regularly adopted in the old town, when a new privy is to be erected, or an old privy to be reconstructed. A single pail is used for excrement, ashes, and dry house refuse."

OLDHAM.—Population, 88,609; mortality, 30.—Water-carried sewage contains refuse from two dye works, is drained direct into the rivers Irk, Medlock, and Beal; 1,420 water-closets in use. Total cost of construction of sewers up to end of 1874, £30,000.

Pan-closets, 7,000; ash-pits, 4,500; and middens, 8; contents collected by the Carbon Fertiliser Company, Limited; system of disposal, treating with charcoal and fixing the ammonia; 3s. per inhabited house is paid by the Corporation to the company for collection; total sum thus paid in 1875, £2,927 19s. 11d; cost of scavenging in 1875, £2,600; removal of ashes, £2,077 14s. 10d. The system of the Carbon Fertiliser Company is stated to answer well in this locality. Medical officer of health remarks on the necessity with public abattoirs that the blood, &c., should be collected and prevented from entering sewers; of preventing steam being permitted to be blown into the sewers; medical officer of health to certify before made ground, containing contents of middens, be built upon; certificate to be given by borough surveyor and medical officer of health before newly built house be inhabited; medical practitioners being legally compelled to give health officer notice when any of their patients are suffering from contagious or infectious diseases.

Mr. J. Netten Radcliffe's report for 1874 states:—"In 1872, arrangements for excrement disposal consisted of 1,300 water-closets, 1,800 pail-closets, and 6,200 middens of the old offensive type; now less than 50 middens remain, for the remainder pail-closets have been substituted. The Carbon Fertiliser Company, Limited, have undertaken collection of pails and disposal of their contents at 3s. per closet, pails collected weekly."

ORMSKIRK.—Population, 6,127; mortality, 30.—Water-carried sewage dealt with by irrigation of land; 186 water-closets in use. Total cost of construction for sewers in 1874, £5,962; annual outlay for maintenance, about £5. Irrigation farm sublet to a farmer on lease. Treatment successful in preventing pollution of rivers.

Middens emptied by employés of Board; ashes mixed with night soil and sold to farmers; in some cases night soil disposed of direct by occupiers of premises; gross cost of disposal of night soil in 1875 about £10; receipts, £9; cost of scavenging, £80. One injunction granted, which cost the town in law expenses, £650.

OSWESTRY.—Population, 7,308; mortality, 20.—Sewage contains manufacturing refuse; is dealt with by filtration, effluent water discharged into a brook; water-closets in general use throughout the town; treatment in action 12 years. Total cost of construction for sewers up to end of 1874, £20,000; annual outlay for maintenance, £90.

Very few privies exist; night soil disposed of to farmers. Cost of scavenging in 1875, £110.

OXFORD.—Population, 32,477; mortality, 22.—Water-carried sewage does not contain any manufacturing refuse; drained direct into River Thames; water-closets in universal use.

PEMBROKE.—Population, urban district, 13,704; mortality, 24·4.—Water-carried sewage is drained into cesspools.

Middens and ash-pits in general use; night soil mixed with ashes and house refuse used on farms. A systematic removal of the soil at

short intervals has been found to be the best method of its disposal. It is stated that there is a great want of a continual water supply and of drainage.

PENRYN.—Population, 3,636; mortality 30·2.—Water-carried sewage does not contain any manufacturing refuse, undergoes no treatment; about 15 water-closets in use. Total cost of construction for sewers up to end of 1874, about £3,000; annual outlay for maintenance about £50.

A large number of middens in use; ashes mixed with night soil, removed by farmers for dressing fields; cost of scavenging £1 1s. per week. About £3 has been expended in legal proceedings in respect of sewage, but no injunctions obtained.

PENZANCE.—Population, 10,414; mortality, 21.—Sewage drained direct into the sea; water-closets in universal use. Total cost of construction for sewers up to end of 1874, £5,237 19s. 10d.; annual outlay for maintenance about £20. There has been expended in water mains and sewers, £47,534 3s. 6d., this includes house drainage not paid by rate. Annual cost of scavenging, £659.

PETERBOROUGH.—Population, 18,000; mortality, 19·38. Sewage does not contain any manufacturing refuse; drained direct into river.

About 50 middens in use; night soil disposed of to farmers. Sewage Bill now before Parliament. It is stated that the want of a good water supply and system of drainage is an obstacle to the progress of improvement in the sanitary condition of the locality.

PLYMOUTH.—Population, 71,667; mortality, 20·62.—Water-carried sewage contains refuse from dye and soapworks, is drained direct into the sea, below low-water mark; water-closets in universal use; middens not allowed, and ashes removed every second day by contract. Total cost of construction for sewers up to end of 1874, £37,000; annual outlay for maintenance, £200; net annual cost for dealing with the sewage, £2,000; cost of scavenging in 1875 was £2,500. Discharging direct into the sea has been found in the locality to be the best method of disposing of the night soil.

PORTSMOUTH.—Population, 113,569; mortality, 19·5.—Water-carried sewage drained direct into the sea; 12,511 water-closets in use. Total cost of construction for sewers up to end of 1874, £160,000; annual outlay for maintenance £870.

About 9,000 privies still exist; night soil removed at cost of owners or occupiers who pay 5s. for emptying single, and 9s. for double pit. Cost of scavenging £2,714 per annum nett cost. Numerous streets neither paved nor drained exist in the borough, many owners of which are unable to pay for the necessary work, and the corporation having no capital cannot construct them; although 214 section of Public Health Act, 1875, provides for this, it is found in practice to be quite impracticable in case of weekly or monthly tenants and void and unproductive land. The borough engineer considers it highly desirable that above-mentioned Act should be amended by making charge upon the owner, and in cases of default giving corporations power to receive rents until charges are paid.

REIGATE.—Population, 15,916; mortality, 15·1.—Water-carried sewage contains small amount of refuse from tan-yards, dealt with by irrigation; the sewage undergoes no treatment previous to its application to land of sewage farm; water-closets in universal use. Total cost of construction for sewers up to end of 1874, £47,796 18s. 2d., exclusive of irrigation works; net cost of dealing with sewage in 1875, £104 9s. 7d., that is to say, excess of expenditure on sewage farm over the amount received for produce. No dry system of any moment in operation.

RICHMOND (Surrey).—Population, 15,110; mortality, 17·7.—Water-carried sewage contains refuse from one dyer's works only, is drained direct into the River Thames; about 4,000 water-closets in use. The parish was sewered in 1850 by the Metropolitan Commissioners of Sewers, at a cost of several thousand pounds. A few cesspools still exist.

As impeding the progress of improvement in the sanitary condition of the locality, it is stated that it is a suburban parish, almost wholly built over, and bounded by Crown property and the river; suggested the formation of a united district of Richmond and adjacent parishes for sewage purposes. A sum of about £2,000 has been expended in legal proceedings in respect of sewage, including a fine inflicted under the Conservancy Acts on the Vestry, costs of unsuccessful appeal, obtaining Local Sewage Act, &c.

ROCHDALE.—Population, 67,590; mortality 24·10.—Water-carried sewage contains manufacturing refuse; is drained direct into the River Roche; 429 water-closets in use.

Pail-closets, 5,552; middens, 2,776; and ash-pits, 1,590 in use; night soil mixed with ashes, and treated by process introduced by Mr. Alderman Taylor, known as the Rochdale system. Gross cost of disposing of the night soil in 1875, for pail-closets £7,057; for middens, &c., £2,456; receipts for the manufactured manure £4,420, for night soil and ashes £537; cost of scavenging £2,431 9s. 9d. Manufacturing the night soil into manure by the Rochdale system has been found to be the best method of its disposal. It is mentioned in the return from this borough as an obstacle that impedes the process of improvement in its sanitary condition, that Parliament refuses to grant the Corporation power to procure a suitable site for irrigation purposes; suggests the necessity of fuller enlightenment of the people and their representatives in Parliament on these subjects. One injunction granted, preventing the sewage being discharged into the river above a certain point, has cost the Corporation the expense of extending the sewers.

Mr. J. Netten Radcliffe's report for 1874 states:—"The Rochdale system consists in the systematic removal at weekly or shorter intervals of the excrement, and dry house refuse in pails each separate from the other, the manufacture of the excrement with the fine coal-ash into manure, and the proper utilisation of the dry refuse;" and mentions that "taking the week ending September 24th, 1873, the total net cost to the town for the removal of excreta and house refuse of a population of 36,894, was £10 3s. 3d., being at the rate of £14 6s. 8d. per 1,000 per annum."

ROCHESTER.—Population, 18,352; mortality, 25·06, inclusive of deaths at the hospital, exclusive 19·72.—Sewage question at present under the consideration of the corporation.

RYDE (Isle of Wight).—Population, 11,234; mortality, 14.—All sewage drained direct into the sea; all houses, with the exception of a very few in outlying positions, use water-closets of some description. Total cost of construction for sewers up to end of 1874, £12,900; annual outlay for maintenance, £120; cost of scavenging, £310 per annum.

SAFFRON WALDEN.—Population, 5,717; mortality, 20·6.—Water-carried sewage; treatment, settling tanks and screen filters; cesspool used to a small extent; about 150 water-closets in use. Total cost of construction for sewers up to end of 1874, £2,930; annual outlay for maintenance and cost of dealing with sewage, trifling.

About 130 houses have dry ash closets, remaining houses, which do not use water-closets, have ash-pits; night soil mixed with dry earth, but none has yet been sold; process in action only a short time. Cost of legal proceedings in respect of sewage, *nil.* Nine injunctions have been granted against locality.

SALFORD.—Population, 124,805; mortality, 31·78.—Water-carried sewage contains manufacturing refuse, is drained direct into the River Irwell. Total cost of construction for sewers for fifteen years ending August 31st, 1875, £140,661; average annual outlay for maintenance, £9,377 8s.; cost of dealing with sewage in 1875, £21,686.

In one district of the borough a pail system has been adopted, in the other districts middens still exist; about 5,000 pail-closets in use; contents are made into a manure by admixture with fine ash and sulphate of lime, and sold at 12s. 6d. per ton; the contents of the middens are sent down into the country at a loss. Gross cost of disposing of the night soil in 1875, £23,988; receipts, £3,725 5s. 6d. As regards cleanliness the pail system has in this locality proved to be the best method of disposing of the night soil. The medical officer of health remarks the want of more compulsory clauses in the Public Health Act, in the place of merely permissive clauses.

Mr. J. Netten Radcliffe's report for 1874 states:—"The number of middens, with certain exceptions, in use, 26,184, and serving, together with 1,500 water-closets, for 29,423 houses. Two experimental methods of excrement disposal had been put in operation by the corporation, viz., Goux's Patent Absorbent Closet System and Morrell's Patent Ash-screening Closet. About 2,000 closets to which Goux system had been applied are now converted into simple pail-closets on the Rochdale pattern, as experience of the system has not induced the corporation to continue it. It must be stated that the manufacture of the manure was carried out as a private enterprise, and the method differed in some details from that proposed by Mr. Goux. Mr. Morrell's arrangement in use in upwards of 300 houses in the Pendleton district, but had been too little time in use for Mr. J. Netten Radcliffe to form an opinion on its merits."

SALISBURY.—Population, 12,902; mortality, 24·3.—Water-carried sewage contains refuse from breweries, is drained direct into River Avon; all houses are provided with water-closets. Total cost of construction for sewers up to end of 1874 about £15,000; cost of scavenging, watering roads, and removal of house refuse, &c., £700.

SANDOWN (Isle of Wight).—Population, 2,350 mortality 16 for resident population, and 18·4 including visitors.—Water-carried sewage does not contain any manufacturing refuse; dealt with by precipitation and deodorisation by means of MacDougall's powder; effluent water drained into River Yar; water-closets in general use; treatment in action about eight years. About six earth-closets in use; emptied by occupiers of houses and used in gardens.

SANDWICH.—Population, 3,050.—Town drainage only provides for storm water and waste from sculleries, &c.; water-closets drained into cesspools, which, with middens, are in general use. A system of tub-closets has been largely in use among the poorer classes for some years; the tubs are emptied weekly or fortnightly by market gardeners.

SHREWSBURY.—Population, 23,300; mortality, 20·8.—Water-carried sewage contains very little manufacturing refuse, drained direct into River Severn; about 2,000 water-closets, as well as, in many instances, common privies, which are drained into the sewers and cess-pits.

Middens in use; contents removed by private arrangement, and employed on cultivated land. It is stated in the medical officer of health's report, March, 1875:—"Attached to many houses are common privies, draining into the sewers; these are simply filthy sewer ventilators, and the most dangerous nuisances of all. In connection with other houses there are privies in situations where collections of excrement should not be allowed at all, and where, however if frequently scavenged, or even if converted into dry closets, they must necessarily be injurious to health. In the case of the majority of the cess-pits, the greater part of the contents percolate away into the surrounding soil."

SOUTHAMPTON.—Population, 53,741; mortality, 19·84.—Sewage does not contain any manufacturing refuse; is drained direct into the Southampton water; water-closets in general use. Total cost of construction for sewers up to end of 1874, £70,318 10s. 11d.; average annual outlay for maintenance for the last ten years, £481 0s. 2d.; net cost of dealing with sewage in 1875, £4,628 16s., including the cost of new sewers paid out of capital account; cost of scavenging, removal of ashes £600, cleansing of streets £1,000 per annum.

SOUTH SHIELDS.—Population, 45,336; mortality, 24·8.—Water-carried sewage contains refuse from alkali works, is drained direct into River Tyne; about 600 water-closets in use in the better class of houses. Total cost of construction for sewers up to end of 1874, about £30,000; annual outlay for maintenance, about £400.

About 500 ash-pits and middens in use; ashes and night soil sold to farmers at a nominal sum. Gross cost of disposing of the night soil in 1875, £1,200; receipts, £280. Cost of scavenging, £1,400. It is stated that the present system was most unsatisfactory. The law allowing middens to be constructed in the midst of a dense population impedes improvement in the sanitary condition of the locality.

SOUTHWOLD.—Population, 2,155; mortality, 12·06.—All sewage drained into dead wells on the premises; about 25 water-closets in use; night soil disposed of to farmers, costing the corporation about

£20 per annum. The healthiness of the borough induces the inhabitants not to incur the risk and expense of adopting any system of sewerage.

Stalybridge.—Population, 21,092; mortality, 25·3.—Water-carried sewage contains manufacturing refuse; drained direct into River Tame; about 300 water-closets in use.

Night soil removed to a depôt, and disposed of for agricultural purposes. Gross cost of disposing of night soil in 1875, £888 18s. 8d.; receipts, £602 15s. 7½d.; scavenging £300 per annum; the present method has been found the best for disposing of night soil in this locality.

Stoke-upon-Trent.—Population, 16,000; mortality, 19·09.—Water-carried sewage does not contain any manufacturing refuse; drained on to meadows, and is partly dealt with by irrigation; about 200 water-closets in use.

Night soil from middens is mixed with screened ashes, and disposed of to farmers; receipts for night soil in 1875, £87; cost of scavenging, £552. The Corporation are about to construct sewage works on the irrigation and downward filtration system.

Stroud.—Population, 7,082; mortality, 23.—Sewage contains manufacturing refuse; is treated by filtration and precipitation by sulphate of alumina and HCl. system in operation several years. Annual outlay for maintenance of sewage works, £100, chemicals, £100.

A few ash-pits exist where it is impossible to connect with the system. Scavengers collect daily all ashes, &c.; cost of scavenging about £200.

Sudbury.—Population, 6,900; mortality, 18·9.—Water-carried sewage contains very little manufacturing refuse; is drained direct into River Stour, close to the town. About 250 water-closets in use. Annual outlay for maintenance of sewers from £15 to £20. In a state of transition from cesspools to Goux; about 50 Goux-pails in use; night soil sold direct to farmers by city authorities, who collect. Cost of scavenging, £240 per annum.

Sunderland.—Population, 103,000; mortality, 22·4.—Water-carried sewage does not contain any manufacturing refuse; drained direct into sea and tidal River Wear; 2,573 water-closets in use. Total cost of construction for sewers up to end of 1874, £69,000; annual outlay for maintenance about £250; net cost of dealing with sewage in 1875, £400.

Between 11,000 and 12,000 ash-pits in use; night soil, &c., disposed of to farmers by private arrangements. Cost of scavenging in 1875, £5,000. The medical officer of health remarks that the difficulty of obtaining information respecting outbreaks of infectious diseases impede progress of improvement in the sanitary condition of the locality, and suggest the advisability of compelling medical men and heads of families to forward immediate information of all cases of zymotic diseases occurring in their practice or in their families, making it penal for persons knowingly entering an infected house, such houses to be marked in some way.

Swinton and Pendlebury.—Population, 18,000; mortality, 17·7.—Water-carried sewage contains manufacturing refuse; treatment, filtration and irrigation. About 12 water-closets in use. Cost of maintenance for sewers, &c., about £80; net cost of dealing with sewage in 1875, about £100.

2,300 ash-pits in use. Up till lately the night soil and ashes were taken to a depôt and ground up together, and sold as manure; now abandoned. The Local Board sell the contents of the ash-pits without their undergoing any preparation whatever. Emptying of ash-pits let by contract, for £530 per annum, for a term of two years; as much as possible of contents sold to farmers for manure, at 1s. per load. Night soil not sold; taken and stored at depôt, away from any houses. Gross cost of disposing of night soil in 1875, £771; receipts, £63.

Tenterden.—Population, 3,669; mortality, 26·71.—Water-carried sewage does not contain any manufacturing refuse, drained into cesspools; 53 water-closets used with a supply of water, and 281 to which water is supplied by hand.

Middens are in use, night soil as well as contents of cesspools mixed with earth and used for manure; in some few cases it is mixed with ashes; 11 earth-closets; contents used by occupiers as manure for garden or land. In respect of cleanliness, water-closets are found to be the best method of disposing of night soil.

Tewkesbury.—Population, 5,409; mortality, 24.—Sewage does not contain any manufacturing refuse, treated by filtration; the residuum after filtration is absorbed by ashes and street sweepings, and sold as manure, but is not much sought after; about 800 or 900 water-closets in use; treatment in action 8 years; gravel filtration has been found successful in preventing pollution of rivers. Annual outlay for maintenance about £30; net cost of dealing with sewage in 1875, £35; cost of scavenging, £140. The medical officer of health in his return remarks that the existing system of sewerage is best suited to this town, having a good current of fluvial water at the outlet, aided by the flushing power from the water works, the principal impediment to perfect success being the occasional prevalence of floods associated with the low level of the land.

Totnes.—Population, 4,073.—Water-carried sewage drained direct into River Dart; about 100 water-closets in use. Total cost of construction for sewers up to end of 1874, about £520; no outlay for maintenance for several years.

About 100 middens in use; contents removed by scavengers. Works of sewage, paving, and channeling, are being contracted for.

Tottenham.—Population, 23,500.—Sewage does not contain any manufacturing refuse; treatment, precipation by magnesium chloride and lime; about 5,000 water-closets in use; system in action about 20 years. Cost of maintenance for the past four years, £2,000 per annum, previously considerably less; net cost of dealing with sewage in 1875, about £2,000. One injunction obtained by the River Lee Conservancy. No dry system in operation.

Truro.—Population, 10,899.—Water-carried sewage drained direct into the sea; about 500 water-closets in use, and 8 miles of main sewers; outlay for maintenance in 1874, £130, 1875, £300.

Night soil from middens mixed with ashes used on land, generally removed by farmers; authorities about to appoint a staff of men for this work; cost of scavenging £208 per annum.

Tunbridge Wells.—Population, [19,410; mor-

tality, 16.—Sewage does not contain manufacturing refuse; employed for irrigation of farm; 7,000 water-closets in use; annual outlay for maintenance of sewers £180; cost of scavenging in 1875, £624. One injunction granted.

TYNEMOUTH.—Population, 38,960; mortality, 22·64.—Water-carried sewage does not contain any manufacturing refuse; is drained direct into the sea and River Tyne. Total cost of construction for sewers up to end of 1874, £1,700; annual outlay for maintenance exclusive of flushing about £100.

Night soil is mixed with ashes, removed by the servants of the sanitary authority. Gross cost of disposing of the night soil was in 1875, £2,000; receipts £165. Cost of scavenging £3,000. This system has been found most conducive to cleanliness, but the loss in money, it will be seen, is considerable. The chief obstacle to any improvement in the sanitary condition arises from the existence in the heart of the district of a mass of tenemented property crowded together on the bank sides, with scarcely any sanitary convenience or space to erect them; entire removal is the only remedy; in the meantime constant scavenging is needed to keep them moderately clean.

ULVERSTON.—Population, 8,000.—Water-carried sewage contains refuse from paper mills; is drained into the sea; Rawlinson's filtration system in action about six years in connection with sewage from water-closets. Total cost of construction for sewers up to end of 1874, about £9,000; annual outlay for maintenance, about £35.

Midden system in general use; ashes mixed with night soil, which is removed at the expense of the occupiers of the property. Cost of scavenging and street repairs, about £300 per annum. Cost of legal proceedings with respect of sewage, about £500.

UXBRIDGE.—Population, 7,497; mortality of Uxbridge Proper, 21·42; no separate death register kept for a part of Hillingham parish, which is included in the Uxbridge Board of Health.—Sewage does not contain any manufacturing refuse; filtered through charcoal, effluent water discharged into River Colne; deposit sold for manure; about 1,500 water-closets in use. Total cost of construction for sewers up to the end of 1874 about £11,000; annual outlay for maintenance about £50; net cost of dealing with sewage in 1875, £210; cost of scavenging about £150; system in action 20 years; has been found successful in preventing any material pollution of the river. One injunction granted, and about £900 expended in legal proceedings in respect of sewage.

WALLINGFORD.—Population, 2,972; mortality, 18.—No system of sewerage has yet been adopted.

WALTON-ON-THE-HILL.—Population, 4,391; mortality, 16.—Water-carried sewage does not contain any manufacturing refuse, is dealt with by precipitation and irrigation of sewage farm; water-closets in use to a large extent; system successful.

Night soil from middens mixed with dry refuse; dry earth system also in use; soil collected by scavengers and used on sewage farm. Dry earth system found to be best method of disposing of night soil.

WARWICK.—Population, 11,001; mortality, 19·1.—Water-carried sewage contains refuse from gelatine works, dealt with by irrigation of 135 acres of stiff land; about 2,000 water-closets in use. Total cost of construction for sewers up to end of 1874, £23,872 1s. 5d.; cost of dealing with sewage in 1875, £1,187, out of which £671 was expended for pumping. Not more than six middens in use.

WATFORD, HERTS.—Population, 7,461 in the district, and about 600 in the London Orphan Asylum adjoining; mortality, 20.—Sewage does not contain any manufacturing refuse; dealt with by lime precipitation and irrigation; part is pumped, and part delivered by gravitation; about 1,400 water-closets in use. Total cost of construction for sewers up to the end of 1874, about £1,400; annual outlay for maintenance very small; cost of dealing with sewage in 1875, £725 14s. 2d.; income from crops, &c., £523 9s. 6d.; loss, £202 4s. 8d.; scavenging about £150. System has been successful in preventing pollution of rivers. One injunction granted, previous to adoption of present method; no expenditure since.

WELLINGBOROUGH.—Population, 9,385; mortality, 16·4.—Water-carried sewage contains scarcely any manufacturing refuse, 9-10ths of which is treated by mechanical filtration and 1-10th by intermittent filtration; about 1,500 water-closets in use. Total cost of construction for sewers up to end of 1874, about £6,950; annual outlay for maintenance, £50; cost of dealing with sewage in 1874 and 1875, about £60. The mechanical filtration process has been in use sixteen years; the intermittent, three years. No method tried has been found successful in preventing pollution of rivers. About twelve earth-closets are in use. Cost of scavenging, about £53 per annum.

WELSHPOOL.—Population, 7,318; mortality, 22.—Sewage contains a small amount of refuse from tanneries, is drained direct into River Severn; water-closets in general use in the locality. Total cost of construction for sewers up to end of 1874, £5,000; annual outlay for maintenance about £50; cost for scavenging about £100 per annum.

WIGAN.—Population, 42,000; mortality, 32·1.—Water-carried sewage does not contain any manufacturing refuse; drained direct into River Douglas, about one mile south of the town. Total cost of construction for sewers up to end of 1874, £27,760.

Midden system in use; night soil mixed with ashes and sold to farmers at a very low price; pail-closets about to be introduced; cost of scavenging, day, £930; night, £2,432 per annum; receipts for night soil in 1875, £564.

WINCHESTER.—Population, 17,003; mortality, 19·51.—Water-carried sewage does not contain any manufacturing refuse; a small quantity is discharged direct into the River Itchin, the remainder draining into cesspools; when emptied, contents used for manure.

Moule's dry earth system in use at the college houses. Cost of scavenging, £350 per annum. Locality has not yet been sewered. Sewage question at present nnder consideration.

WINDERMERE.—Population, 909; mortality, 19.—Water-carried sewage does not contain any

manufacturing refuse; drained through two cesspools where subsidence takes place, effluent water running into lake. Total cost of construction for sewers up to the end of 1874, about £500; annual outlay for maintenance about £5.

Midden system in use; night soil mixed with ashes, carted away by farmers at their own expense.

WISBECH.—Population, 9,362; mortality, 23·71. —Water-carried sewage drained principally into cesspools, remainder into tidal river; works under construction for disposal of sewage by irrigation of land that has been bought for that purpose. Sewers and works commenced in 1874.

Middens in general use; night soil removed by private contract; cost of scavenging, £158 3s. 3d. A sum of £267 10s. has been expended in legal proceedings in respect to sewage matters. Return from this borough remarks that the medical officer of health has not sufficient power and control in relation to persons suffering from infectious diseases.

WOKING (Prisons).—Population, 1,750.—Sewage drained into a tank, deodorised with lime, and run out daily on the land; 19½ acres of land under irrigation. The settlement in the tank is cleaned out every second or third day, and mixed with lime and ashes, and also used on the land; two tanks are employed, one filling whilst the other is emptying. This system, which has been found the most suitable method of disposing of the night soil, has now been in action four years. The cost, materials only, not including house drains, was about £420; work performed by convict labour. In addition to above, eight earth-closets are in use, contents of which are removed daily to the farm.

WOLVERHAMPTON.—Population, 68,279; mortality, 25·2. — Water-carried sewage contains manufacturing refuse, is dealt with by the irrigation; about 500 water-closets in use; treatment in action 5 years. Sewage farm contains 300 acres, purchased at a total cost of £32,000. Total cost of construction for sewers up to the end of 1874, £54,436, for works on sewage farm, £9,391, and for compensation and survey charts, £5,150. Annual outlay for maintenance, about £100; net cost of dealing with sewage in 1875, about £850. System has been successful in preventing pollution of water courses.

About 5,000 middens and ash-pits, and 350 pails; ashes mixed with the soil at reception yard, and sold to farmers. Gross cost of disposing of the night soil in 1875, £6,284; receipts, £1,773. A sum of about £800 has been expended in legal proceedings with respect to sewage, but no injunctions have been granted, several threatened actions have been referred to arbitration.

WORCESTER.—Population, 33,226; mortality, 25·58. Sewage contains a small quantity of manufacturing refuse, is drained direct into River Severn; there were 3,368 water-closets in use on a sanitary survey of the city in 1874. Total cost of construction for sewers since 1857 is £21,500; average annual outlay for maintenance about £150, without including any proportion of the salaries of officers.

Middens in use, 1,847; earth-closets 35; night soil removed by the sanitary authorities, mixed with refuse from the streets, and sold to farmers for manure at 2s. per ton. Receipts for manure in 1875, £224 6s.; cost of scavenging, £1,560. No injunction has been obtained; a suit was instituted by the Local Board of Health of Tewkesbury, in 1872, but has not since been proceeded with; £169 have been paid on account of costs incurred by the Local Board of Health of the city of Worcester as the defendants in such suit.

WORKSOP.—Population, 10,410. Sewage does not contain any manufacturing refuse; water-carried sewage, dealt with by filtration; about 50 water-closets in use. Total cost of construction for sewers up to end of 1874, £7,150. Middens in general use; ashes mixed with night soil.

Mr. J. Netten Radcliffe's report for 1874 states:—"The total number of water-closets in the town does not exceed 90, and from these 18 to 20 were without cisterns. Other provision for excrement disposal consisted of common midden closets."

WREXHAM.—Population, 8,537; mortality, 25·6. —Water-carried sewage contains refuse from leather manufactories and breweries, is dealt with by irrigation of sewage farm of 80 acres, in lease to the Corporation, and underlet to Lieut.-Col. Jones; system in action six years; results successful in preventing pollution of rivers; water-closets used by 30 per cent. of the inhabitants. Total cost of construction for sewers up to end of 1874, £11,081 16s.; annual outlay for maintenance, £10. In dealing with the sewage in 1875, profit to borough, £30.

By remaining 70 per cent. of the inhabitants middens, ash-pits, and cesspools in use; night soil carted to depôt, and sold by auction. Gross cost of disposing of night soil in 1875, £494 6s.; receipts, £200; cost of scavenging, £198 12s. 5d. The above method has been found to be best for disposing of night soil. The mayor and medical officer of health remark, that powers are wanting for compelling substitution of water-closets for middens, and suggest an application to the Local Government Board in order to have some stringent enactments passed. Storm water being conveyed through the main sewers along with sewage matter is much complained of by the occupier of the sewage farm.

YORK.—Population, 43,796; mortality, 23.—Water-carried sewage drained direct into river; about 3,000 water-closets in use.

Midden system also in use; night soil removed by private contract.

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 3rd; P. MARTIN DUNCAN, Pres.G.S., F.R.S., in the chair.

The following candidates were proposed for election as members of the Society:—

Graham, George, 20, Lancaster-gate, W.
Knobel, W. R., Conservative Club, St. James's-street, S.W.
Monkton, John Braddick, 44, Wimpole-street, W.
Stiff, Ebenezer, London Pottery, High-street, Lambeth.
Tarn, William, 21, Lancaster-gate, W.

The following candidates were balloted for and duly elected members of the Society:—

Allen, Stafford, Parkfield, Upper Clapton.
Barff, Arthur, Merton-cottage, Merton, Surrey.

Brazier, Charles Thomas, 106, Blackfriars-road, S.E.
Crossley, John, Sidney, Barrow-on-Soar, near Leicester.
Eastwood, Arthur William, Junior Athenæum Club, S.W.
Ellis, Edward Shipley, Leicester.
Gordon, Rev. David, Downs-park-road, Clapton.
Soto, His Excellency Don Marco Aurelio, Guatemala, Central America.
Verney, Major Sir Harry, Bart., F.R.G.S., 32, South-street, Mayfair, W.

The paper read was—

ON THE CHINA CLAY AND CHINA STONE OF DEVON AND CORNWALL.

By J. H. Collins, F.G.S.

Introduction.

The granite rocks of the West of England have long yielded materials for the use of the potter. These consist chiefly of a fine white refractory clay, called indifferently kaolin, porcelain clay, china clay, or Cornish clay, and a white vitrifiable variety of partially decomposed granite, known as porcelain stone, china stone, or Cornish stone. This latter appears to be identical with the petuntze of the Chinese.

The production of china clay and stone in the two western counties during the year 1874, was upwards of a quarter of a million tons.* The rise, progress, and present condition of so important an industry cannot fail to be interesting to many, and I have, therefore, endeavoured in the present paper to bring together some of the leading facts.

Bibliography.

No very complete account of this industry has ever to my knowledge been published, but there are many partial statements scattered through the proceedings of different scientific societies, mostly local. The earliest direct mention of the clay-works, which I have been able to find, is a remark by Dr. Pryce, who states that china clay was, in 1778, prepared for the use of the potters in the parishes of Breage and St. Stephens, and afterwards packed in casks for exportation† The trade was, however, many years old when Pryce wrote, as Mr. William Cookworthy, a native of Kingsbridge, in Devon, had established its value more than twenty years before, and had used it under a patent in his pottery at Plymouth. Mr. Cookworthy was a very observant person—he was the first to recognise the fitness of the clay for fictile purposes, and its identity with the kaolin of China, and he first discovered and used in England the other essential ingredient of porcelain, china stone, or petuntze.

His pottery was first established at Plymouth in 1733. It is not clear from whence he obtained his first clays, but in a pamphlet published in 1853‡ a letter from William Cookworthy to a friend is inserted, in which he states that an American brought him specimens of *kaolin* and *petuntze* found in Virginia, and also specimens of porcelain made

* 226,309 tons, according to Hunt's "Mineral Statistics." More than 60,000 tons of ordinary potter's clay is excluded from this return.
† Mineralogia Cornubiensis, p. 116.
‡ "Relics of William Cookworthy, collected by John Prideaux." London: Whitaker and Co.

therefrom. This material, he observes, could be imported for £13 per ton.*

The American and his specimens set him thinking and observing, and very soon he found a stone resembling petuntze in St. Stephens, probably about the year 1755. Three years later he found a similar material in the parish of Breage.

It is probable that the Cornish clay was already known to him, and that he had already used it to some extent, keeping the fact secret, in the manner of the times.† At any rate he patented the use of these materials, in conjunction with Lord Camelford, in 1768. Dr. Borlase, who wrote in 1758,‡ does not expressly say that Cornish clay was then employed, but he states that many suitable clays may be found in Cornwall, and especially mentions those of Towednack, Tregoning Hill, and St. Enoder. He also states that he had himself made experiments with the the clay of Towednack, and that Mr. Cookworthy had tried that of Tregoning Hill. This latter locality, therefore, was probably the birth-place of the Cornish china clay trade, as St. Stephens was of the trade in china stone.

Dr. Thomson, who paid a visit to Cornwall in 1813, briefly referred to the condition of the china clay districts as he saw them, in the "Annals of Philosophy" for that year.§ He speaks of both china clay and china stone, but evidently imagines them to be the same substance differently treated. The mistake arose, perhaps, from the very soft variety of china stone which came under his immediate notice, and which, as he says, was so soft as to crumble between his fingers. This is certainly not the case with what is generally sold for china stone now.

Dr. Fitton, in an admirable paper which he contributed to the same journal a few months later,‖ describes what he saw when he visited Cornwall six years previous to Dr. Thomson's visit. He states that there were in his time seven works in operation in the parishes of St. Dennis and St. Stephens, the largest of which produced some 300 tons per annum.¶

The next notice with which I am acquainted occurs in a short paper contributed to the Royal Geological Society of Cornwall, and printed in the year 1818.** The writer, Dr. Paris, gives the quantities of china clay and stone shipped from the port of Charleston in 1816-17; and he remarks that the amount of royalty or "dues" paid to Lord Granville was £700 per annum. The total quantity shipped at Charleston was under 4,000 tons, and it is not likely that more than a few hundred tons were shipped from any other ports at that time.

The natural clay rock, or "soft growan," as it

* Count Reaumur had previously reported (in 1729) on the materials used in China for making porcelain, and his report had led to the establishment of the works at Sevres.
† It is stated in Keate's "Gazetteer" of Staffordshire that clay from Dorset and Devon was used in the Staffordshire Potteries soon after 1707, but this was probably coarse clay for common ware.
‡ "Natural History of Cornwall."
§ "Annals of Philosophy," vol. ii., p. 348.
‖ *Ibid*, p. 475.
¶ The works he mentions are:—
Two at Treviscoe.
One at Goonemaris.
One at Goonvean.
One at Trethosa.
Two at Hendra.
The first five are in the parish of St. Stephens, the last two in the adjoining parish of St. Dennis. China clay is still obtained in very large quantity in the immediate vicinity of each of these old pits.
** Trans. Roy. Geol. Soc., Corn., vol. i., p. 233.

was called by the miners, met with at Beam and Carclaze tin mines, in the parish of St. Austell, was described by Mr. John Hawkins in the 18th vol. of the same society's transactions,* published in 1832.

An outline of the mode of occurrence of the china clay and clay stone of the Hensbarrow district, and of the mode adopted for preparing the clay for the market, is given by Dr. Boase in the same volume.†

A brief memoir on the same subject was in 1839 contributed by the late Mr. W. Jory Henwood, to the Royal Institution of Cornwall, and published in the reports of the institution.‡

Several interesting paragraphs on this subject occur in Mr. Henwood's "Metalliferous Deposits," published in 1843, and in Sir H. Delabeche's report on the geology of Cornwall, Devon, and West Somerset, published about the same time.§

A valuable paper on the china clay and stone of Cornwall was in 1852 read to the Royal Cornwall Polytechnic Society by Mr. H. M. Stocker, of St. Austell. This paper was printed in the reports of the society for that year, and an award of the second silver medal of the society was made to the writer by the Committee of Judges.

In 1868, some interesting particulars were given by the Rev. C. M. Edward Collins in a lecture delivered to the members of the same society, and afterwards published in the report.

In 1870, a visit of the Miners' Association of Cornwall and Devon to the celebrated Carclaze Works took place, and a description of the works is given in the report of the Association for that year.

A few brief notices by myself and others in various publications complete, so far as it is known to me, the bibliography of the subject.

Mode of Occurrence.

In each of the granite masses which rise like islands in the sea of clay slate forming the western extremity of England, some portions have their felspar so decomposed as to be converted into kaolin, or china clay. Other portions are less decomposed, and of somewhat different composition, and these supply the china stone. These decomposed portions are always associated with veins of black tourmaline and other minerals containing fluorine, as has been shown elsewhere. Without entering into detail on the question of the mode of alteration of the granite rocks in these neighbourhoods, I may state that, in my opinion, it has certainly been effected by fluorine and other substances coming up from below, and not by carbonic acid and water acting from above. As a rule, the decomposition is more general near the junctions of the granite with the surrounding rocks than elsewhere, but to this rule there are some notable exceptions.

The natural clay rock is almost always covered with a thick layer of stones, sand, or impure and discoloured clay, known as "overburden." This capping often much resembles glacial drift, but it never contains any scratched or glaciated stones or travelled blocks. This capping varies from 3 feet to 40 feet in thickness, and it must, of course, be removed before the clay can be wrought.

* Trans. Roy. Geol. Soc. Corn., p. 475, Vol. IV. At both these places large quantities of china clay are now annually produced, but they were originally worked as tin mines open to the day. There are records now extant which show that they were in full work in the reign of Henry VII.

† *Ibid*, pp. 237-8.

‡ Rep. Roy. Inst. Corn., 1840.

§ Pp. 160, 509, &c.

The decomposed granite is found at all elevations except the very highest points of the districts, which are always composed of hard rocks; but yet their situation is usually indicated to the practised eye by a peculiar depression of the surface. These depressions are not observed in the case of china stone. The natural clay rock, being a decomposed granite, consists of kaolin, irregular crystals of quartz, and flakes of mica, with sometimes a little schorl and undecomposed felspar.

Ancient Mode of Working.

Writing of the mode of working in 1807, Dr. Fitton says:—"The overburden being removed to a considerable extent, the clay itself is dug progressively in steps, the discoloured portions being picked out and thrown away. The selected clay is then wheeled to the washing place or 'strake,' and washed with a stream of water. A large quantity of 'sand' is at once separated, and this is shovelled away continually. The clay and finer mica is carried on by the flowing stream to 'pits' and 'ponds,' which are rectangular receptacles built of rough stone, cemented by lime; the pits 5 or 6 feet in the side and 4 feet deep, the ponds 20 feet by 12 feet, and the same depth. The first pit receives the fine sand and coarser mica, the second, and perhaps the third, the fine mica, while the fine clay settles in the last or passes on to the ponds. When the ponds are full their contents are transferred to shallow 'pans' lined with granite, about 40 feet by 12 feet, and 14 feet deep. In these pans it remains from four to eight months, often from September to the following May. It is by that time stiff enough to be cut up into square blocks, which are further dried by exposure to the sun, scraped, and rammed into casks. The scrapings and waste are wheeled back to the strake and re-washed."

Mr. Henwood's account adds to the above the statement that when, during rainy weather or from any other cause, the clay does not settle, it is watered with a solution of alum from a common watering pot.*

Frequently the works were so laid out that the partially consolidated clay had to be pumped up to the drying pans. Mr. Henwood observes on this point, "I noticed, with surprise, that clay, sufficiently consistent to stand in a heap, will run through a common suction pump worked by hand, though when so drawn it requires to be raked from the pump-head."†

Very great care was taken in all the old works to avoid all stains and impurities which would affect the colour of the clay, but not so much to secure a fine and even texture. Mr. Henwood says that the direction in which the clay had been deposited in the pans could be detected by scraping or cutting the clay in various directions. This test would certainly fail if applied to any clay considered fit for the market in the present day.

Present Mode of Working.

The mode of preparation just described was fairly well adapted to a time when the demand was

* *Op. cit.* Mr. Stocker, in his paper read to the Royal Cornwall Polytechnic Society, says that any saline solution will do, and that he himself had used charcoal.

† *Ibid.* The pumps used were always of wood, and were bored from trunks of trees, and bound with iron. Such pumps will last for many years.

limited, prices comparatively high from the absence of competition, wages and royalties very low, and water abundant. These conditions are now very much changed; the demand is very great, but prices are lowered by a keen competition, the wages and dues are much higher than formerly, and in many districts water is scarce, or only to be obtained in the winter.

At the time of Dr. Fitton's visit, 70 years ago, Trethosa was one of the largest works, but it only produced about 300 tons per annum; now there are many works producing 20 times as much. The old-fashioned system, somewhat modified in detail, but the same in principle, still survives in a few places, but the bulk of the clay produced in the west of England is now obtained in a greatly different manner.

The following descriptions apply with more or less accuracy to a majority of the larger works of the present day, turning out from 2,500 to 8,000 tons of clay each yearly. Two somewhat different methods are employed, according to the situation of the "bed" of clay, in relation to the surface contour of the immediate neighbourhood. The most general case is that in which the clay has to be raised from a veritable pit, the bottom of which is lower than the ground in the immediate neighbourhood on all sides.

The exact situation of the clay is first determined by systematic "pitting," to a depth of several fathoms, or occasionally by boring. A shaft is then sunk either in the clay itself or preferably in the granite close to the clay. From the bottom of this shaft a level is driven out under that part of the clay which it is intended to work first, and a "rise" is put up to the surface, which should by this time be partially cleared of its overburden. A common depth for such a shaft will be from ten to twelve fathoms.

As soon as the rise is completed to surface, a "button-hole" launder is placed in it, and the remainder of the rise is again filled up with clay.

In the meantime, a column of pumps has been placed in the shaft—say from 10 inches to 12 inches diameter, and an engine erected to work them, unless water-power is obtainable.* The pump is generally, and preferably, of the "plunger" kind.

For water, many works are almost entirely dependent upon that met with in sinking the shaft and driving levels; but, of course, this may be, and is, eked out by catching the rain-water in reservoirs, and by making use of such small streams as may happen to be available. A small constant supply is sufficient even for a large work, as it is used over and over again. The work is now begun by digging a small pit in the clay, around the upper end of the button-hole launder, and running a stream of water over the exposed clay, the "stope," which is broken up with picks. A very large quantity of sand is constantly produced, and as constantly shovelled out of the way, while the water, holding the clay and finer impurities in suspension, runs down the launder, along the level, and into the bottom of the shaft, from whence it is pumped up by the engine or water-wheel.

* The value of water-power is well understood in Cornwall, where coal is very dear, and sometimes power is communicated from a water-wheel to a column of pumps by a "run" of "flat rods" for a distance of a mile or more

As the excavation becomes larger and deeper, more overburden is removed, and the upper portions of the launder are taken away, until at last the stopes reach the level, when the launder is of course no longer required.

At first the sand is thrown out by one or two "throws," but very soon it becomes necessary to put in an inclined road for pulling up the sand in waggons, and this is worked by a horse-whin, or by winding gear attached to the engine or water-wheel. As there are from three to eight tons of sand produced in getting each ton of clay, of course its removal in the cheapest possible manner is a matter of the greatest importance. Any veins or lodes of stone, or discoloured portions of clay, are raised from the "bottoms" in the same way as the sand. The stream of water-holding clay, fine sand, and mica in suspension is in well-arranged works lifted at once high enough to allow of all subsequent operations being carried out by the aid of gravity. The stream is first led into one or two long channels, the sides of which are built of rough stone. In these channels, called "drags," the current suffers a partial check, and the fine sand and rougher particles of mica are deposited. From these drags the stream passes on into other channels much resembling them, but of greater number, so as to divide the stream still further. These second series of channels, known as "micas," is often built of wood, but sometimes of stone. They differ in no respect essentially from the drag, but are more carefully constructed and better looked after, and as the stream is greatly divided and is very gentle, the fine mica is deposited in them. The micas are often about 11 inches wide, ten or a dozen in number, and 100 feet or more long. Provision is made, by underground channels and plug holes, for the periodical cleansing of the drags and micas. This may have to be done twice a day, but generally only once. The deposit in the drags is worthless at present, and is always thrown away, but that from the micas is often saved, and sold as inferior or "mica" clay. The refined stream of clay then passes on to the "pits," which are often made circular, 30 to 40 feet diameter and 7 to 10 feet deep. These pits are built of rough masonry, and they have an outlet at the bottom opposite the point at which the stream of clay-water is admitted. This outlet is stopped by a gate or "hatch," or else by a plug, which is kept closed until the pit is full of clay. In each outlet, however, is fixed an upright launder some 4 inches square, provided with "pin holes" and wooden pins set close together. As the stream of clay enters on one side it is constantly depositing its burden, and the water is as constantly drawn off nearly or quite clear from the pin-holes, the pins being put higher and higher as the clay rises in the pit.

The effluent water is conducted directly to small storage reservoirs, and thence over the clay slopes, whence it does its work over again. I may here mention that when the stream of clay water enters the pits it contains from 1½ to 3 per cent. of clay, and what is called a good washing stream will carry about one ton of clay per hour.

When the pit is full, the "hatch" is drawn, and the clay is "landed" into the tank. The upper portion is sufficiently fluid to run in of itself, but that near the bottom has to be helped out by men

using "shivers" of wood or iron, which resemble large hoes, and by a small stream of water. The tanks are commonly, but not always, rectangular, built of stone, and paved with stone at bottom, often 60 by 30 by 6, or larger. Once in the tank, the clay is left to settle until it has the consistency of cream cheese, the water being drawn off from time to time, when it is ready to be trammed into the "dry."

The dry is a large building erected in immediate proximity to the tanks. It is always composed of two parts, the dry proper and the "linhay." The floor or "pan" of the dry is composed of fire-clay tiles 18 inches square, 5 or 6 inches thick at the fire end, and gradually thinning off to 2 or 2½ at the stack end. The flues are built of fire-brick about 14 inches wide, 2 feetdeep at the fire end, and 9 inches deep the stack end. Each flue should be supplied with a damper. The furnaces are built in and arched over with best fire-brick; the fire bars run longitudinally, and are about 6 feet long. The grate surface is about 2 feet 6 inches wide in front, and 4 feet 6 inches to 6 feet at back, according as each furnace supplies three or four flues.

The clay is brought in from the tanks in tram-waggons, holding about half a ton, tipped on to the tiles, and spread in a layer from 9 inches thick at the fire end to 6 inches thick at the stack end. The fire end is loaded and cleared every day; the other end perhaps twice or thrice a week, according to the length of the dry, thickness of tiles, perfection of draught, &c. An average size for a first-class dry is perhaps 15 feet wide and 120 feet long, but some have been constructed by the writer considerably larger than this.

The pan of the dry should be 6 or 8 feet above the linhay whenever possible, so as to afford storage space for the dry clay without expending labour in piling. The tiles should be as porous as possible, for very much more water passes through the tiles and into the flues than is driven upwards in the state of steam.

I was led to adopt this form in consequence of the formation of the ground, but I am inclined to recommend it in most eases if practicable. Very large quantities of stone are required in the dry pits, tanks, &c. Very often this is got, in part or entirely, in the process of excavating the pits, &c.; but if it cannot be so obtained, a very serious expense will be incurred, in some instances amounting to several thousand pounds. The total cost of the works may even be doubled from this cause, if stone has to be fetched from a distance of several miles.

Two modes of building with rough stone are adopted in china clay works, known as lime building and dry stone walling. The first needs no special remark, but the second is very ingenious and very effectual. The wall is built up double, with a batter of about three-quarters of an inch, or one inch to the foot. Moss is placed between the joints of the wall, and the space between filled in with sharp sand, the refuse of that or some other clay works. A small stream of water is then made to flow over the sand, aud it is well beaten in with rammers, or by treading with the feet. This process is continued, a foot at a time, till the wall reaches the required height, when it is either paved with rough stones set on edge, or turfed. A wall properly built in the manner just described, is quite impervious to moisture, and will stand for 50 years or more. It is, where the proper kind of sand is abundant, much cheaper than lime-walling, and is always preferred for the walls of pits and tanks.

I will now describe the mode of working where the bed of clay is situated on a hill-side, with plenty of space below. In this case a tunnel is driven in from the hill-side or from the valley to the required depth, and a rise is put up as before. This rise is then divided off into two parts. In the smaller a button-hole launder is placed as before, and packed around with clay, but the larger is left open. A stream of water obtained by pumping or otherwise is made to run over the stope and down the button-hole launder. It then flows along a launder placed in the bottom of the level, until it makes its exit in the valley. It may now be purified, settled, and dried exactly as already described—the works being laid out at a lower level than the adit, or if the clear water is wanted to flow over the stope, or if for any reason it is necessary to place the pits and tanks at a higher level than the stopes, it is pumped up after partial or complete purification.

The main difference in this mode of working is that, instead of pulling the sand and rubbish up over an incline, it may be tipped down the pass into waggons, run out through the level, and tipped over the hill sides. In cases where water is abundant, it may even be washed out at night, so saving the expense of tramming. Of course, when the workings have reached their full depth, the rise and the launder are dispensed with, and the adit level communicates directly with the "bottoms." By this mode of working a considerable economy may be effected, especially when it is not necessary to pump the clay water for settling or repeating.

Uses of China Clay.

The first use to which china clay was applied was, as already stated, the manufacture of porcelain, and this is still popularly believed to be its sole use. This, however, is by no means the case—probably little more than one-third of the clay now produced is so applied. Large quantities are used by bleachers for filling up the pores of calicoes as a dressing, and still larger quantities are used by paper-makers to give "body" and weight to their paper, especially printing papers. The manufacture of alum, sulphate of alumina, and ultramarine, uses up very large quantities annually. Small quantities are used by photographers, manufacturing chemists, and colour makers, for a great variety of purposes, and if reports are to be believed, it has been used in the adulteration of flour and of artificial manures. Should the present low prices be maintained, its use will, no doubt, be still more largely extended in directions as yet unsuspected.

Cost of Production.

Where the conditions of production vary so greatly, there must necessarily be a great difference of cost, but I have been at some pains in determining the cost under average conditions, and I believe the following figures and statements may be relied upon.

A work capable of producing say 4,000 tons of clay yearly will cost from £2,500 to £5,000. To get the clay in the linhay ready for the market

will cost about 9s. per ton, of which about 2s. 6d. must be expended in fuel for pumping and drying, 1s. in removing overburden, 1s. in removing sand, and 1s. for management and office expenses, leaving 3s. 6d. as the net labour cost of washing and drying a ton of clay.

To the 9s. net cost of clay must be added an average of 3s. for royalties, 4s. for transit and placing on board ship, and 1s. for agencies, commission, bad debts, and sundries, making the average actual cost amount to 17s. Some favourably situated works can no doubt save two or even three shillings on this amount, in others the cost may amount to 20s. or even 22s., but I do not think the average is far from the figures I have stated.

As to the selling price, this varies much more widely than the cost of production; at present prices are very low, ranging from 14s. to 35s. *f.o.b.* Clays sold at the lower rates are at present, and must necessarily be, unremunerative.

Nature and Utilisation of Debris.

Besides the clay proper, there are certain waste or pseudo-waste products, produced in very large quantities. These are as follows :—

Fine mica.—This is deposited in the "micas;" a few years since it was thrown away or rather washed away, as is still the case in many works. Sometimes, however, it is collected, dried in the manner of clay proper, and sold to the makers of soft paper, pasteboard, inferior pottery, &c., at a low price.

Coarse mica.—This is invariably washed away or thrown away, there being at present no demand for it. It, however, contains a very beautiful material, as shown in the small specimen on the table, and I should think a demand ought to be soon set up for the use of this material for many ornamental purposes.

Sand.—This consists of broken quartz crystals, mostly white or pale brownish; when washed clean it is the finest building sand known, as the angles are all so sharp. Mixed with one-eighth of Portland cement, it forms a concrete as hard as stone.

Discoloured Clay.—This has to be dug out from among the good white clay in many places. It has been successfully used in the manufacture of white bricks for building purposes. In some instances a quantity of the sand already mentioned is mixed with the refuse clay, when an excellent firebrick results.

The same material is used in the manufacture of the tiles used as a floor for drying the clay. The manufacture of bricks and tiles from this debris is a growth, I believe, of the last twelve years.

Overburden.—The upper part of this consists of soil, or "meat earth," and this is usually removed and carefully preserved. Under this is a hard, often stony or sandy, layer, which in districts where tin is worked often contains enough tin to pay for washing. Between this stony or sandy layer is usually a considerable thickness of discoloured clay suitable for brick making.

Branches. — These are stony veins which run through the clay stopes in various directions. Sometimes they are quite worthless, but in a few instances they are veritable tin lodes, and contain enough tin to pay for stamping and dressing. Thus at Carclaze, near St. Austell, each 1,000 tons of clay yields something like one ton of oxide of tin, and formerly the proportion was much greater.

I have been at some pains in determining the proportions of these waste materials as compared with the fine clay produced. My results are as follows :—

In producing one ton of fine clay there is produced
from 3 to 7 tons of sand, average about $3\frac{1}{2}$ tons.
„ 2 to 5 cwt. of coarse mica, average 3 cwt.
„ 1 to 3 cwt. of fine mica, average 2 cwt.
„ 0 to 1 cwt. of stones, average $\frac{1}{4}$ cwt.

A cubic fathom of clay rock, of average quality, will yield about $2\frac{1}{2}$ tons of fine clay, and about $\frac{1}{2}$ a fathom of overburden must be removed to get it.

Preparation of China Stone.

The preparation of china stone for the market is a very simple matter. The overburden is removed as before and the stone is rudely quarried; as the rock is everywhere traversed by numerous joints this is very easily effected, and usually without blasting. Very few of the pits are worked to any great depth, as the top stone is much more cheaply wrought than that which lies beneath. The joints are usually discoloured by green vegetable stains, and brown stains due to oxide of iron. This is chipped off with a kind of axe, when the stone is ready for shipment.

Before it can be used by the potter it must be finely ground. Sometimes this is done in Cornwall, the grinding being effected by water power, but in general it is done by "millers" in the potteries, who add to it felspar and other ingredients as may be necessary.

Suggested Improvements in Manufacture.

No doubt there is still much room for improvement in the preparation of china clay, but such must be a growth of time and circumstances. At the present time about one ton of water has to be driven off from each ton of clay in the dry, and this uses at least two cwt. of coals on an average, and costs from 8d. to 10d. in labour.

In a few modern drys a small economy in fuel has been effected by lengthening the kiln, but in none has it been brought so low as $1\frac{1}{2}$ cwt. to the ton of clay. Mr. Stocker, in 1862, suggested the use of filter beds, and also devised a centrifugal dryer, but neither of these contrivances have come into use, and the first would seem quite inapplicable on account of the extreme fineness of the particles of clay and the impermeability of even a thin layer of that substance. I am inclined to believe, however, that some economy might result from the ues of hydraulic filters of calico, such as are used in the potteries for drying the slip. In washing the clay from the stope I think some economy would result from the use of a jet of water under a pressure of from 50 to 100 lbs. per square inch, as in the so-called hydraulic mining. This could only be applied to stopes of even quality, where very little picking out of inferior portions was required, but it would supersede the services of the "breakers" on the stope, and greatly lessen the labour of the washers. It is but rarely that a natural head of water is obtainable equal to the required pressure, but where machinery is used for pumping, the additional cost of pumping, say 250 gallons per minute to a height of 150 feet in a standpipe, would be very

slight, as the extra power required is little more than that of one horse.

Statistics.

The following statistics have been obtained from many sources, most of which are indicated by footnotes:—

	China Clay.		China Stone.	Total.
1809....	1,757		1,162	2,919
1810....	1,888		1,563	3,451
1811....	2,086½		1,535	3,621½ *
1812....	1,252		1,530	2,782
1816....	1,775		2,135	3,910†
1826....	7,538		5,252	12,790‡
1831....	7,000		5,000	12,000 §
1834....	....		....	12,000‖
1838....	13,440		7,344	20,784¶
1839....	7,600		....	**
1851....	....		....	98,000 ††
1852....	....		....	.... §§
	Cornwall.	Devon.		‖‖
1855....	60,188	1,100	19,961	81,249
1865....	97,750	....	25,500‡	....
1866....	105,000	12,000	35,000	152,000
1867....	127,000	12,000	33,500	172,500
1868....	100,000	11,900	29,000	140,000
1869....	105,700	11,700	28,500	145,900
1870....	110,520	12,500	32,500	155,000
1871....	125,000	19,000	33,000	177,000
1872....	141,000	26,982	48,000	215,982
1873....	153,000	27,197	45,000	225,197
1874....	150,500	33,309	42,500	226,309

The great increase in the quantities produced from 1809 to 1874—2,919 tons against 226,309, is almost parallelled by the increase of production in individual works. In 1810, Trethosa (one of the largest works) produced 300 tons per annum, and employed 13 persons at the time of Dr. Fitton's visit, viz., eight in removing burden and raising (breaking) clay (at per fathom), three washing, two attending ponds and packing.¶¶

In 1874 one of the largest works near St. Austell produced 9,000 tons, employing about 30 men. Many works produced 6,000 tons, employing 20 men.

The foregoing figures show that the trade has had periods of great development between the year 1816 and 1826; between 1834 and 1838, between 1839 and 1851; between 1855 and 1865; and in 1871; while from 1868 to 1870, it showed some slight falling off. It is now passing through another period of depression, but a study of the figures already given leads to the belief that the trade will again recover itself after a short period of quietness and comparative rest.*

* Lyson, Magna Brit., Cornwall, p. ccxi. These quantities were shipped at Charlestown for the Potteries. It is not likely that any considerable quantities were shipped elsewhere

† Trans. Roy. Geo. Soc. Corn., Vol 1., p. 233. Shipped from March to March, for Worcester.

‡ Ibid, Vol. iii, p. 360. Of this quantity 1,298 tons were shipped at Charleston, the rest at Pentewan, Porthleven, and St. Michal's Mount.

§ Henwood, Rep. Royal Inst. Corn. These quantities do not include any clays or stone raised outside the St. Austell district. Perhaps 1,000 tons would cover such production.

‖ Boase, Primary Geology.

¶ Henwood, Rep. Royal Inst. Corn. Of the quantity stated, all but 500 tons were from the St. Austell district.

** This is an estimate given by Sir H. Delabeche in his report, p. 510.

†† This is an estimate given by Sir H. Delabeche in his report, p. 510.

‡‡ Stocker, Rep. Roy. Corn. Geol. Soc., 1852.

§§ Ibid, p. 81.

‖‖ Hunt's Mineral Statistics. The returns are here given in round numbers only.

¶¶ Fitton, p. 184.

DISCUSSION.

Mr. Stinton said he was apprenticed to the old Royal Pottery Works at Worcester, and the analysis, by Dr. Wall, of the steatite, or soapstone, which was used there, was as follows:—Silica, 48; magnesia, 25; alumina, 14; water, 15·5; in fact it would have been impossible to use it if it had not contained alumina, one of the most valuable materials which could be used for the production of good porcelain. He had also found among the Persian specimens a porcelain made entirely of soap rock, and he had with him a small portion of this rock, which had been exposed to a much greater heat than porcelain went through, and it had suffered no deterioration. He was sorry to say that most of the porcelain of the present day was poor and soft, and would not stand any heat. He had in his pocket a small vessel made without either sand or flint, which would stand any heat to which it might be exposed; you might boil water in it without its cracking; and he contended that utility was of more importance than appearance.

Mr. Blashfield had been much pleased with the paper, one portion of which referred to the possibility of drying the clay by some means similar to that in use for removing the water from the "slip" at the potteries. He understood, however, that there was a considerable loss incurred by means of the destruction of the calico bags, though possibly some other material might be employed. He could hardly suppose, however, that in works of any magnitude hydraulic presses would be found economical for removing the moisture. There was no doubt that in slip kilns a good deal of fire was wasted, and the clay often injured by excessive heat; and if it were made generally known that some improved mode of drying the clay was desirable, he thought great good would be done. Some mechanical contrivance might be devised for turning over the clay on the drying stove, because it was apt to get baked underneath while quite soft and wet above. The same difficulty occurred with cements. With regard to the coarser clays, he believed a great deal more use might be made of them, for some of the best material he had produced in the shape of terra cotta had been by combining some of the coarser clay containing much of the sand, with the ordinary clays from Poole and other oolite beds. He was also convinced that if more attention were paid to the use of sand or Portland cement carefully ground and burnt,

* Besides the true kaolin, the district yields large quantities of other materials used in pottery, pipe making, crucible making, &c. Of ordinary potter's clay, no less than 60,000 tons were exported in 1874, chiefly from Devonshire, besides large quantities used in the county. A large deposit of what may be called impure naturally washed china clay, occurs at Bovey Tracy, near Newton Abbot, in connection with the well-known lignite beds of that locality. This clay is said to have been worked ever since 1730. The annual output was estimated at 20,000 tons by the Rev. J. Templar, in 1822. In 1839, the average output was stated by Delabeche, at 25,000 tons. In 1873, it reached the large total of 56,000 tons. It is used for making coarse pottery, pipes, crucibles, &c. Another potter's material, yielded by the china clay districts, is felspar, considerable quantities of which have been raised and sold from time to time from the parishes of Roche and St. Stephens, from veins of what may be called giant granite. These works are now stopped, as a finer quality is obtained from Norway and Sweden. Still another material may be mentioned here, viz, steatite, a large vein of which was worked at Gue Grease, near Kynance Cove, in the Lizard Serpentine district. Chemically, steatite differs very widely from china clay, the former being a silicate of magnesia, while china clay is silicate of alumina. About the year 1820, some 10 tons were annually shipped to Swansea, and sent from thence to the potteries. The vein is now almost exhausted, and could only be worked at such a cost as would prove unremunerative.

exceedingly fine skirtings, lintels, and other things could be prepared capable almost of taking a polish, and much superior to the material ordinarily used for the skirtings, &c., of large buildings. Mica might be advantageously used in making scagliola to imitate granite and other marbles. He had used it in this way at the Reform Club, and also in laying down a floor for Mr. Hope, at Deepden, in which some valuable ancient mosaics were embedded, the margin being formed of scagliola in imitation of antique marbles. Scagliola was composed simply of glue and plaster of Paris, with a small quantity of sulphate of zinc thrown in occasionally, and the colours carefully blended, but nothing could be better than mica for producing a transparent effect.

Mr. Stinton concurred in the view that if heat could be done away with in the preparation of the clay a better material would be produced. Formerly no heat was used, but it was now generally employed.

The Chairman, in proposing a vote of thanks to Mr. Collins, said the kaolin of geologists was a very different thing to that with an admixture of sand and mica which had been treated of in the paper. It was a mineral not found absolutely in granite, but was produced from one of its constituents, felspar, by a curious secondary decomposition; and from felspar which contained either potash or soda. He believed there were no instances known of kaolin being produced from felspar containing little silica and a great deal of lime, such as were known as basic felspars. Felspar was the white, larger crystalline portion of granite, the quartz being the more glassy-looking and smaller crystals, and the mica the flaky element. Felspar consisted of silica, alumina, and some base in the form of an alkali—potash or soda. In Chinese granite you could perceive large nodular masses of felspar in crystals, mixed with pieces of quartz, the mica having almost disappeared. Such masses had been subjected for long periods to the action of the atmosphere, the felspar gradually wore away and decomposed, it was carried away grain by grain, and, if it was to become kaolin, it was necessary that this product of denudation should be taken into some quiet nook where it could collect, not having too much drainage applied to it, but where a certain amount of percolation of water went on. Such a place was the valley at Bovey Tracy, and there this detritus collected. Kaolin, then, was decomposed and metamorphosed felspar, and the change it underwent was by no means satisfactorily explained. There appeared to be a loss of silica and of the alkali, but taking it that six molecules of silica were decomposed they did not separate into two 3's, but into 4 and 2; some of the silica then was carried away and also some of the alkali, and water was added, and thus you got hydrated silicate of alumina. This compound existed pure in nature only in very small quantities, being almost invariably mixed with these other substances, quartz, not in form of crystals, but rolled into the form of sand, and mica, more or less broken up, showing abundant evidence of the action of water. It came from two kinds of granite, forming the clays containing a large quantity of potash, and the clays containing soda, and this was generally found in connection with tin. He should like to know from Mr. Collins if this kaolin was ever found *in situ* on the surface of the rock, or whether it was always carried away first of all. In this country we knew little practically of the wear and tear of the rocks *in situ*, but in India and those countries where the action of the elements was more potent, they wore down to a wonderful extent below the surface without any wreckage, some of the most important soils of India being produced absolutely *in situ* for scores of yards from the wreckage of the old rock below by the percolation of water and by heat. The Cornish granites which produced this kaolin were exceedingly old, and no doubt many came to the surface during the close of the carboniferous period. The other rocks did not form around them in sliding layers as was sometimes represented in pictures, but the whole strata covered the mass of granite for hundreds of thousands of feet, and through one of those great lateral crushes produced by the contraction of the deep-seated rocks the granite was forced up into masses with the other strata, which were gradually worn off the top. The valley of Bovey Tracy, therefore, might be of extreme antiquity, but nevertheless there was a kind of trough made for the reception of the future kaolin, amongst which were found leaves of plants evidently belonging to a flora of a much hotter climate than that within many degrees of this latitude. Mr. Collins had been doing with his kaolin stone that which nature had been doing through all time on a grand scale; getting the mica away with the sand. Nature washed away the granite, and wore away the quartz, producing micacious sandstone. Granite was the origin of nearly all the great clays, hydrated silicate of alumina being at the bottom of them all; and these clays were subjected by nature to all those operations employed by the potter. They were not indeed moulded on the wheel, but the crushing, pounding, watering, and baking were all the same, and they often underwent great metamorphoses. In the West Indies were found clays beautifully baked, called porcelainite, which very much resembled Samian ware, and the fire-clay of the coal measures was produced from the wear and tear of rocks originally granite. Only the other day it was stated at the Geological Society that the clays worn out of granites, might, in the course of the subsidence of the ground, come within the range of such forces as to be transformed in their turn into gneiss, and evidence was given of triassic clay, containing shells, which had been turned by the action of a neighbouring volcano into a substance indistinguishable from granite. The felspar from this granite might, in the process of ages, again be turned into kaolin for the benefit of future generations, who, he trusted, would have better pottery than ourselves. The whole subject might be said to show evidence of design. In the very beginning of things, men were, no doubt, destined to drink tea out of tea-cups. The granite was formed when the earth first came together, *en masse.* Out of the granite kaolin was produced, the ingenuity of man developed the tea-cup and his industry the tea; and, finally, we drink it. Thus we had, in this cycle of events, quite as reasonable an example of design as many others which were brought forward. He should like Mr. Collins to state why he considered that kaolin was produced by the action of fluorine, and also whether he had ever seen any granite rocks sufficiently decomposed to produce a mass of altered felspar on the surface.

The vote of thanks having been passed,

Mr. Collins, in reply, said he was familiar with the analysis of steatite, showing 14 per cent. of alumina, but he had no doubt it was used in conjunction with a large quantity of china clay, or else it would not produce a good result. The ordinary china clays contained from 36 to 40 per cent. of alumina, and no doubt the addition of 1 or 2 per cent. of magnesia would improve them. China clay, however, did not contain more sand than stope-rock. He believed a great deal of the fault of modern pottery was due to the fact that potters stinted their coal, and did not burn it at a sufficiently high temperature. With regard to hydraulic presses and calico, he admitted a doubt as to the economy of such a process. At present, it cost about 2s. a ton for coal, and 8d. a ton for labour; the latter item would probably be about the same in either case, and the wear and tear of the calico would have to be set against the 2s. per ton for coal. There was no reason whatever for injuring the "slip" by baking it, and though clay did leave Cornwall which had been burnt on the kiln, it was only from carelessness. If the tiles were of the proper thickness and the fire kept moderate, there was no danger

of burning; the temperature ought not to be too high, to allow of the men walking on the kiln. He had been investigating the subject of the formation of this clay for some time, and hoped soon to be able to lay his views before geologists. At Bovey, the clay was no doubt derived from the decomposition of granite, but he did not think it was decomposed in *situ*, but was washed from the granite already in the state of kaolin. That would simply show that it took place before the miocene period, which was the date of the leaves in the clay, and later than the upheaval of the granite, which was about the close of the carboniferous period, but did not give much clue to its precise date. The bulk of china clay came from granite which had been decomposed in *situ*, in his opinion, because they could often see the gradual passage from china clay rock, for which no precise name had yet been found, but which he proposed to call carclayicite, into the undecomposed granite. You could often see large porphyritic crystals of felspar changed into kaolin without losing their form. He believed the change was due to the action of fluorine for the following reasons. In the first place fissures were always present in such clay, which always contained minerals of which fluorine was an essential ingredient; there was nearly always tourmaline or mica containing fluorine, sometimes both. Tin also was frequently in connection with it, and for reasons which he could not then state, many geologists came to the conclusion that tin was brought into the veins in which it occurred by the agency of fluorine. Lastly he had himself acted upon granite with dilute hydrofluoric acid, and without otherwise altering its appearance, changed it into kaolin.

MISCELLANEOUS.

THE PATENT BILL.

The following summary of the new Bill may perhaps be found useful at the present time. It does not profess to include everything, but is intended simply to indicate the novel portions of the measure which appear to be of importance.

The application, the fee on which is £5, must be accompanied by a declaration and a specification describing the nature of the invention. Notice of the application will be published, and oppositions may be entered on payment of a fee of £2. Provisional protection will be granted to the applicant for six months, which may be extended on petition to the Lord Chancellor, during which period he may freely publish and work his patent. After a certain time (not yet fixed) notice to proceed must be given, when the application will be referred to an examiner. The examiner will report to the law officer whether the invention is a proper subject for a patent, whether it is new and useful, and whether the specification is sufficient. The applicant will then give another notice to proceed, on which the specification and examiner's report will be transmitted to the law officer. Oppositions may be heard at this stage, and the law officer is empowered to award costs. The law officer's report will, after having been laid before the Commissioners, be published, together with the specification and examiner's report. These documents will always go with the specification. Upon notice to proceed being given by the applicant, the warrant and Letters Patent will be prepared and submitted to the Lord Chancellor in cases where the report is favourable. Where the report is unfavourable the applicant may, however, after notice to proceed, petition the Lord Chancellor for the grant and sealing of a patent. No appeal is permitted, but a re-hearing may be granted. Opposition to the sealing will be heard at this stage by the Lord Chancellor, or by a judge of the High Court, power being given to call in the assistance of an expert, and to award costs. Whatever may be the result of any of these proceedings, the patent will not be sealed unless a request for sealing be made within three months from the date of the warrant, and within the period of provisional protection. This time may, however, be extended on petition to the Lord Chancellor. The stamp duty on the patent will be £15. The patent will be dated as on the day of application, and must be sealed within seven days before the expiration of the provisional protection, and not sooner, but this period may likewise be extended by the Lord Chancellor. The Great Seal is abolished, a simple stamp being substituted. The total fee for a three years' patent will then be £20, supposing that no amendment is necessary.

Amendments prior to sealing may be made on payment of a fee of £5, and the same fee will be charged on amendments made at any time subsequent to the sealing. In the latter case, however, the fee will be £10 when the amendment is "by way of supplement." The provisions of the Bill with regard to amendments are very minute, although the proceedings on a request for leave to amend pending the application, are relegated to the rules, to be hereafter published. Generally speaking amendments will have to pass through the same stages as new applications, and no amendment will be allowed which would extend the ground covered by the original specification. The fee on a caveat against leave to amend will be £2. In the case of amendments after sealing, leave to take proceedings for infringements committed prior to the amendment may be made part of the leave to amend.

Clause 18 empowers the Lord Chancellor to grant an extension of time for the payment of the periodical stamp duties of £50 and £100, due at the end of the third and seventh years respectively. The stamp duty on these "orders for enlargement of time" will be £5 in the one case, and £10 in the other. Permission to take proceedings for infringement during the enlarged time may be made a part of the order for enlargement of time. These provisions will apply to patents already in force. The statutory mode of prolonging patents beyond 14 years, by application to the Privy Council, is abolished.

Patents will not be granted in respect of inventions for which a foreign or colonial patent is in existence, except to the foreign or colonial patentee or his agent, and then only when application is made within six months of the date of the earliest foreign patent. In case there is no foreign patent, the applicant must show that he is the first and true inventor, or that he is entitled to all the rights of such inventor. No patent will be granted for "a communication from abroad," nor for an invention which is the subject of an expired foreign patent. A British patent for a foreign invention will, as now, cease on the cesser of the foreign patent.

A patent will be liable to be revoked after it has been in existence for two years, if the patentee has failed to use it "to a reasonable extent," or has not made "reasonable efforts to secure the use or practice thereof" in the United Kingdom. It may also be revoked if "the patentee fails to grant licences to proper persons requesting the same, in terms which the Lord Chancellor deems reasonable."

Any Government department, by itself, its agents, contractors, or others, may use any invention for the service of the Crown, on terms to be agreed on, with the approval of the Treasury, by the patentee, and the department. If the two parties fail to come to an understanding, the Treasury will settle the terms.

The Bill contains in all 60 clauses and 2 schedules. The clauses relating to procedure are 10 in number. Clause 47, which is of considerable length, confers very wide powers upon the Commissioners, with regard to making rules. In the absence of these, it is impossible to form any opinion as to the probable working of the

measure. For instance, the nature and extent of the examination as to novelty, which is of one of the vital principles of the Bill, is left to be defined by the rules.

CORRESPONDENCE.

ELECTRICITY AT THE NATIONAL ASSEMBLY.

Sir,—In the *Journal of the Society of Arts* issued on the 14th instant is published an account of a method employed by M. Gaiffe for lighting the gas at the National Assembly, at Versailles, for which he has received the platinum medal of the Société d'Encouragement of Paris.

The description given will do, almost verbatim, with one or two unimportant exceptions, for the plan adopted for lighting the gas at the Royal Albert Hall about five years ago, which has been working successfully ever since. I use a much greater length of wire than M. Gaiffe, and light 30 jets; these ignite others, so that 3,150 lights are produced in about three seconds.—I am, &c., W. Ladd.

11 and 12, Beak-street, W., April 19, 1876.

DEXTRINE-MALTOSE.

Sir,—I am sorry to find that my remarks upon the above subject in a recent letter have been so thoroughly misunderstood by Mr. Frank Faulkner, of the Brewery, St. Helens, and that I have succeeded in turning all tho saccharine matter of his constitution into the most pungent vinegar. The only remedy which I can suggest is that he should adopt the vulgar one of "a hair of the dog that bit him," and read again my obnoxious letter, when he will find that, for onco, he is a most hasty and unfair critic in asserting that I have dealt in any way with the scientific merits of Messrs. O'Sullivan and Valentin's discovery. If Mr. Valentin had suppressed all allusion to patent right, or to the hardship of infringement, I should have said nothing, because I should look upon it as superfluous to make any comment upon the obvious value of their scientific discovery.

The means discovered by Messrs. O'Sullivan and Valentin for ascertaining the correct time at which to arrest the action of the sulphuric acid, are beautifully simple, and must prove useful to those who are desirous of employing that exact imitation, called dextrine-maltose, of the best malt extract at which those chemists aim. But how will the patent work when dextrine-maltose is produced, as Mr. Valentin admits that it may be, without any regard to those scientific considerations and test which he has stated?

I maintain that the production of "the identical article," or dextrine-maltose, has long been effected by makers who knew nothing about the nature of that product which they sold as "glucose," and by various other names. They worked by the rule of thumb, never heard of a polariscope, but succeeded in "chalking the acid" syrup at the right time for securing that product which gave the best result. The latter is the object of Messrs. O'Sullivan and Valentin, and, no doubt, they have attained a most valuable means of ensuring the uniform accuracy of the required composition; but, seeing that the same result, according to their own admission, can be had without their scientific precautions, how can a patent right be sustained?

In order to see the extreme injustice and hardships which might arise from such a patent, if the patent were valid—which I question in this instance—let us suppose the case of a manufacturer of so-called glucose, who ha hit instinctively upon the right timo for "chalking the acid," and who has thus long enjoyed the custom of a brewer, whose ale is neither so poor, thin, and liable to turn sour in the stomach as that in which Mr. Faulkner appears to indulge before writing a letter. Some day Mr. Valentin procures a sample of the "glucose," and finds that it is not glucose, but "the identical article," and at once threatens legal proceedings, as I am assured was quite recently done with as littlo justice. Is it to be held that the discovery of the true nature of a substance is to give the discoverer the right to levy a toll upon all who, by the rule of thumb, made the same substance for years without any knowledge of its real nature?

I fully admit the importance of the discovery in question in a purely scientific point of view, and I deny wholly having given any ground whatever for Mr. Faulkner's remarks. I am also prepared to admit that brewers are likely to receive much benefit from the new and more accurate means of guidance which is now placed at their disposal. All this, however, does not alter the fact that men who know nothing of that "chemistry of sugars," which fails to sweeten your St. Helens correspondent, have made "the identical article" long ago.

I once had an old recipe for brewing ale, a statement of part of which will illustrate clearly the serious difficulty to which I have been so unlucky as to draw attention. In this old instruction no mention whatever is made of a thermometer, and the hot water for mashing is said to be ready the moment the brewer sees his face in it through the covering cloud of steam. "The identical article" was made then, and I am quite certain that a pot of it would do Mr. Faulkner good; but does any rational man suppose that the person who first used the thermometer in brewing, as the only accurate and convenient gauge of heat, could enforce by law a toll upon all who made "the identical article" without any such help.

That which prompted me to write upon the subject was the allusion to patent rights and the neatly concealed threat of violated title which wound up Mr. Valentin's paper, and this, I am sorry to say, was the reason why I felt constrained to confine myself wholly to the patent side of the question. The Society of Arts does not, I believe, countenance the use of its meetings and *Journal* for the discussion of private questions like the infringed rights of patentees, and I am sure that I am not alone in regarding the introduction of such a subject into Mr. Valentin's paper as an objectionable blemish to an otherwise interesting record of scientific research. I have no personal interest whatever in the matter.—I am, &c., W. A. Lyttle, C.E., F.C.S.

The Grove, Hammersmith, W.

[As Mr. Valentin's paper upon the above subject was brought before the Chemical Section of the Society solely with reference to its scientific and technical merit, no advantage can result from a discussion of any patent rights that may or may not be involved; any further correspondence on this subject must, therefore, be declined.—Ed.]

Messrs. Brooke, Simpson, and Spiller have discovered and perfected a process for the manufacture of artificial alizarine, in the form of a dry soluble powder, containing 80 per cent. of pure colouring matter (hitherto considered a chemical impossibility). It has also a greater affinity for the cloth than the paste product now in use, and for purposes of export it is considered to be invaluable.

A new scientific and technical journal is announced for publication under the title of the *Inventor, Patentee, and Manufacturer*. Its principal object will be to give the earliest possible information on all matters connected with patents for inventions, in which respect it hopes to anticipate the official publications.

In the discussion on Mrs. Neill's paper last week, reference was made to Lord Lytton. By a typographical error, the name given was that of "Lord Lyttelton."

GENERAL NOTES.

"The Trade Marks Journal."—The first number of the official *Trade Marks Journal* appeared on Wednesday last, and will be continued on every succeeding Wednesday until further notice. It is of the size known as royal quarto, and the present number consists of 24 pages, besides containing representations and particulars of about 150 marks. Three pages of "Instruction to Applicants" are important, as being supplementary to the rules under the Act, which were issued at the close of last year. Owners of marks should bear in mind that if they intend to oppose the registration of any mark which is similar to or identical with their own, and applied to the same class of goods, they must do so on the appearance of the rival mark in the *Journal*. Although the *Trade Marks Journal* is unexceptionably got up, especially when we remember that it is a Government publication, it will, probably, be thought that the arrangement of the matter leaves much to be desired. The marks are published with very little attempt at classification, so that a search will be a task of very great difficulty. The only help is that furnished by an index to classes, from which it appears that the marks in class 3 are scattered over five different pages, and the same is the case with those in class 50, and even where several marks of the same class occur together, they are not always in numerical order. Some of the classes are not represented at all. The blocks, which are furnished by the applicants, are exceedingly good, and leave nothing to be desired.

NOTICES.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

May 10.—"A New Method of Propulsion for Street Trams," by E. H. Leveaux, Esq. E. Chadwick, Esq., C.B., will preside.

May 17.—"Railway Safety Appliances," by F. J. Bramwell, Esq., C.E., F.R.S.

May 24.—*The same continued.*

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

May 9.—"The Commerce of the Gaboon," by R. B. N. Walker, Esq.

May 23.—"The Development of Central Africa," by Edward Hutchinson, Esq., Lay-Secretary of the Church Missionary Society.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

May 5.—"Irrigation Works in India," by W. T. Thornton, Esq., C.B.

May 19.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood.

May 26.—"Thaumatodendra, or the Wonders of Trees in India," by William Tayler, Esq., late Commissioner of Patna.

Chemical Section.

Friday evenings at 8 o'clock. The following arrangements have been made:—

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne. Mr. W. Weldon will preside.

The Paper on "The Cinchona Alkaloids, their Sources, Production, and Use," previously announced to be read by Dr. B. H. Paul, before this Section, is unavoidably postponed until next session, owing to the present impaired state of Dr. Paul's health.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...Royal Institution, Albemarle-street, W., 2 p.m. General Monthly Meeting.
Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Discussion upon the Paper by Mr. W. H. Michael, "The Working of the Sanitary Acts in Rural Districts."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Mr. Octavius C. Stone, "Description of the Country and Natives of the neighbourhood of Port Moresby, New Guinea." 2. Mr. L. M. D'Albertis, "Natives and Products of the Fly River, New Guinea."

Tues. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 11 a.m. Sewage Conference. 8 p.m. (African Section.) Mr. R. B. N. Walker, "The Commerce of the Gaboon; its History and Future Prospects."
Royal Institution, Albemarle-street, W., 3 p.m. Professor Duncan, "The Comparative Geology and Physical Geographies of India, Australia, and South Africa." (Lecture III.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on "Fascine Work and Reclamation." 2. Mr. W. R. Browne, "The Construction of Railway Waggons, with special reference to Economy of Dead Weight" 3. Mr. W. A. Adams, "Railway Rolling Stock Capacity in relation to the Dead Weight of the Vehicles."
Photographic, 5 Pall-mall East, S.W., 8 p.m.
Anthropological Institute, 4, St. Martin's-place, W.C. 1. Mr. H. W. L. Ranken, "The South Sea Islanders." 2. Mr. Hyde Clarke, "Pre-historic Names for Weapons." 3. Mr. Canon Rawlinson, "The Ethnology of the Cimbri." 4. Professor Lubach, "Hunebedden."

Wed. .. SOCIETY OF ARTS, John-street, Adelphi, W.C., 11 a.m. Sewage Conference. 8 p.m. Mr. E. H. Leveaux, "A New Method of Propulsion for Street Cars."
Geological, Burlington-house, W., 8 p.m.
Royal Literary Fund, 10, John-street Adelphi, W.C., 3 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Thurs... SOCIETY OF ARTS, John-street, Adelphi, W.C., 11 a.m. Sewage Conference.
Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Civil and Mechanical Engineers, 7, Westminster-chambers, 7 p.m. Messrs. P. Burrell and H. Valpey, "Railway Rolling Stock."
Inventors' Institute, 4, St. Martin's-place, W.C., 8 p.m.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Conversazione at South Kensington Museum, S.W.
Royal Historical, 11, Chandos-street, W., 8 p.m. 1. Mr. Joseph Fisher, "The History of Landholding in Ireland." 2. Mr. George Browning, "Gustaf Wasa, of Sweden."
Royal Institution, Albemarle-street, W., 3 p.m. Professor Tyndall, "Voltaic Electricity." (Lecture II.)
South London Photographic (at the House of the Society of Arts), 8 p.m.
Royal Society Club, Willis's Rooms, St. James's, S.W., 6 p.m.
Mathematical, 22, Albemarle-street, W., 8 p.m.

Fri........SOCIETY OF ARTS, John-street, Adelphi, W.C., 11 a.m. Sewage Conference. 8 p.m. (Chemical Section.) Mr. J. Morrison, "Salt Cake, with Special Reference to the Hargreaves-Robinson Process."
Royal United Service Institution, Whitehall-yard, 3 p.m. Colonel Lord Waveney, "The Italian Army."
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m. Mr. W. Froude, "The Fundamental Principles of the Resistance of Ships."
Astronomical, Somerset House, W.C., 8 p.m.
Quekett Club, University College, W.C., 8 p.m.
Junior Philosophical, 6a, Victoria-street, S.W., 7.30 p.m. Mr. W. H. Good, "Hamlet."

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Mr. G. Furnival, "Chaucer."
Physical Science Schools, South Kensington, S.W., 3 p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, MAY 12, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of this Section was held on Friday, May 5th, ANDREW CASSELS (Member of the Council of India) in the chair.

The paper read was—

IRRIGATION WORKS IN INDIA, WITH ESPECIAL REFERENCE TO THEIR REMUNERATIVENESS.

By W. T. Thornton, C.B.

The remunerativeness of Indian irrigation works being the subject of this paper, a very few prefatory remarks will suffice for its introduction.

Every apparatus, from a watering-pot upwards, contrived for conveying water to cultivated land, is entitled to be classed among irrigation works. Such certainly is the *Shadoof*, or pole and bucket, which has been immemorially in use in many Eastern countries, and in India among the rest, for drawing up water from the wells. Such, too, are the wells themselves. In regard to such simple contrivances, however, the question before us does not arise, for they are usually formed by individual cultivators, who would certainly not have gone on making them for so many ages if they had not found their account in so doing. Neither, and for the same reason, does it arise in connection with the tanks or reservoirs, on however large a scale, which village communities or other associations of land owners have, of their own accord, constructed. It is only when the State, or some other second party interposes, and, trusting to its own discretion, provides the means of irrigation, that much doubt can reasonably be entertained, whether the discretion exercised has been a wise one.

Now, in India, the State, not to speak of what was done under native rule, has within the last forty years done a very great deal for irrigation. It has provided one or two districts with tolerably complete systems of tanks, and in most parts of the peninsula has constructed works of a more ambitious character, throwing bunds across rivers high up stream, and from the reservoirs formed behind the bunds, leading off canals, from which, and from whose multitudinous ramifications, water becomes capable of distribution over wide stretches of country lower down, often to the extent of many hundreds of thousands of acres.

Have works of this description hitherto proved, and are they likely hereafter to prove remunerative? This is the question suggested for consideration, and a very important one it is, for on the answer to which it is entitled depends whether or not the State will be warranted in continuing its present course—whether, having laid out between thirteen and fourteen millions sterling on irrigation, it can prudently, in accordance with its present intention, lay out six millions more during the next few years; or whether it had not better stay its hand, and, contenting itself with the liabilities already incurred, not risk any additional funds in the same particular kind of investment.

Before proceeding further, we must, if we desire to proceed safely, settle what precise meaning is to be attached to the word "remunerative."

Every Government that both adequately performs its duties and confines itself within its legitimate functions, is neither more nor less than trustee and administrative agent for the governed. The funds at its disposal are exclusively national money, and whatever investment it makes of this money may, with perfect strictness, be termed remunerative, provided the resulting benefits to the nation at large, of whatever sort the benefits be, are commensurate with the outlay. But, on the other hand, every Government, even the most absolute—even one which theoretically has the entire property of its subjects at its disposal, is practically incapable of appropriating to its own use more than a portion of that property. Practically, its income is limited, and no more than any other recipient of a limited income, can it, without imminent risk of bankruptcy, systematically spend more than its income, borrowing money for the purpose, unless the borrowed money be applied in such a manner as to yield pecuniary returns sufficient to pay the annual interest due to the lenders. Imagine it, for example, to go on raising loan after loan in order to throw down town after town and to rebuild them, in accordance with the sanitary principles lately enunciated by Dr. Richardson—the good done to the inhabitants of the remodelled towns might possibly be fully equivalent to the money spent, but, unless the inhabitants could be persuaded or compelled to pay rents and rates duly proportioned to the cost of the sanitary improvements, the Government would eventually have no better alternative than that of resolving itself into an insolvent court for self-emancipation from its financial difficulties. Although, then, of the two specified senses of which the term "remunerative" admits, the first must by no means be disregarded, the second is the one that here claims our chief regard. Be the advantages of irrigation works what they may to the entire community, what more immediately concerns us here is their effect on the Government Treasury; and we may therefore at once proceed to inquire whether those which the British Government has constructed in India do actually make, or are likely to make, within the period during which the Government can afford to wait, satisfactory pecuniary returns upon the capital outlay. Not that we have as yet quite done with our definitions. We have still to determine what species of disbursements ought to be included in, and what excluded from, capital outlay, and also what receipts can properly be treated as irrigation revenue. These points will come before us presently, but for the moment they may be conveni-

ently postponed. Their significance will be better appreciated after a brief examination of such statistical data as are at present accessible.

According to the latest official accounts, the totals of capital which have hitherto been laid out on irrigation works by the British rulers of India are as follows :—

	From ordinary income.	From loans.	Total.
	£	£	£
Bengal	93,879	3,058,019	3,151,898
North-West Provinces	2,753,530	1,225,634	3,979,164
Punjaub	1,590,058	1,094,221	2,684,279
Madras Presidency	1,015,038	541,488	1,556,526
Bombay Territories inclusive of Sind	853,165	709,495	1,562,660
Rajpootana	18,943	18,696	37,639
Oudh	44,122	..	44,122
Central Provinces	32,983	..	32,983
British Burmah	211,024	..	211,024

making for the whole of India a total of £13,260,295, whereof £6,612,742 was obtained from ordinary income, and £6,647,553 consists of borrowed money.

On a few of the larger complete works the expenditure is stated as follows :—

	From income.	From loans.	Total.
	£	£	£
Ganges Canal	2,342,680	301,945	2,644,625
Eastern Jumna Canal	201,035	6,708	207,743
Western Jumna Canal	231,389	102,828	334,217
Godavery Delta Works	505,303	138,978	644,281
Kistnah Delta Works	317,053	115,841	432,894
Cauvery Delta Works	1,999	40,205	42,204
Sind Inundation Canals (computed)	483,000	113,000	596,000

Regarding revenue from irrigation works, our statistics are to the following effect :—

	Net annual revenue.		Percentage on capital outlay.
North-Western Provinces	£184,670	..	4·6
Punjaub	151,826	..	5·6
Madras	430,162	..	27·6
Bombay, including Sind	264,534	..	16·9
British Burmah	6,917	..	3·27

From Oudh and the Central Provinces the returns are *nil*. In Rajpootana there is a loss of £7,156, or 19 per cent. upon capital, the canals not even paying their working expenses. For all India the net revenue is stated at £1,021,430 or 7·7 per cent.

Among separate works the Ganges Canal is represented as yielding 4·88 per cent. The Eastern Jumna, 25·2; the Western Jumna, 30; the Godavery Delta Works, 42·19; the Kistnah Works. 19·73; the Cauvery Works, 273·31; and the Sind Inundation Canals, 33·3.

Before attempting to draw any general deductions from these figures, we shall do well to inquire into their trustworthiness, which, though open to severe criticism in some important particulars, has, I think, been somewhat unduly impugned in regard to others. It must, in the first place, be admitted that the amount given as the total of capital outlay is in part made up of sums which are far from expressing the total cost of the particular works to which they relate. Among the works occupying the highest places in the scale of remunerativeness are several, which, how much soever they may have been subsequently improved by British engineers, date originally from days long anterior to British domination. The Annicut across the Cauvery, in Tanjore, is supposed to have been raised, and the canals from the reservoir in its rear to have been excavated, by a Hindoo Rajah sixteen centuries before they were remodelled by Sir Arthur Cotton; and the eastern and western Jumna Canals, though re-opened, between 1823 and 1843, by Sir William Baker and his coadjutors, had been first opened more than two hundred years earlier, in the reign of the Mogul sovereign Shah Jehan; while, of the numerous canals branching out from the Indus, very many must be nearly as old as the first dawn of civilisation in Sind. No one, who reflects for a moment, can suppose that for the £42,000 laid out by the British Government on the Cauvery works, or for the £542,000 expended by it on the Jumna Canals, or for the £600,000 expended on the inundation canals of Sind, the works severally in question could be created, if they had now to be created afresh. Possibly it may be the fact that in Tanjore and Sind the greater part, and it certainly is the fact that in the territories watered by the Jumna Canals, the whole of the present irrigation revenue is due to British expenditure, but it is needless to observe that the percentage of revenue earned in such exceptional circumstances can be no criterion of the percentage of earnings reasonably to be expected from absolutely new works. The admission of such percentage, therefore, into calculations designed to show the average remunerativeness of irrigation works in general cannot fail to mislead, unless very considerable additions be entered on the expenditure side of the account. To judge from the estimated cost per mile of the Soane Canal, £1,200,000 at least must be added for the Jumna Canals, and, from calculations of a different kind, it may be inferred that not less than £250,000 will suffice for the Cauvery, nor than £600,000 for the Sind Canals, so that altogether about £2,050,000 must be added.

The amount given as total capital outlay must further be admitted to be imperfect in not including anything for loss of interest during construction, on whatever portion of the cost of the several works may have been defrayed with borrowed money. If the works had been paid for entirely by savings from income, such loss of interest would not be properly chargeable against them. It is true, that, if an individual capitalist lay out £100,000 of his own in constructing and fitting up a factory, which is not furnished for a twelvemonth, his money lies unproductive during that period, and the factory may seem to have cost him not merely the amount expended upon it, but also a year's interest thereon at the current rate, and, if that rate be taken at 4 per cent. to have cost him not £100,000, but £104,000. Here, however, it is assumed that, if his money had not been invested in the factory, it would necessarily have been applied in some other way, which would have yielded him an immediate net return. But this is

far from being the case, for the owner of the money might, quite possibly, have engaged in some unlucky mercantile adventure, or might have entrusted his cash to a bubble company, or sunk it in a railway doomed never to make any net earnings, and so, instead of gaining any interest, might have irrevocably lost the principal. Possibly, indeed, he might have avoided this risk by selecting consols or some other stock adequately guaranteed; but the field offered by such perfect securities is exceedingly small in proportion to the total of capital seeking investment, for the greater part of which there is, therefore, no alternative, besides either letting it lie idle, or committing it to enterprises more or less hazardous. No private person consequently, dealing only with his own money, ever says that he has sunk in a given undertaking more than the principal actually spent. He never, while computing what the undertaking has cost him, dreams of adding interest to principal.

If, however, a private undertaker, having no capital of his own, borrow, at 4 per cent., £100,000 for expenditure on a factory requiring a twelvemonth for its completion, he will clearly be at the end of the year £104,000 out of pocket; his factory will clearly have cost him so much. Or, if we can suppose a single individual to go on borrowing at the same rate £100,000 a year for ten consecutive years, for expenditure on some work of gigantic proportions, that work will at the end of the ten years have cost its proprietor, not simply the million sterling actually spent upon it, but a million plus the interest he had to pay on his successive loans, or £1,220,000 altogether.

And as of an individual, so of a Government. The Anglo-Indian Government has spent upon irrigation works, which on an average have probably each taken not less than ten years to complete, about £6,650,000, borrowed at 4 per cent or thereabouts. To this amount, therefore, should be added £1,463,000 as simple interest during construction. Perhaps it may be thought that the interest reckoned should be not simple but compound, inasmuch as the sums paid annually to the lenders might, if not so payable, have been applied annually to the redemption of previous debts. But although they might have been, they certainly would not have been so applied, but would have been devoted instead to some species of expenditure not directly productive—to the construction of roads perhaps, or of barracks, or of civil buildings; to the extension of education, or possibly to the multiplication of functionaries, or to the augmentation of salaries. Perhaps, too, it may be thought that, not merely should interest on capital during construction be added to cost, but, likewise, all deficits of annual earnings after the works are completed. But why, it may be asked, should this be done in the case of only partially productive expenditure, more than in that of expenditure necessarily and absolutely unproductive? If a palace, when just finished, has cost half-a-million, you would not, ten years later, state its cost at £700,000, because, if the money, instead of being sunk in the palace, had been put out at interest at 4 per cent., it would, in ten years, have produced so much. Surely, in the case of an unsuccessful irrigation work, as of a palace, the absurdity would be equally great in representing the cost as everlastingly increasing, notwithstanding that all expenditure upon it had long ago ceased. Simple interest on capital during construction, however, is undoubtedly a genuine element of cost, and the addition to be made on this account to the cost of Indian irrigation works, amounts, as we have seen, to nearly a million and a-half. Moreover, a third addition, which may be roughly estimated at £400,000, remains to be made for compensation to the owners of land occupied by irrigation works, and for capitalisation of the land-tax lost in consequence.

But, if the official accounts underrate in some respects the cost of Indian public works, they somewhat exaggerate it in others. At first sight, it may seem manifest that the pay and allowances for the time being of persons employed in planning, executing, or superintending the execution of any project, are component parts of the outlay on that project; but this is not altogether so manifest as it seems. A very large establishment of engineers, overseers, surveyors, and subordinate employés is permanently entertained in India, at an annual expense to the State of about a million and a half, for the general business of the Public Works Department; and as, if there were no public works to be constructed or maintained, this establishment would not be needed, its entire expense may no doubt, from one point of view, appear justly divisible amongst the whole number of public works. Still it may be suggested that this establishment may appropriately be likened to a standing army in time of peace. If war break out, whatever extra expenditure is incurred for munitions, stores, commissariat, or carriage is, of course, legitimately debited to the war; but, in so far as the troops ordered on active service consist of previously existing regiments, their pay and allowances remain the same as they were in peace, and are never, therefore, reckoned among war charges. It is only the additional forces raised, the entire expense of maintaining and utilising whom, is so reckoned. In like manner, when any particular Indian public work—the Soane Canal, for example—is undertaken, if for the execution of that work additional engineers or other agents be engaged, the hire of those agents is clearly an essential part of the cost of the particular work. But not so the pay of such of the engineers or others as were already beforehand in the permanent pay of Government. These, if not employed on the Soane Canal, would have been either working, or resting from work, somewhere else—but drawing the regular pay of their rank all the same. To employ these persons on the Soane Canal thus costs the Government nothing, and their pay, consequently, adds nothing to the cost of the canal, and need not, I submit, be included in it.

Not only, however, is it included, but to it is added a share of the cost of training engineers and others, and of pensions and of leave allowances of members of the establishment. Now, surely, this addition, at any rate, is unjust, since whether the Soane Canal project had been undertaken or not, the annual expense of Coopers'-hill, or of Roorkee College, would have remained the same, and neither more nor fewer persons have retired on pensions, or have been allowed leave of absence. The charge, too, made for tools and plant seems to

me excessive. Even though some articles of this description were purchased with a view exclusively to the requirements of some particular project, it may be doubted whether their entire cost should be added to that of the project, since, after that particular work was completed, they might still be available for other works of the same kind; while, in so far as tools or plant are taken from some pre-existing stock, it seems to me that the project is not justly chargeable with more than their wear and tear.

We come now to irrigation receipts, which in the official accounts are arranged under the two heads of direct and indirect, the former consisting of water rates, tolls on boats, sale proceeds of timber grown on the canal banks, and a few other miscellaneous items—the latter of land revenue assumed to be due to irrigation. As to the direct receipts there is no question; these are, undoubtedly, genuine irrigation earnings, but there is not, nor can there be equal assurance in respect to the indirect receipts. That land, for which irrigation is suitable, is always immensely benefited by irrigation, may indeed be accepted as an ascertained fact, the produce being increased in proportions, varying with the character of the soil, but seldom less than one-half, and sometimes as much as six or sevenfold. The lease-holding middlemen, who intervene between the Government and the cultivating tenants of the soil, observing this increased production, naturally raise their rents, and the Government, when periodically revising its arrangements with the middlemen in those of its territories in which it has not committed the fatal blunder of a permanent settlement, exacts, in its turn, some corresponding addition to its previous share of the rent. Probably, however, it is not to irrigation alone that the growth of the Government revenue from irrigated land is due. Many other causes have most likely co-operated—greater security for life and property, better administration of justice, improved agricultural processes, stricter and more judicious fiscal management; and the members of the public works and revenue departments can never agree as to which of these sets of causes has exerted the most influence, public works' officers naturally laying most stress on the first set, and revenue officers on the second.

This conflict of opinion is especially obstinate and acrimonious in the Madras Presidency, where, as also in the Bombay territories, the actual levy of water-rates is a very exceptional proceeding, and all Government dues, from irrigated and unirrigated land alike, are, as a rule, collected under the name of land assessment. To get at the exact rights of the matter is of course impossible; some tolerably close approximation to the truth is the utmost that can reasonably be hoped for. As fair a way as any would apparently be to compare fields of similar soil, irrigated and unirrigated, and to credit irrigation with whatever surplus of production was observable in the former. But not to speak of the extreme minuteness of examination which this operation would require, exactly similar soils would seldom be found far apart, and even if found, they would be sure to be differently circumstanced. They could scarcely have equally easy access to good markets, or be farmed with the same skill and judgment, and they would generally be under quite different crops. Practically, then, the controversy is, and needs must be, settled more or less arbitrarily by guesswork, and with such strong prejudices as those under which the guessers are labouring, the sentences passed are sure to be more or less erroneous. Fortunately, however, the errors committed are pretty sure to be on the safe side. In point of fact, it is left to revenue officers to decide what portion of the revenue collections shall be attributed to irrigation; and as these officers are not likely to assign to irrigation more than its due, we may reasonably take for granted that the share assigned to it in the official accounts is rather below than above the mark. We shall not then run much risk of exaggeration in assuming the official figures of revenue to be accurate, so that, after making the necessary corrections in the corresponding figures of expenditure, we may proceed without further delay to compare the two.

To the official total of capital outlay, in round numbers £13,260,000, we must add a million and a-half for loss of interest during construction, £2,050,000, as the difference between what the Anglo-Indian Government has laid out on the Jumna, Cauvery, and Sind Works and what the entire construction of those works would have cost, and £400,000 as compensation to land-owners, and capitalisation of land revenue sacrificed; thereby raising the aggregate amount to £17,210,000.

From this amount something ought, perhaps, to be deducted for excess of charge under the heads of establishment, and tools, and plant, but having no means of ascertaining how much should be deducted on this account, I prefer, on the principle of erring on the right side, if at all, to deduct nothing.

There is, however, one and a very important deduction to be made. Of the total of £17,210,000, rather more than three millions have been expended upon surveys and other preparations for schemes not prosecuted beyond the preliminary stage, or upon undertakings which were either abandoned as hopelessly unsuccessful while still unfinished, or which, though expected to turn out well eventually, are as yet only in process of construction, and have not been even partially brought into operation; while half a million more has been absorbed by portions hitherto inoperative of works, other portions of which have been for some time in operation. There are then three millions and a half which it would be at least premature to admit into calculations designed to show the remunerativeness of irrigational expenditure, and part of which can never with any fairness be so admitted; and by deduction of these three millions and a half, and of £140,000 for simple interest on three millions, the total of expenditure with which the total revenue is to be contrasted will be brought down to £13,570,000, upon which £1,020,000 is equal to 7·5 per cent, the corresponding provincial percentages, and the percentages of certain specified works being as follows:—

	Corrected Total of Capital.	Percentage of Revenue on Capital.
North-Western Provinces ..	£3,565,425 ..	£5·2
Punjaub	3,134,702 ..	4·8
Madras	1,893,440 ..	22·72

	Corrected Total of Capital	Percentage of Revenue on Capital.
Bombay, including Sind	£2,222,788	.. £11·9
Ganges Canal	2,880,178	.. 4·5
Eastern Jumna Canal	467,978	.. 11·2
Western Jumna Canal	1,306,393	.. 7·6
Godavery Canals	683,705	.. 39·7
Kistnah Canals	467,427	.. 13·2
Cauvery Canals............	293,578	.. 36·6
Sind Canals	1,186,000	.. 18·6

Even to myself these are unexpectedly favourable results, and they will probably take most other people by surprise, but they will, I hope, be admitted to have been honestly reached. But this is not all. Pecuniary investments may be remunerative, not only by causing gain, but also by preventing loss; and irrigation is often remarkably efficacious in this second mode. Wherever, in India, agriculture is entirely dependent on the sky for its supply of water, any very sensible failure of the periodical rains is inevitably accompanied by a corresponding failure of the crops, and the Government, besides having to make large remissions of its land assessment, has to incur a large and often immense expenditure in order to prevent the necessarily defaulting cultivators from dying of starvation. Scarcely a year passes without the occurrence of drought in some district or other of the far-stretching peninsula; and there is seldom an interval of more than five or six years without drought spreading over some extensive region. In either case, if means of effective irrigation have been provided in any part of the area affected, their value becomes strikingly apparent. The enormous outlay consequent on the famine of 1874 must have been more enormous still, but for the Soane Canal, which even in its then imperfect condition, and when the entire expenditure upon it had not risen above £800,000, enabled luxuriant harvests, valued at £500,000, to come to maturity over 159,000 acres, where otherwise every green leaf must have been parched into powder; and, in the rainless autumn of 1860, when other districts in the North-Western Provinces were baked as if in an oven, the Ganges Canal preserved grain crops enough for the sustenance of more than a million of people, who must otherwise have perished, unless kept alive at the expense of the Government, which had already foregone its revenue from the country inhabited by that same million. If the indirect savings annually effected in this way were added to direct annual earnings, the result would be a total that would convince the most sceptical that, regarded as a whole, the investment of the Anglo-Indian Government in irrigation works, has hitherto been decidedly the reverse of unprofitable.

Here, however, it behoves us to be on our guard against the deceptiveness of general conclusions. What practical inference can be drawn from the fact that for all India the average rate of profit on irrigation expenditure is 7·5 per cent., if this imperial average be the medium of provincial averages ranging downwards from 22 per cent. to less than nothing, and if of some separate works the percentage is nearly 40? In Sind, where rain so seldom falls that, without artificially conducted water, there would be at best but browsing ground for camels, the canals are for the most part shallow trenches, without headworks of any kind, from 15 to 20 feet wide, and from 5 or 6 to 60 or 70 miles long; but what argument can the financial success of these afford in favour of devoting from three to six millions to the construction of a vast irrigational apparatus in that garden of India, Oudh, which suffers more on the whole from excess than deficiency of water, and where droughts are virtually unknown? or why should it be supposed that, because a system of canals led off from the apex of the delta of a mighty river like the Godavery has answered well, that therefore it would answer equally to throw a bund over the Betwa in Bundelcund, whose bed in a severe drought might quite possibly be left almost as dry as the land on either side. The only useful moral is one which might have been safely assumed beforehand without inquiry into the facts, viz., that there are irrigation works and irrigation works; that when placed in well selected situations, skilfully planned, and economically executed, they will pay well, but that if placed where they are not wanted, or designed upon an extravagant scale, they will pay badly or not at all. No doubt, India offers a wide field for the profitable extension of irrigation, provided operations be carried on with adequate circumspection and forethought; but, no doubt either, that, unless due note be taken of the failures as well as of the successes of the past, failure will continue to preserve the same proportion to success as it has hitherto done.

Passing on now for a moment to a broader view of the general subject, we may be tempted to take for granted that, in so far as the extension of irrigation may prove remunerative to the Government, it must needs prove at least equally beneficial to the nation at large. How can it be otherwise, if its effect will be to double, treble, perhaps sextuple, the productiveness of the soil, and in equal measure to augment the main constituent of national wealth? If he is proverbially a benefactor of his species who causes two ears of corn to grow where but one grew before, how can corresponding praise be denied to a process that causes land to produce sustenance sufficient for double or treble its previous population? At the risk of being charged with paradox, I must hint a doubt as to the apparent truism to which these questions point. The mere quantity of national wealth is sometimes of less importance than its distribution. Wherever, as in a portion of the Damoodah Valley described by Colonel Haig, the present Chief Engineer in Lower Bengal, there is an agrarian population of little less than a thousand to the square mile, belonging mainly to the ryot class, and with, on an average, not more than a pound of rice per head per day to live upon, matters would, I imagine, not be greatly mended by arrangements which caused two thousand per mile of such wretched starvelings to take their place, even though at the same time the incomes of the half-dozen zemindars interspersed amongst them should be quadrupled or quintupled. This latter augmentation of the possibilities of human happiness would not go far towards counterbalancing the unequivocal multiplication of human misery. Now this, or something like this, is often the principal change to be expected from irrigation, operating by itself, and unaccompanied by subsidiary influences. In the greater part of Northern, in great part of Central, and in considerable portions of Southern

India, the bulk of the peasantry are a cottier tenantry, who often legally and almost always practically, are liable to have their rents raised at the discretion of the zemindars or of the middlemen, of whom they hold. As a natural consequence, wherever irrigation is introduced, rents are raised. If any general inference may be drawn from Colonel Haig's observation of what has already taken place in Orissa, they are almost immediately doubled, trebled, or quadrupled, according to the character of the soil. The Government and the zemindars or the long leaseholders, between whom the proprietorship of the land is permanently or temporarily divided, divide also the profits of irrigation, while the ryots—the immediate occupants and tillers of the ground—share only infinitesimally, if at all. Bearing these facts in mind, not only am I not prepared to admit that the application to irrigation of immense sums of public money must necessarily be for the benefit of the community regarded as a whole, where a large majority of the population consists of ryots—I cannot, also, but think it exceedingly hard that, in so far as the money is raised at the expense of the ryots, it should be devoted to works, one principal effect of which is to subject the ryots to increased exactions. I cannot bring myself to set much store by irrigation unless it be accompanied by such modifications of the present system of land tenure, as by securing to the actual cultivator a sufficiently augmented share in the fruits of his industry, may be calculated to raise his standard of comfort, and so to hold out a prospect of a lasting improvement in his material condition. Here, however, I am adverting to a subject but slightly connected with the one immediately before us, and which I will not venture to pursue further. Indeed, all that I should have liked to say upon it, if opportunity had served, has been already said in a special chapter of a recent volume of mine on "Indian Public Works."

One other point demands a few words of notice before this paper is brought to a close. It will, I trust, have been observed, that I have anxiously endeavoured to do the best with my materials, dealing with them quite impartially, and neither aught extenuating nor aught setting down in malice. Yet I cannot but feel that the conclusions arrived at are, after all, but dubious approximations to the truth, and I am bound to confess that I have been compelled to resort largely to conjecture, in order to fill up gaps in the statistical records. These, consisting of Finance and Revenue Reports of Public Works, Administration Reports, Irrigation Revenue Reports, Board of Revenue Reports, Forecasts of Expenditure, Government Resolutions, and Miscellaneous Minutes and Memoranda, are voluminous enough in all conscience, but that is about the highest praise that can fairly be claimed for them. No one that I know of has them more completely at his fingers' ends than my friend, Mr. Frederick Danvers, to whom I am exceedingly indebted for his valuable aid in analysing their contents, and he, I am sure, will bear me out in saying that, if their object had been the mystification instead of the enlightenment of the reader, they could scarcely have been more cleverly contrived for that sinister purpose. Their internal arrangement has indeed been carefully—even painfully—elaborated; exhibiting a straining after almost metaphysical refinements. The figures are distributed into divisions and sub-divisions classes and sub-classes, heads, sub-heads, and sub-sub-heads, but when we proceed to inquire what are the subjects of this beautiful capitular graduation, we are sadly tantalised at finding how little solid grain can be extracted from the imposing array of fair-seeming husks. Scarcely any two documents have been drawn up on the same plan, and even in one and the same document there are sometimes discrepancies not easily reconcileable. Thus, according to one set of accounts the total of irrigation revenue for all India is £1,020,000, whereof Madras is credited with £430,000. In a separate table, purporting to exhibit the entire irrigation revenue brought to account in the Public Works Department, the total is reduced to £475,000, towards which Madras contributes something less than £7,000, the column for water-rates being left blank in the place opposite Madras. Yet in a third document £220,000 of water-rates are assigned to Madras, while a fourth informs us that in Madras water-rates are, as a rule, not collected at all. Again, the irrigation revenue of the Bombay territories for 1873-4 is in one set of papers stated at £260,000, and in another at £100,000 more, and it is only by referring to entirely separate documentary evidence that we find that, whereas the smaller sum represents net revenue, the larger represents gross receipts previously to the deduction of working and maintenance expenses.

Plainly these things ought not so to be, and it is but fair to mention that the Indian Government does not intend that they shall so remain; though I must take the liberty of questioning whether it is going the best way to work to set them to rights. What has hitherto most attracted attention is the defectiveness of the revenue accounts; and in these, no doubt, there is much room for amendment. However impossible it may be to discover any principle, whereby the proportion of land revenue due to irrigation can be determined with perfect accuracy, and however indispensable, consequently, to select some mode more or less arbitrary, one and the same mode ought at all events to be adopted throughout India. There should not be one measure of apportionment for Bengal, the North-West, and the Punjab, another for Madras, and yet another for Bombay. The selfsame items, too, should everywhere be deducted from gross receipts in order to produce a net residuum.

But the craving for uniformity and symmetry prevailing just now in the Accounts Branch of the Public Works Department is not to be appeased by such concessions, and an edict has gone forth that the form in which Public Works books are kept in Bengal and its sister provinces shall in future be taken as a pattern in the rest of India. Now in the Bengal books, actually realised water-rates figure largely among the receipts, whereas in the Madras and Bombay Presidencies water-rates are at most levied only exceptionally, and there is strong reason for doubting whether they are levied at all. The descriptions given of the existing practice are provokingly ambiguous, but as far as can be made out, what really takes place is this. The whole of the ryot's dues, in respect of irrigated

as of unirrigated land, is paid by him in a lump sum under the name of land assessment; but in some districts the total amount paid is subsequently divided by the revenue officers into water-tax and land-tax, and entered in their books accordingly. But whether water-rates have any real existence or not, it has been ordained that they shall henceforth appear in the Madras and Bombay books, just as they do in those of Bengal, and there are two ways in which the order may be complied with. Either the farce of entering under one name what has been received under another, may be enforced universally, or two distinct demands instead of one may really be made upon the ryot, whom, however, it may then be difficult to persuade that his aggregate taxation has not been added to, instead of being simply divided. In either case, much additional trouble must be taken, much time wasted, and much additional expense incurred, and, in one of the cases, a very mischievous impression produced into the bargain. And all for what purpose? The real desideratum is to ascertain the total net return yielded by irrigation, but nothing will be gained by decomposing the total, and assigning separate names to its several component parts. If so much more be styled water-rate, so much less must be styled land-tax, in all else things will remain as they were. But with a tithe of the time and trouble requisite for this unnecessary change, some substantial improvements might be effected in the expenditure side of the accounts.

Mr. Danvers and I have endeavoured to correct the official estimate of capital outlay by computing, as well as we could with the data in our possession, how much should be added for original cost of ancient works, for interest during construction, for compensation for land occupied, and for capitalisation of land revenue lost, and also how much should be deducted on account of expenditure which it would have been unfair or premature to include in our calculations; but what we, here in England, could do only with doubt and hesitation, might be done in India with comparative confidence. Where we have too often been obliged to guess, inquirers on the spot, with local experience, technical knowledge, and free access to details, might decide authoritatively, and produce in consequence an irrigational balance-sheet little in need of the apologies for possible, or rather inevitable, inaccuracies with which the present paper must necessarily conclude.

DISCUSSION.

Sir Arthur Cotton said the paper they had heard read was an entirely fair representation of the state of the case with regard to irrigation works. It might be questioned whether the returns were 7½, 10, or 12 per cent., but there was no doubt that, really and truly, irrigation works had made returns far exceeding the interest paid by the Government. In one or two points of detail he should differ from the writer, but he did not wish to dwell upon them at present. For instance, with regard to works having taken ten years to execute, and interest having to be paid during the whole of that time, the Godavery works paid interest from the very first year they began, and before five years were over were in very extensive operation. For Tanjore, also, the expenditure was put down at £42,000, but how in the world any man could put his name to such nonsense, and how Government officials could sign it, he could not understand. It was absolute nonsense on the face of it. The actual cost of the works in Tanjore was probably about £400,000. Mr. Thornton estimated it at £250,000, but that was probably below the mark. He had written officially in India several times, and two or three times since he had been out of office, to the India-office, entreating them to insist on their officers not putting their names to returns which they must know were incorrect. For instance, he had a return from Madras, in which the non-irrigated land in Godavery was put at 280,000 acres, and in Kistna at 120,000 acres; the two districts being precisely similar, and with the same population. Yet this paper was signed by the collector, by the secretary of the Board of Revenue, and by the secretary of the Government. He could not agree that the first question was how these works affected the Treasury. The first question was, what effect had it on the community. When they spent six and a-half millions in saving men's lives during the famine, it was not a question whether it would make a return to the Government, but whether it was absolutely essential; whether they would get any interest on the six and a-half millions was never thought of; and therefore the first question should be, what would be the effect of irrigation works on the country generally. Almost every paper on irrigation reminded him of what used to be said of the old India-house Government, that they carried on their trade like princes and governed their country like grocers. The papers continually dealt with this question as if the Government were persons, or private individuals, investing capital; if the works returned five per cent. they were good, but if they returned only 3 per cent. they were bad. Surely the first question was, whether a work returned 50 or 100 per cent. to the community; and whether it returned 5 or 6 per cent. to the Government was a secondary thing. This secondary point was not to be neglected, but it was not to be put in place of the great question for statesmen. Out of the engineering department, this was the first paper he had ever seen which dealt with the subject with the slightest approach to fairness and honesty of investigation. With regard to the Tanjore works, something had certainly been done by the natives, but it was very insignificant. A great deal too much was said about the conflict of opinion with respect to the water rates in Madras. In Godavery and Kistna the water rates were levied as regularly as in Bengal, at four rupees an acre. In Tanjore it was a very simple matter, although it was not levied as a water rate. The average rent of irrigated land was 5½ rupees, and the dry land 1½ rupees, giving just 4 rupees for the water rate, and thus no room was left for question. It was truly remarkable to see from these returns that there was not one failure amongst the whole of these works which were in operation. The returns differed from 40 down to about 4½ per cent., and they were most curiously contrary to the statements made in Manchester a short time ago, to which he was requested to reply. No engineer in his senses would dream of applying general rules to every case, but there were two or three fallacies which appeared in every paper on the subject; one was that of supposing that if there were plenty of rain, there was no need for irrigation. But in the year of the famine in Orissa, there were 30 inches of rain in June and July, and 30 in September; yet between the two the whole harvest perished, and a million and a-half of people died. It was not a question of the quantity of rain, but how it fell. A second fallacy was that water was water. Rain water and river water were two totally different things. Speaking of Oudh, he might say that if they had rain water every week, it would not settle the question whether it should be irrigated or not. The river water was highly fertilising, very different to rain water, and would make a

difference of 50 or 100 per cent. in the crops. With respect to the remarks on the raising of rent, that did not affect their part of the question; but it was an astonishing proof of the defects of our Government, with all its excellencies, that it should leave the great mass of the people an utter prey to the zemindars. In beginning to irrigate in the Godavery, the Government were extremely tender about applying the water rate, and allowed the people to go several years without paying anything, but the instant the water touched the land, every zemindar raised the rent five, six, or eight rupees an acre. There was a despotic Government backed by a large army, and yet they allowed the zemindars not only to rob the Government, but to rob the natives and ruin themselves, for such was their course of action in Orissa. The moment any water reached the land, they put on such an increase of rent as entirely robbed both the Government and the cultivators, and thus prevented anybody else using the water. When the question was raised about irrigating Oudh, it was stated that the zemindars themselves did not wish irrigation, and that was the same all over the world. Manchester manufacturers did not want laws to correct the evils of their factories. When he was in Tanjore he used to send round, asking the principal zemindars to meet him; then he would tell them what he was going to do, and hear what they had to say against it. Of course several stupid ignorant men put themselves forward and called themselves the public, who said all sorts of absurd things, but then he had an opportunity of answering, so that the quiet, sensible people heard both sides. Then after a few months had passed, and they had had time to consider it, he called them together again, and found that these troublesome self-sufficient men had been overthrown. Of course there were now and then thoroughly obstinate men, like some of the landowners in England, who objected to canals or railways. He recollected in particular one incident of an old zemindar in Tanjore who opposed him with all his might, and whom he then lost sight of for two or three years, but he accidentally met him on one occasion, when he came up and saluted him in English, throwing dust upon his head, and saying that the value of his estate was increased tenfold by the irrigation. In Godavery almost all the large landowners were opposed to irrigation, because they were afraid of the people becoming more independent, as happily they were. In Orisssa, Colonel Haig stated if he asked a cultivator if he did not see the benefit of the water, as it would increase his produce by perhaps fifteen rupees an acre, he would acknowledge that, but say that was no use to him, as he would have to pay one half of the profits to the money-lender and the other half to the zemindar. It was this sort of thing which prevented the Orissa works being used. Those works, which were said to be failures, had not failed from an engineering point of view. The cost of irrigation in Orissa was about £3 an acre, and the increase of produce had been carefully estimated at 15 rupees or 50 per cent. of produce alone, besides all the benefits derived from cheap transit and other matters; so that one might really conclude that as engineering works they were calculated to yield 100 per cent. Of course the council, being composed of revenue officers, threw the blame on the engineers, and said the work was a total loss. That was not the right way to look at it. The same with the Toombuddra works. They were calculated to irrigate 150,000 acres of wheat, and would probably return 100 per cent., but they were not in operation, and an engineer told him that on speaking to a landowner he said he dared not encounter the opposition of the revenue officers. If they had a council of engineers and the revenue men in the minority, they would hear the other side of the question. With regard to the returns from the works, the revenue of the district of the Godavery works before they began was £220,000; it was now £330,000, the expenditure having been about £700,000, showing an increase of 50 per cent.; at least 40 per cent. of which was due to the works alone. About 550,000 acres were irrigated, and the increase of produce had been most carefully estimated, and shown to be about £2 per acre, or 180 per cent. increase on the whole cost of the works. There were besides cheap transit, freedom from blight and other advantages. With regard to the traffic of the district there were 31 millions tons carried, but if only two annas per ton per mile were saved by water carriage, that was equivalent to £400,000 a-year, which added 50 per cent. return on the whole cost of the works. The exports of the district were formerly £60,000, but were now £800,000, and the imports, which were formerly £20,000, were now £200,000. The traffic on the principal canal, which was formerly 200 tons, was now probably 10,000 tons, so that the increase of income to the people was assuredly three or four times the amount of taxation paid by the district. The chief fault he found with the paper was that it omitted all considerations of cheap transit. He had been considering this question for forty years while in office, and for ten or twelve years since, and he felt that the chief thing still wanted in India was cheap transit. Therefore, to omit the consideration of it from a discussion on irrigation canals was the greatest possible mistake. In the United States there were three water communications, by which the produce of the land was conveyed to the coast. Ten million tons a-year were carried by the St. Lawrence, the Erie Canal, and the Mississippi; and whether that was carried 1,200 miles by railway at 1d. a mile, or by water at $\frac{1}{10}$d. per mile, made a difference of forty-five millions a-year. The whole question as to whether England should be supplied with wheat from Chicago or from Allahabad turned on that one thing, the cost of inland transit. If the cost of transit from the north-west was reduced from 1d. to 1-20th of 1d. it would make all the difference as to whether it would be sold in the English market or not, and whether we should pay 10, 20, or 30 millions sterling annually to India for wheat. Cheap transit would take off 2s. a bushel on the cost of carriage from the north-west to Calcutta, and would make the whole difference of there being an enormous demand in those provinces. Two shillings a bushel made all the difference to the English market as to whether it was 1s. above, or 1s. below the present price. The price in the north-west of India was now 2s. 6d. a bushel, and if it could be brought here for 1s. that would leave 3s. a bushel profit. The Sirhind, the Ganges, and the Soane canals formed a line of 1,000 miles, but with two breaks, one of 100 miles and the other of 50. If those were completed there would then be water carriage from the north-west right to Calcutta, and the whole of those provinces would be opened up to the London markets. Nothing was wanted but to complete this line, and he begged to ask gentlemen interested in India, whether this was not an important question? In his consideration of this subject, every year the importance of cheap transit had increased, and the simple figures he had now given would show the grounds for it. He must say he was disappointed in the paper in one respect, because instead of finding an enemy he had found a friend, and therefore had nothing to oppose. In Manchester every conceivable objection was made to irrigation, and it was inconceivable the absurdities that were stated, sometimes by those who did not know the facts, and sometimes by those who wished to prejudice the question. There were now almost seven millions of acres in India actually irrigated, whilst the works at present in progress would irrigate at least six millions more, or a total of thirteen millions, which would be to make some improvement in the country, and would provide for the feeding of forty millions of people. He concluded by again adverting to the importance of completing the system of water carriage from the north-west provinces to Calcutta.

General **F. C. Cotton**, in reference to a remark in the

paper that the increased produce from irrigation tended to increase population too much, said the answer was that when cheap transit was introduced it would not be necessary to produce only rice or any particular crop, for the cultivators might raise anything for which there was a demand, and convey it to markets where it could be sold.

Mr. William Tayler said the subject of irrigation in India was one to which he had devoted great attention for the last ten or twelve years. It first came under his notice at Simla ten years ago, at a time when antagonism was rife, and when Sir Arthur Cotton's schemes were subjected, if not to ridicule, to severe official opposition. Having, then, access to the pages of the *Pioneer*, he did all he possibly could to give his countenance to Sir Arthur Cotton's grand schemes. He had always felt that water to India was life, and if the English Government wished really to secure the prosperity of the ryot, and the advancement and stability of the British Empire, it must be done by supplying water to the ryot. After a time the opposition he had spoken of became milder, and now he saw with immense gratification that the schemes of Sir Arthur Cotton had been subjected to fair criticism. Hitherto it had always been said he was an enthusiast, and that his calculations must be subjected to a discount of at least 50 per cent., but now an impartial examination of the figures showed a result which quite bore out Sir Arthur Cotton's calculations; but there was one point to which he must advert, viz., that he considered it degrading to look at this subject as a mere commercial speculation. It was insulting to them as civilised beings to leave out of calculation the benefit and prosperity to the country, and the well-being of the people, because, if 5 or only 2 per cent. were returned as a commercial speculation, still the increased prosperity of the people was an infinitely greater consideration than the highest money returns.

Mr. Thomas Briggs said they seemed to have come to a certain position and there stopped, as if they were on the horns of a dilemma. They all agreed the cat should be belled, but they failed to see how to bell the cat; that was an expression made use of by the last speaker ten years ago. Now he thought the last link to make the chain on which to hang the bell was this—the law which Lord Canning passed with regard to dealing with the waste land of India; until that law was re-imposed in all its purity, without any addition, they would never be able to bell the cat in India.

Mr. Edwin Chadwick said, looking at his high official position, the writer of the paper had set an important example, in coming out of his office to present them with authentic, important leading facts for public consideration, and it was satisfactory also to have there in the chair a member of the Indian Council specially conversant with questions of finance. It was well to have such questions discussed here, where they would be better and more purely discussed, without the least taint of party spirit, and with the aid of specialists, who could not afford to pay for seats in Parliament. We have pessimist cries, raised by directorates and private money-lenders, and the like,—that Government does, and, as compared with themselves, must need do everything badly. But what was the great fact presented to-night? that all round the Government irrigation works of India pay more than 7 per cent. Contrast that with the outcome of the impudently boastful private enterprises—the railway directorates, which, having promised 10 per cent. have given all round, from the first, less than 4 per cent. This 7 per cent. of the Indian yield, however, represents only a part of the money value as the interest of the works. But the Indian Government, having a deficit, occasioned partly from overcharges from the private enterprises in railways,—for was it not the proper policy to reduce those charges, by going on with paying works, by borrowing money for them, as might be done, at less than 4 per cent., and by a competent administration reaping 7 per cent. or more? The most abject financial policy was in staying paying works—economising, as he termed it, the means of economy; economising the means of reducing existing charges and of reducing existing deficits—shutting up and doing nothing, which should be received as a declaration of the incompetency of the administrators to do anything befitting their position, and of the need of occupying their places by others, who were ready to make good their competency to do something? To all who had considered the subject, especially with reference to India, the work of collecting and storing water, and of its distribution so as to promote good culture, to avert deficiencies, and drought, and avoid malarious excess and waste, was a primary function of good government peculiarly befitting the position of the Indian Government as the great landlord power; and, in the interest of its rental as revenue, the foremost and closest attention was due to it. We foretold that the collection and storage of water would hereafter be in this country a public function in the interests of agriculture, and of private property as well as of health. The appointment of an Inspector-General of Irrigation Works was a good step in the right direction, but further and closer provision appeared to be needed to bring modern science, the best practical science, from the East, including the science of the horticulturist, to bear for the advantage of the West. Years ago, when his friend Baird Smith was at home on vacation, and considering what engineering works he might examine to take back with him for use in India, he (Mr. Chadwick) advised him to get permission to examine the irrigation works for Northern Italy. The East India Company gave him leave, and paid the expenses of the publication of a very good exposition of those works as contributions for the service of India. But even those works were deserving of re-examination at some points; and, moreover, it would pay well to have renewed examinations of irrigation works in Spain as well as in Italy, for varied executive details. The whole subject was at present only in a rudimentary state. The data as to the sizes of channels were only rudely approximative, and it would pay to have them closely corrected, and an expenditure which should secure a better model than any which now existed would be remunerative. It was too common a notion that the exclusive object of irrigation was to distribute plain water solely without regard to its quality. The great axiom of de Candolle, the chief vegetable physiologist of late times, had to be understood and made prevalent; that the future of agriculture everywhere will be in giving food and water at the same time. This will bring in aid of the agriculturist the science of the horticulturist, and the art of the plant feeders, the growers of prize plants, who have effected such wonderful transformations and augmentations of the edible qualities of plants. This principle of culture should be promoted by horticultural and model gardens attached to cities. This principle, too, of giving food and water at the same time will comprehend as irrigation works, water carriage, and the application of the refuse of cities to agricultural production. On some elementary principles for the drainage of cities and on their sanitary relief, and at the same time on the production of fresh and more powerful manure, he had prepared a paper for the Indian Government, which it had done him the honour to transmit to the Department of Works in India for their information, but in that paper, he had represented that it would be worth while to have variations in methods and details in the application of those same assured principles well examined for future practical guidance. Indian administrators might reproach us here with our backwardness on some of these works, and very justly; but this was to be considered, that in India the task was chiefly to inform simple ignorance; here the task was not merely that but to remove dense sinister interests, which infested the

seats of administration. It is these sinister interests of all sorts, though they do not appear to be so powerful in India, which here oppose not only works for the storage and collection of water, and its application to agriculture, but its storage and collection for the use of urban populations, and its re-distribution as manure to the land. Mr. Lewis Jackson had written a very useful work, containing a comprehensive view of the existing knowledge, and of what was wanting for its completion on the subject, from which a reference to the latter branch of the functions of a public water administration might be cited, as showing a dawn of light here, which may have its reflex on India. He says:—"The collection of drinking water from the surface of land needs, in the first place, a clear, uncultivated, and uninhabited tract of land as a catchment area; and in the second place, the water stored in the reservoir, which is liable to become putrescent, or seriously affected by the organisms, plants, and animalcules that inhabit stagnant water, requires a very perfect and careful filtration, of a sort beyond the ordinary economic powers of municipalities or public companies. Indeed, it is now asserted to be an incontrovertible fact, that it is to the tainted water of rivers and reservoirs that one-half of most preventable diseases are due, the other half being caused by want of ventilation, faulty drainage, and mistaken modes of managing sewage, or in other words, that impure air and tainted water are the chief enemies of human life, and there is, therefore, every reason to believe that in the future, when the general public become awake to this, and acquire enough energy to throw off the incubus of vested interests in the form of water companies, both tainted rivers and open reservoirs will be universally condemned as sources of drinking water supply, and the water filtered, stored, and preserved against impurity by nature in the permeable strata of the earth will be drawn on in a more scientific and enlightened way than is at present usual, and be considered, as it justly is, a necessary of life. Another quarter of a century may show us scientific men objecting, on sanitary grounds, to the watering of our streets with such water as is now used in our food. It will, therefore, be only under very favourable conditions, or under circumstances that admit of no better alternative, that the water of storage reservoirs will be used to drink. For extinguishing fires, watering streets, and many other purposes, such water is, however, still valuable under ordinary circumstances." With the greater freedom in India from the incubus of such sinister interests, we may expect, in so wide a field, a return of leading instances though opinion is advancing in this country to justify better anticipations than those stated. With 7 per cent. achieved from rudimentary work, there was every reason for calling for further advances, one means of which would be model farms and trial works with liquefied manures in model gardens near cities.

Mr. Thornton, in reply to what had been said by Sir Arthur Cotton, said he really was not guilty of any depreciation of the more important considerations which he and Mr. Tayler had referred to. He was quite willing to admit that the importance of irrigation to the nation at large was of infinitely greater consequence than its pecuniary value to the Government, supposing the money was subscribed by the people for the purpose. What he wished to point out was that a Government having only a limited income could not do even good, however great that good might be, unless it received from the good work it did a return sufficient to pay the interest on the money which was borrowed, since it must inevitably become bankrupt.

Sir Arthur Cotton said it was not a question whether they should spend money or not, but whether they should spend it on a famine or in preventing it. They had spent $6\frac{1}{2}$ millions on the last famine, and surely it would have been wiser to have spent it before, and to have prevented famine over the whole of the country for ever.

The Chairman, in proposing a vote of thanks to Mr. Thornton for his valuable paper, said he had never heard the facts and figures more clearly brought forward on this important subject. He felt very proud to think that he had insisted on this subject being brought forward, and had asked Mr. Thornton to take it in hand. As a merchant long acquainted with trade, he concurred in the fullest manner with what Sir Arthur Cotton had said as to the necessity of providing cheap transit if you wished to make a country prosperous; in fact, it was the foundation of all good trade and of national wealth. He begged to assure him, however, that there were those on the India Committee who never lost an opportunity of insisting on that policy; and he only wished that he were a few years younger, that he might live to see things done in India which he felt sure would be done in the next generation. The necessity for irrigation works was shown by the extraordinary difference in the rain-fall. At Kurrachee it averaged about 15 inches a-year; but last year, at one of the hill stations, more than 25 inches fell in one day. There was water enough in the country, if it were utilised, and he did hope to live to see many excellent admirable works of irrigation carried out. They were censured, he thought, a little too harshly for allowing the doings of the zemindars; but the fact was, they were suffering for the sins of their forefathers. The perpetual settlement was the foundation of a vast amount of suffering and loss for India, and he never could speak of it with patience. It was one of the greatest mistakes ever made by a statesman, and they had suffered from it in every possible way. The difficulty had shown itself, especially in the present depreciation of silver, but he feared they could do nothing to remedy it at present.

The vote of thanks was carried unanimously, and the proceedings terminated.

The following letter has been received from Mr. Briggs:—

"Sir,—May I venture to ask to be allowed in your next issue to supplement the few hurried observations I made at the meeting last night on the above question, by way of explanation, which time and a due regard for other speakers prevented me entering into then.

First, then, allow me to explain what I mean by the term "bell the cat." The fable says that the mice all agreed that the cat should be belled, but when they came to consider how and by whom the operation was to be performed, an overwhelming difficulty presented itself. So it is with the Government of India.

The periodical famines in India, causing the death of hundreds of thousands of thrifty subjects, and millions sterling to be ever wasted and for ever lost, forms the typical cat of which we speak. It was Mr. Tayler, some nine or ten years ago, who put it in this shape, I think, in one of his speeches at the Indian Association.

Ever since then the Indian authorities (with a few exceptions) have been waging a deadly war against those who suggested that these famines arise from preventable causes. It appears now that truth has asserted itself, judging from the tone of Mr. Thornton's most excellent paper, and the able remarks of the champion of India's welfare (Major-General Sir A. Cotton), in the discussion thereof at the Society's rooms last night, and that the official red tape is about to yield to the pressure of the inexorable logic of facts, and that they are now, after throwing away much valuable time, resources equivalent to thousands of millions sterling of material wealth, and millions of valuable lives, beginning to open their eyes to the fact that Sir A. Cotton was right after all, and, in order to "bell the cat," we must have proper irrigation and navigation works as well as railways; all three are links of one chain whose interests are mutual.

This brings us to the "last link," which I spoke of, viz., how to provide the ways and means. Sir A. Cotton's indignation at the fact that Government should

allow the zemindars to oppress the ryots, especially in regard to the over-charges on improved production of the soil, is very just, and ought to occupy the attention of the statesmen, who have the work of legislating for India in hand. In my opinion, the "last or missing link" is the only remedy, or first condition on which a true remedy can be built. What is it? It is this, viz., the Waste Land Laws, or rules sent out to India by the present Lord Derby about 1859, when his title was Lord Stanley, and he held the office of Indian Secretary. Lord Canning was then Viceroy or Governor-General of India.

The latter, after mature deliberation and travel throughout India on a tour of observation, came to the conclusion that they were wise rules for developing the resources of the soil, and recommended the council to pass them into law, which was done, and whilst this law was being sent home to be ratified, some 100,000 acres were surveyed and sold under it. In the district of Cachar, says a correspondent in the *Times*, June 12th, 1863, "They were having a fair trial. The whole valley is now owned by English settlers under Lord Canning's Waste Land Rules. Savage Kookees, who used to cut each other's throats, and those of our subjects, are now thriving labourers in neat cottages A valley destitute of population, and worthless to the State before the mutiny, now yields a good revenue besides the purchase money of the land, and is as smiling as an English county."

The gist of those rules was as follows:—"That all waste land shall be surveyed and marked out in blocks not exceeding 3,000 acres, subdivided down to blocks of 40 acres or under, then offered at 10s. an acre for those which had once been occupied but abandoned and gone to waste, and 5s. an acre for those lands which had been allowed to remain in a state of nature from the Creation," subject of course to the imperial land tax and local burdens. This was a most beneficent law; it was the "taking of the tide at the flood, &c.," for just after it had been passed the American civil war broke out, which created the cotton famine in Lancashire.

This law, if it had been allowed to proceed on its mission of blessing, would have had the effect of providing an outlet for the natural increase of agricultural labour, by which the ryots would have been able to defend themselves from the ferocious rapacity of the cruel zemindars. This would be the greatest blessing of all. If the natural increase of population there be the same as here (in London), they will have out of $3\frac{1}{2}$ millions of population an increase of births over deaths of about 1,000 a week, this means that every week there are 1,000 adults added to the stock of those seeking employment. This "last link," being once restored, would provide the first condition for wedding the labour to the land, and therefore it would create the material wealth wherewith to provide security for interest on loans of money for irrigating, making railways and steamboat canals, to cheapen production, increase consumption, and facilitate the distribution of the nation's wealth.—I am, &c., T. BRIGGS.

The Homestead, Richmond, Surrey, May 6th, 1876.

AFRICAN SECTION.

A meeting of this Section was held on Tuesday, 8th May, Vice-Admiral ERASMUS OMMANNEY, C.B., F.R.S., in the chair.

The paper read was—

THE COMMERCE OF THE GABOON: ITS HISTORY AND FUTURE PROSPECTS.

By R. B. N. Walker.

The mouth of the estuary of the Gaboon is situated between 22′ and 30′ north latitude and in 9° longitude, east of Greenwich. Owing to a hiatus in the relations of the voyages of the Portuguese navigators of the fifteenth century, no record of the actual discovery of the Gaboon appears to be extant, but there can be little doubt that it was first visited in the year 1471 by Joas de Santarem and Pedro de Escobar, who were sent on a voyage of discovery by Fernao Gomez, to whom the trade of Guinea had been farmed by Alfonso V., King of Portugal, for the sum of 500 cruzados for five years from 1469, during which period Gomez was under the obligation of exploring the West African Coast for the distance of 500 leagues beyond Sierra Leone. As navigation in those days consisted in creeping along the coast, and Santarem and Escobar reached Cape St. Catherine in south latitude 1° 48′ (which they named after the saint on whose day it was first seen), it is scarcely possible that they could have overlooked so extensive and important an inlet as the Gaboon.

The once-potent Kings of Pongo (or, to give the native title, the Mani-Pongo) resided at Gaboon, their authority being respected and their power dreaded, according to Dapper, Barbot, and other early writers, along a very considerable extent of coast, even as far as the Camaroons on the north, and beyond Cape Lopez to the south; but all trace, and even tradition, of such power has long ceased to exist, although the present inhabitants of Gaboon, the Mpongwe, have the arrogance even now to consider themselves superior to all other negroes, evidently not having the remotest idea of such kingdoms as Asyanti, Dahomé, &c., or of the despotic rule of the kings thereof. The so-called Mpongwe kings are now, and have been for many years, mere petty chiefs, only one of whom, Rapantyamba (called King William by the English and le Roi Denis by the French), possesses even a shadow of influence beyond his own village and immediate followers. According to my own theory and belief, the Mpongwe of the present day are not the actual descendants of the old Pongos, but belong to a tribe which reached the estuary at a period subsequent to the decadence of the renowned Pongo kingdom, and who usurped the name of their predecessors, probably amalgamating with the small remnants thereof, from whom they derived their arrogant notions of superiority. The difference between the modern Mpongwe language and the few words of Pongo handed down to us by Barbot favour this idea; this, however, is a matter of speculation, which scarcely falls within the scope of this paper, and I shall, therefore, endeavour to confine myself to the commerce of the district comprised within the present limits of the French possessions in equatorial Africa, that is to say, from 55′ north latitude to the River Bange, in 1°, 48′ south of the equator.

Little is now known of the earlier commerce carried on between the natives of Gaboon and their European visitors, but it was undoubtedly confined almost entirely to ivory, beeswax, honey, and barwood, the latter being erroneously termed camwood. Later on the trade in the foregoing articles was in a great measure superseded and dominated by the nefarious traffic in slaves, which seems always to have had a peculiar attraction for the negro; but strange as it may appear, the Pongos were at one time importers, and not, as in later

years, exporters of slaves, as we are told by Barbot, Dapper, and others, that formerly the Dutch purchased slaves at Camaroons and elsewhere, whom they carried to Gaboon and sold to the Pongos for ivory, receiving one hundred and fifty to two hundred pounds weight of that valuable commodity for a male slave. Few records exist of the development and progress of trade at Gaboon, but it must soon have become considerable, as the river speedily became well known, and was much frequented by adventurous merchants from all the maritime States of Europe, as Bosman, who visited it in 1698, says of the "Rio de Gabon," as he calls it, that "it is so famous that no nation which ever sailed to this part of Africa can be unacquainted with it." It is uncertain at what date the English first commenced trading at Gaboon, although it is on record that Townson, who was one of the first of our mariners to embark in the Guinea trade, sighted the neighbouring island of St. Thomé in July, 1555, but it does not appear whether he touched at the river (which is on the same parallel) or not. Bosman speaks of the ivory trade at Gaboon in his day as being both tedious and troublesome, the natives then, as now, delighting to haggle for an entire day over the price of a single tooth, instead of having a fixed rate and coming to the point at once, as is the custom at Ambriz, Kinsembo, and other places to the southward, where frequently more ivory changes hands in one day than is bought at Gaboon in two or three months. The system known as the "round trade," which is the mode of barter employed at Gaboon in the ivory trade, and the constant endeavour of the native dealers to over-reach and impose upon their European customers, are the principal causes of the slowness which exists in the purchase of ivory, and of the severe strain which is put upon the time and patience of European factors.

The Gaboon estuary (variously known in former days as Gabona, Gabaon, Gaba, and Gabam) forms a commodious and safe harbour, and was, on this account, for a long period the favourite resort, not only of honest traders, but of slavers, buccaneers, and pirates, who found secure shelter in its many creeks and rivers. Senga-tanga and the mouths of the Ogowe in Cape Lopez Bay were also much frequented by slavers and freebooters, those places, as well as Gaboon, being convenient for wooding and watering, but the latter would seem to have had the preference, as in the days before ships were sheathed with copper or other metal, and when, consequently, frequent careening was necessary, its quiet haven afforded unusual facilities for the purpose, superior, probably, to any place on the West Coast of Africa, Sierra Leone alone excepted. On this account it was long the practice, not only of trading ships, but of others of more doubtful character, to visit the port for beaching and cleaning, which was usually done at Konig or Konikey Island, since re-christened Ile d'Orleans, by the French. It would appear, however, that the operation was attended with some danger, especially in the case of large vessels, owing to the hard and rocky nature of the ground, as Bosman tells us that one of his consorts preferred to heave down by his ship on that account, but according to Barbot and others, there was a still more serious danger, the natives being not only savage and treacherous, but cannibals to boot, and in 1601 they massacred and ate the crew of a Dutch vessel, and afterwards did the same by some Spaniards. This statement proves that the Fans, or Ba-Fant, of whom we heard so much some fifteen years since, were not by any means the first tribe located in the Gaboon which displayed a predilection for human flesh; nor was the plundering of ships and slaughter of their crews confined to the old Pongos, a similar act having been perpetrated by their descendants or successors, the Mpongwe, about forty years since, the ringleader in which outrage was known to myself, and is mentioned by Du Chaillu in his "Equatorial Africa," under the name of Njâgâni, who afterwards became King Glass. The Pongos are described as being fierce and cruel, always at war with other tribes, and much addicted to intoxicating liquors; in the latter respect the Mpongwe of the present day vie with their ancestors, although they have somewhat mended their manners in other points.

The slave trade was carried on at Gaboon with great activity from an early period until the occupation of the river by the French in 1843, which rendered its continuance both difficult and dangerous in the estuary itself, although the almost inexhaustable supply of slaves furnished by the River Ogowe kept it alive at Cape Lopez and its vicinity for some years later, until, in the latter part of 1857, when the baracoons at Senga-tanga were destroyed by the British squadron, by which a blow was inflicted from which the demoralising traffic has never recovered in that locality, and since that period it has been confined to a petty traffic between Cape Lopez and the Portuguese Islands of St. Thomé and Principe; but as slavery has recently been abolished in these islands, it is to be hoped that the slave trade will soon become a thing of the past on this part as well as elsewhere on the West Coast.* It is to be regretted that for a few years (1857 to 1860) the system of "free emigration," under the auspices of the French Government, led the natives of Gaboon and other parts of the coast to hope that their favourite commerce was about to be revived under the protection of one of the most powerful European nations, and some 1,500 or more poor creatures were exported from Gaboon to Martinique, Guadaloupe, and Cayenne, under engagements for seven years, not one of whom has ever returned to the colony. A far greater number was, during the same period, shipped at Loango, the Congo, &c., for the same destination, and I never heard of any returning. Happily for humanity, and for the interests of legitimate commerce, the representations of the British Government induced the late Emperor Napoleon III. to discontinue this so-called "free emigration," which (whatever might have been his wishes and intentions, and however well his instructions might have been followed by the agents and *délégués* employed in this service) was to the native mind neither more nor less than the slave trade, and to Europeans appeared to be the same thing under a very transparent disguise indeed, and all the more so from the fact that many

* Since the writing of this paper I have heard from one of my former assistants just returned from the Ogowe, that the slave trade is still rife in that river. He states that he has seen as many as ten canoes pass his factory in one day on their way to the coast, containing from 3 to 10 slaves in each, most of whom find their way to Princes and St Thomé, notwithstanding the recent abolition of slavery in those islands.

former slave-dealers, both white and black, were employed to procure the pseudo emigrants. At all events, so long as this "free emigration" lasted, it certainly tended to check the development of the trade in the legitimate, though possibly less profitable, articles of export from Gaboon; on the other hand, it cannot be denied that it was looked upon with a certain degree of favour, not only by the natives, but by some of the white residents, because it offered a means of clearing the country of thieves and malefactors, whom it would otherwise have been impossible to get rid of, or whom, in extreme cases, their masters would quietly have put out of the way.

During the latter part of the 18th century and the beginning of the 19th, the legitimate commerce of Gaboon, so far as the English were concerned, was principally carried on by Bristol and London ships, which at that time generally resorted to Ngango (the Naängo of Bowdich), the residence of King George; then, however, and until very recently, ships visited Gaboon not only to purchase ivory, but chiefly with a view to fill up with barwood after trading for more valuable, but less bulky commodities on the Gold and Ivory Coasts, and in the Oil Rivers, some, also, coming from Ambriz, Loango, and other places on the South Coast for a similar purpose. The deplorable "trust" system prevailed then, as it has done in later years, but notwithstanding this, and the losses occasioned by the dishonesty of the natives, who very seldom paid up in full, the profit must have been very considerable, as, according to Captain John Adams, who published a work on the Guinea trade in 1823, an assortment of goods, which he gives of the value of £558 in England, was then adequate for the purchase of from four to five tons of ivory, and fifty to one hundred tons of barwood at Gaboon, the River Danger, and places to the southward, unless there was much competition; he also states that in the year named goods costing £200 would buy one ton of ivory in the Camaroons.

Bowdich, who visited Gaboon in 1818, on his way to England after his mission to Ashanti, and remained in the river about two months, unfortunately gives little information as to the commerce of the place, his enquiries having been chiefly confined to geographical and ethnographical subjects, and to natural history; but he does not speak very highly of some of the English traders of his day, mentioning that they invariably sold into slavery the sons of native chiefs entrusted to them for the purpose of being educated in England. It is interesting to note *en passant* that Bowdich appears to have been the first to direct attention to the importance of the Ogowe, or Ogoväwai, as he calls that river, which he expressed a wish to explore, but unfortunately did not live to carry out his intention. In the map appended to his "Mission to Ashanti," Bowdich makes the Ogowe communicate with the Congo and the Niger, and the latter with the Nile. The ship in which he was passenger completed her lading at Gaboon with ebony and barwood, but although Bowdich mentions the existence of caoutchouc, and describes the method of collecting it, it had not then become an object of barter, but simply appears to have been regarded by the natives as a curiosity. The brother of King George, known to the English as Tom Lawson, appears to have been at the period of Bowdich's visit, a skilful and trustworthy trader, much trusted by the London supercargoes resorting to the river, who, if the stories of some of the older natives now living may be credited, delivered to him entire cargoes to barter for the produce of the country, receiving always a fair equivalent in return. Glowing accounts are still current of the grand style in which Tom Lawson lived in those halcyon days; but, unfortunately, he left no worthy successor, and it is now some twenty years since a fairly honest native trader existed in the place, the last of them being Songé, or Will Glass, whose position with regard to King Glass was much the same as that of Tom Lawson to King George, although the relationship was not so near as in the latter case. Will Glass died in 1855, and with him all sense of honour and commercial morality seems to have become extinct in the Mpongwe tribe, who are noted at the present day for dishonesty and duplicity in their trading transactions. Six slave-ships (3 Portuguese, 1 French, and 2 Spanish) visited Gaboon during Bowdich's stay in the river, besides several small craft from Prince's and St. Thomé engaged in the traffic, and the vessel on board of which Bowdich was, quitted the river precipitately, owing to the arrival of an armed Spanish slaver of piratical tendencies, whilst after leaving, they were chased and boarded by another vessel of the same nationality and character, which wanted provisions.

Until some few years after Gaboon was taken possession of by the French, the trade in ivory and other descriptions of produce was carried on by vessels visiting the river for the purpose, the barter being in some cases conducted on board directly with the natives, and in others considerable quantities of goods were given out to some of the principal native traders, who possessed boats of their own construction, of considerable dimensions, in which they not only traded in the various effluents and creeks, but extended their excursions to Corisco, Benito, Batanga, and other places in the north, and to Senga-tanga, Cape Lopez, and Camma to the south. In this case, the ships making such advances would proceed to the Grain, Ivory, and Gold Coasts, and to the Bights, to trade, and return some months later to settle with their Mpongwe trade-men, and at the same time, if necessary, fill up with barwood. As might be expected, such a system had many disadvantages, and very frequently masters and supercargoes received very inadequate returns for the merchandise they confided to their native agents, many of whom could give but a Flemish account of the goods they had been entrusted with, although there were some honourable exceptions. This abuse of their confidence induced supercargoes and others to establish temporary factories on shore, in which case hostages were generally put on board each ship, and one of her officers, or a senior apprentice, was left in charge of the goods, a Mpongwe factor carrying on the barter with his countrymen under the surveillance of the white overseer. At length, about 1846, one or two of the French houses established permanent trading depôts on shore, under the protection of the block-house, their example being followed in 1851 by the principal (and, at that

time, only) Liverpool firm engaged in the trade, whose factory has been maintained until the present time, others being established in later years by Glasgow, New York, and Hamburg houses.

Until 1851 ivory and barwood constituted the principal articles of export from Gaboon, the former being, as is well known, of the finest quality in the world; caoutchouc, although known to exist, had never been turned to any account as an object of barter. The Rev. J. L. Wilson, in his "Western Africa," claims to be the discoverer of "gum-elastic" at Gaboon, but he must have been unaware that Bowdich had mentioned its existence, and described its mode of collection by the natives nearly twenty-five years before the American missionaries settled at Glasstown. Mrs. Bowdich-Lee also alludes to india-rubber in her little work "The African Wanderers," the heroes of which are made to visit Gaboon in the course of their adventures. About the year named samples of caoutchouc were first exported to New York and Liverpool from Gaboon and places in the vicinity, at the cost of about one halfpenny per lb. on the spot; but owing, in the first instance, to the defective mode of collecting it, by which too much water was mixed with the juice of the vine, and afterwards to its gross adulteration by the natives, it was fully ten years later before African caoutchouc took a permanent place in European markets, but since that time it has become an established article of export, and very large quantities of it have been shipped to Liverpool and Hamburg, as much as 400 tons having been produced in one year in the Gaboon country, properly so called, alone. African caoutchouc is the produce of a giant creeper, *Landolphia*, which is not confined to the Gaboon region, but is to be found along many hundred miles of the West African coast. The mode of collecting the milk or juice varies in different places; at Gaboon it is usually caught in small cups made of leaves; the primitive plan, mentioned by Bowdich, of first smearing it on the body and then scraping it off, having long since become obsolete. The trade in African caoutchouc has fluctuated very materially during the past fifteen years, and may be considered as being still in its infancy, but is, I believe, capable of enormous extension. Caoutchouc is now procured at most places from a little south of the Congo to 2° north of the equator, and also as far north as Sierra Leone, and at a few other places on the West Coast, whilst during the last three or four years small quantities have been obtained on the East Coast, and at Madagascar, &c., so that in a few years its production may be expected to increase very rapidly, and its exportation become general from almost all parts of the African continent. The total quantity of india-rubber imported into the United Kingdom from West Africa in 1874 was 19,677 cwt., of the value of £145,189. Of this total, 2,573 cwt., valued at £22,232, came from British Settlements, and 13,297 cwt. from places "not distinguished," and I think I shall not err in putting down three-fifths of this quantity, or 7,978 cwt. as being exported from the French settlement of Gaboon; whilst of the small quantity of 780 cwt., the origin of which is given as Fernando Po, probably one-half also came from Gaboon, as the island at which it was shipped has not exported any, but is frequently visited by vessels from the coast for the purpose of trans-shipping to the mail steamers calling there. In seven years (1868-74) I purchased on the West Coast 20,235 cwt. of caoutchouc, of the aggregate value of about £114,000, of which about two-thirds were procured in the Gaboon district.

The caoutchouc of Gaboon and the vicinity is brought for sale by the natives in different forms, and of several qualities. The difference may be the result of the variety of modes employed in its collection, but there is reason to believe that the inferior descriptions are composed of caoutchouc mixed with the juice of some other vine or creeper, which has a tendency to deteriorate what would otherwise be of fair quality; but other methods of adulteration are practised, chiefly for the purpose of increasing the weight, and all kinds of foreign substances are mixed with the caoutchouc, or concealed under a thin coating of that article, so that it has become a matter of necessity to cut each separate piece before purchasing it. The most innocent mode of increasing the weight is to keep the rubber immersed in water until it is delivered to the purchaser, and canoes and boats frequently arrive at the factories half-full of water, so as to maintain the absorption of moisture by the rubber they carry, until the very last moment. The various qualities of rubber obtained at Gaboon are known as knuckles, tongues, balls, and flakes, the first-named being the best and purest; it has now, however, become very scarce. The vast forests of Western Equatorial Africa, to a distance of 200 miles or more inland, appear to abound in rubber-producing creepers, of which, probably, there are several varieties; but many of the native tribes have not yet engaged in the collection of a substance so valuable and useful to us, and so profitable to themselves; in some instances the natives have from ignorance or cupidity demanded such exorbitant prices as to render it impossible to deal with them, but this will work its own cure in the course of time. This exaggerated idea of the value of caoutchouc is not always to be regretted, as it has been found that owing to the greater profit to be derived from the sale of rubber, and the facility of its collection which is free to all, the quantity of ivory and other articles of barter has had a tendency to decrease in those localities where the trade in rubber has most progressed. This has been observed in the neighbourhood of Gaboon, where the importation of fire-arms and gunpowder has increased ten-fold within the past few years, and where, consequently, it might reasonably be expected that more elephants would be slain; but the reverse appears to be the case, and the slight falling off in the quantity of ivory would seem to be caused not so much by any diminution in the number of elephants, as by the fact of the natives engaging so extensively, and almost universally, in a more profitable and less dangerous occupation than that of hunting those animals. The opening up of the Ogowe since 1871 has brought the merchants into communication with more distinct tribes, especially with those who have hitherto furnished the greater portion of the ivory exported, the trade in which ought, therefore, to be facilitated, were it not that the collection and sale of rubber is easy, and open even to women and children, whilst elephant hunting is necessarily confined to men, and to the bravest and most skilful and active among them;

the weaker and less courageous finding more lucrative and congenial employment in the rubber trade.

Another evil, and a very serious one, entailed by the bulk of the population of this region devoting themselves to the collection of caoutchouc, is the increasing neglect of the culture of the soil, never a favourite occupation with most Africans, especially the males, particularly in the region of which I am treating, where the freemen look upon such labour as degrading. At present the natives of Gaboon and of many places to the southward of that place do not produce sufficient food for their own consumption, and are to a greater or less extent dependent on the importation of rice, biscuit, &c., for their sustenance, whilst the Kroomen and other labourers employed by the merchants are almost entirely maintained from this source. Again, the ease with which money is now earned by the native traders has developed and encouraged a taste for various luxuries which were utterly unknown to them until quite recently, and the factories, in addition to the old-established articles of barter, such as guns, gunpowder, brassware, Manchester goods, beads, earthenware, cutlery, tobacco, rum, &c., now import very considerable quantities of preserved meats, sardines, tea, sugar, butter, flour, salt-fish, ale, wine, brandy, and even champagne, as also wearing apparel of fair quality, jewellery, and other finery, organs, drums, musical boxes, and I am sorry to add, more objectionable articles, in the shape of rifles, revolvers, &c., which may some day be turned against the vendors and other white inhabitants, for however timid the Mpongwe and other tribes inhabiting the Gaboon may be, the possession of arms of precision may give that confidence in themselves which is as yet wanting. Of course this demand on the part of the natives for what I may justly term *objets de luxe*, has been accompanied by keen competition among the merchants, producing a corresponding increase in the price paid for caoutchouc, the cost of which has risen to 8d. or more per pound as the invoice price of the goods in Europe; to this must be added the outward freight of merchandise, homeward freight of produce, cost of maintaining factories, commissions and salaries of agents and employés, and other expenses, so that, on the present price of india-rubber in England ranging from 10d. per pound for flakes to 1s. 4d. for tongues, there is not a very encouraging margin of profit left for the merchant. The quantity of caoutchouc annually exported from the French possessions, comprising Gaboon, the Ogowe, and the Fernand Vas, with some minor and less important sources of supply within the same jurisdiction, will average, as nearly as I can estimate it, 350 to 400 tons.

To return to the ivory trade. I have mentioned the price at which ivory could be purchased in Gaboon between 50 and 60 years ago; unfortunately since then its cost on the spot has increased far more rapidly than its value in Europe, and had it not been for the diminution in the price of the multifarious articles employed in bartering for this valuable product, it would long since have been utterly impossible to carry on the trade with any chance of profit to the merchants engaged in it, although at present both the Mpongwe middlemen and the hunters (especially the latter) must reap a greater benefit than they did 20 or 25 years ago. Some interesting, but rather highly coloured details of the mode in which the ivory trade was conducted at Gaboon between the years 1850 and 1860 may be found in the Rev. J. L. Wilson's "Western Africa," and Du Chaillu's "Equatorial Africa," but they are far too lengthy to quote here, and must be taken *cum grano salis*, being given more from the point of view of the missionary and traveller, than from that of the practical and matter-of-fact trader, whom the authors in question scarcely give credit for the possession of such discernment and acuteness in his dealings with the natives as he may be deemed justly entitled to. Such sensational descriptions may do very well to amuse the general reader, and I for one, am far from being desirous of withholding from the "poor benighted negro" the possession of many of the most essential qualities for driving a hard bargain; neither do I wish to deny that he very frequently gets the better of his less patient and more confiding white customer. Dealing in ivory at Gaboon, as also at Batanga and other places, is conducted on the system of barter known as the "round trade," that is to say, what is termed a "bundle" is paid for each piece of ivory, the value of the "ivory bundle" (Mpongwe igolo-myi-mpunji) varying according to the size of the tusk, the variety of articles comprised in the bundle being the same for the larger tusks, called teeth, and weighing 20 lbs. and upwards, but of course, the number of each article increasing according to the weight of the tooth purchased. So much importance is attached by the native trader to the completeness of the assortment, that the absence of one particular article will render it almost impossible to do business, even with thousands of pounds worth of goods in store, although at present the stringency of this rule is somewhat relaxed, the middleman not infrequently taking something else in room of what may be wanting, and being able to satisfy the hunter or "bushman" out of his own little stock. In 1850 the Gaboon bundle or assortment necessary to purchase 100 lbs. of "prime ivory" (consisting of from two to four teeth, according to weight), comprised about fifty distinct articles of the total value of £17 10s., or 3s. 6d. per lb.; and the bundle for 100 lbs. of scrivelloes (*i.e.*, small tusks between 2 and 20 lbs. weight), of some 25 articles valued at £7 10s., or 1s. 6d. per lb. It may not be uninteresting to give, *in extenso*, the bundles in question, although I shall omit the prices of the different articles, as being now obsolete.

Bundle for 100 *lbs. of Prime Ivory at Gaboon in* 1850.

6 guns (muskets or fuzees).	2 cotton umbrellas.
12 brass neptunes.	2 fathoms of red baize.
10 ,, kettles.	2 cloth caps.
8 Guinea pans.	2 straw hats.
24 brass rods.	2 fathoms of brass chain.
24 iron bars.	2 four-gallon jars.
3 kegs of gunpowder, each 10 lbs.	2 one-gallon ,,
	4 half-gallon ,,
25 pieces of common cloth.	4 iron pots.
2 boxes.	4 matchets.
2 swords.	4 wash basins.
2 soldiers' coats.	2 3-quart jugs.
2 pieces of satin stripe.	4 cotton shirts.

4 red woollen caps.
4 padlocks.
4 small bells.
2 large ditto.
6 plates.
6 mugs.
6 bowls.
4 small jugs.
2 French bottles.
4 gallons of rum.
6 razors.
6 scissors.
6 files.
6 firesteels.
6 looking glasses.
6 snuff-boxes.
8 Dutch knives.
4 spear-pointed knives.
4 papers of needles (each 25).
4 bunches of seed beads.
4 „ white pound beads.
25 heads of tobacco.
25 pipes.
25 gun flints.

Bundle for 100 *lbs. of Scrivelloe Ivory at Gaboon, in* 1850.

2 horse pistols.
2 small neptunes.
5 brass kettles.
10 Guinea pans.
20 brass rods.
10 iron bars.
10 matchets.
2 kegs of gunpowder (each 10 lbs.), or 4 kegs (each 5 lbs.)
20 pieces of common cloth.
12 red woollen caps.
20 plates.
10 bowls.
10 files.
10 small bells.
10 looking glasses.
20 Dutch knives.
20 pipes.
20 heads of tobacco.
20 gun flints.
2 gallons of rum.
2 ½-gallon jars.
2 bunches of seed beads

When it is considered that such a bundle had to be given for each piece of ivory, and that the difference of a few pounds in weight occasioned a corresponding difference in the number of each of the many articles enumerated, and that the native vendor often haggled as much over each pipe, plate, or packet of needles, as he did over a musket or a keg of gunpowder, it will easily be conceived how tedious a matter the purchase of a ton of ivory would be (consisting as it does of upwards of one hundred tusks, large and small), and how true was old Bosman's remark, that "the merchants who would trade here ought to be well armed with Job's weapon, without which nothing is to be done." If we consider the many other duties which each factor has to perform, and remember the nature of the climate, which is so unfavourable to Europeans, we have no difficulty in realising the almost total impossibility of doing business were it not for the employment of a native "trade-man" at each factory, who, knowing the current rate of ivory, and almost the exact bundle which his employer will give for each tooth, does the rough work of bargaining, and contests each item as if his life depended upon it, always displaying the utmost good humour; whilst by the use of any amount of small talk and gossip, quite independent of the matter in hand, and the judicious application of flattery, to say nothing of an occasional glass of rum when the trade appears to flag, or the seller is unusually obdurate, he generally succeeds in securing the larger portion of each lot of ivory submitted to him. The more important middlemen are, as a rule, far easier to deal with than those individuals who, on rare occasions, have a single tooth entrusted to them for sale, and who will then, perhaps, visit each factory in turn, chaffering for a whole week or more before they make up their minds to part with what invests them with a temporary importance, and gives them the opportunity of drinking pretty freely at the expense of the white man. It is almost superfluous to say that the ivory bundle of the present day not only comprises a more extensive assortment of articles than was the case five-and-twenty years ago, but that the number of each has been much augmented; prime ivory now costs 7s. or more per lb. on the spot, and in 1874 even as much as 9s. per lb. was paid for it, thus, with expenses of freight, &c., making its cost equal to its value in Europe, and at times of keen competition even in excess thereof. To meet the increase in the variety of articles composing the bundle, and the greater number of each now paid, merchants are compelled to provide cheaper, smaller, and inferior goods, otherwise it would be impossible to purchase ivory at all. It is only necessary to give one instance of this change, that of brass neptunes, which in 1850 were from 27 to 33 inches in diameter, and cost 6s. 6d. to 8s. 9d. each, but are now made as small as 20, and even 18 inches, in diameter, being also thinner and of inferior metal, and cost only 1s. 6d. each, or even less. Thus, the native hunters in reality gain but little by the apparently higher price they receive for ivory, as most of the goods are so much depreciated in quality, and those of the better class are now reserved for ready money business in rubber and specie, as being more profitable and confined mainly to the Mpongwe, to the exclusion of the actual producers of the different articles of export. The quantity of ivory annually exported from the Gaboon country averages, as nearly as can be ascertained, about 25 tons; this estimate applies to French territory alone, but the only available statistics are so very scanty and inexact that I am compelled to rely chiefly on my own observations in arriving at the quantities of this and other products of the country. There seems to be a very gradual decrease in the quantity of ivory exported from Gaboon, which, as I have said before, I am inclined to attribute to the extension of the rubber trade rather than to any sensible diminution in the number of elephants in this particular locality, although doubtless in other parts of the African continent those animals are succumbing gradually to the increased number and activity of their enemies, or are retreating to less accessible regions of the interior. In 1874, 13,365 cwt. of ivory were imported into the United Kingdom, of which 6,736 cwt. were from different parts of Africa; so that Gaboon does not contribute a very large proportion, as of the 25 tons shipped at that port 10 tons, if not more, go to Hamburg. In fact, not only the French houses, but the English firms, seem to become yearly more and more unable to compete successfully with Carl Woermann, of Hamburg, whose goods, although not so much appreciated by the natives, appear to be obtained on cheaper terms than they can be procured by Liverpool, Glasgow, and Bristol houses.

Gaboon (including the River Mondah) furnishes fully three-fourths of the total quantity of bar-wood exported to Europe and the United States of America, the remaining fourth being supplied by the River Danger, Bapuku, and Benito, to the north of French territory. A superior quality of the same wood is to be found in the Ogowe, the Fernand Vas, and at Mayumba, but it cannot now be obtained at those places on remunerative terms, although it was formerly exported from Mayumba in some quantity. At Gaboon, the quantity is almost illimitable, but the export

of course varies with the demand; the same remark will apply to its value in Europe, which generally ranges between 65s. and 75s. per ton on the average; it has been lower than the former figure, and occasionally higher than the latter, and during the Crimean war, attained as high a price as £12. Barwood has been confounded by some writers with camwood, and supposed by them to be the produce of the same tree, but this is an error; the difference between the two is considerable and unmistakable; camwood (which is derived from *Baphia nitida*) is heavier, closer in the grain, and produces a much superior and brighter dye than barwood, whilst its comparative rarity greatly enhances its value, which is at present between £20 and £33 per ton. I have purchased very large quantities of barwood during the last 25 years, and not a little camwood, but I never experienced the slightest difficulty in distinguishing one from the other at a glance. Camwood is chiefly obtained in Liberia and the vicinity, whilst barwood is most common at Gaboon, where the former is unknown. Barwood is, I believe, the produce of *Baphia laurifolia*, and red sanders and other dye-woods of *Pterocarpus angolensis*. Barwood is an article of commerce which rarely repays the cost of freight, &c.; as, however, the exigencies of the African trade frequently render it necessary to employ more vessels for the conveyance of merchandise outwards, to be exchanged for the produce of the country, than can be loaded in return with palm-oil, palm-kernels, ground-nuts, ebony, ivory, and other valuable commodities, many sailing ships, rather than proceed in ballast to seek a freight in other parts of the world, take homeward charters from Gaboon, Eloby, &c., to which they proceed from the oil rivers and other places, either to take in barwood in completion of their cargoes, or to load with it entirely; many vessels which carry out coals for the use of men-of-war, mail-steamers, and the numerous small steam tenders now employed on the coast, do the same. Thirty years ago, barwood was usually cut in billets, averaging 60 or 70 to the ton, or upwards of 30 lbs. weight each; ten years later the average was about 100 to 120 billets to the ton, but the size has gradually diminished till now, when the billets are 380 to 400 to the ton, or betwen 5 and 6 lbs. each, necessitating considerable modification of the machinery used in grinding them down for use. Notwithstanding this enormous falling off in the size and weight of the billets, the price has varied little since 1850, in which year it ranged from 6s. to 10s. per 100 billets, and is at present 6s. to 8s. for the same number; but profit to the European merchant is now almost a matter of impossibility, although the natives probably make a very good thing of it. I estimate the average annual exportation of barwood from Gaboon to England, France, Germany, and the United States of America at not more than 10,000 tons. I am aware that a more recent French official publication puts the export of barwood and ebony at 25,000 tons, but this is an evident exaggeration, and I place little reliance on the returns made by the local officials, having found them fallacious in so many instances—moreover, until mail steamers called at Gaboon, the united tonnage of the ships of all nations frequenting the port was not sufficient to carry such a quantity, leaving all other descriptions of produce out of the question; and as the freight on barwood by those steamers is dear, no merchant would ship that article by them unless its value was unusually high in Europe. It would lengthen this paper far beyond due limits to enter into any description of the uses to which the products exported from Gaboon are applied, and I will merely state that the bright red colour of the English bandana handerchiefs is produced from camwood and barwood, the intensity of colour being very much increased by the use of sulphate of iron.

Ebony (*Diospyrus ebenum*) has been for many years an article of export from Gaboon, but the trade in it has been subject to many fluctuations, and during some years was almost extinct; it revived again about the year 1858, and has been more or less brisk ever since. The ebony of the Gaboon itself is cut in billets, averaging 2½ to 3 feet in length, but these are so rugged and irregular in shape as to diminish considerably their value, which is at present £12 to £13 per ton in the English market; in the Ogowe and Fernand Vas rivers the billets are smaller, but of a better and more uniform shape, and run about 120 to the ton, worth at present £10. In all parts of the Gaboon district there has lately been an improvement in the size and weight of billets of ebony, and the quantity annually exported has largely increased since a direct trade with the Ogowe was opened in 1871, attaining at present upwards of 1,000 tons, with every probability of a considerable augmentation. As other houses are embarking in the Ogowe trade, which is rapidly increasing, that river will ere long be the principal source from which produce shipped at Gaboon is obtained.

Beeswax is the only other article at present exported from Gaboon, but the quantity has been steadily decreasing, and is now very insignificant, although at one period much more of it was to be had; there is as much of it in the country as ever, but the natives have ceased to collect it in any quantity, as they find caoutchouc so much more lucrative and abundant an article of trade. Gaboon beeswax is worth in England about £6 10s. per cwt., and it is usually made in small cakes called "cups."

Previous to the French occupation of Gaboon, and for some years afterwards, masters and supercargoes of vessels coming for the purpose of trade, were compelled to give a "dash," or present, to the king or chief of the village with which they did most of their business, or nearest to which they took up their anchorage, and smaller ones to the other chiefs and head men; this "dash," or mpago, like the hongo, mhongo, or black-mail, so often mentioned by Burton, Stanley, and other travellers in East Africa, was extorted inexorably, and until it was forthcoming, a ship or factory was not permitted to open trade, and, as a means of compulsion, when the "dash" was withheld, or considered insufficient, the supply of water was stopped. But the influence of these kings and chiefs gradually declined as the French authorities took more interest in the commercial affairs of the colony, and the exaction of "dash" became less rigorous as the power of the chiefs to protect

traders diminished, and became superseded by that of the French masters, so that about 1860 the custom disappeared altogether. However, it was not until 1869 that the French Imperial Government finally decided upon making the merchants resident at Gaboon contribute their quota to the revenue of the settlement, and for a considerable time previously it was a matter of serious debate as to what form the local taxation should assume. The French merchants, with an eye to their own interests, strenuously opposed the levying of import duties, as a large proportion of the goods in which they dealt consisted of provisions and other articles, chiefly sold for specie, their ships taking little ivory, caoutchouc, or ebony, but loading barwood almost exclusively on the return voyage. The English and other foreign houses, on their side, vigorously objected to the imposition of export duties, which would weigh unfairly on them, as, from the nature of their business, they would have to pay at least three-fourths, if not more, of such a tax, their returns consisting, not of specie or bills of exchange, but principally of ivory, caoutchouc, and ebony, with barwood to complete the lading of their ships. However, as might be expected, the French merchants carried their point, and from January 1st, 1869, an *ad valorem* duty of 4 per cent. was imposed on all produce purchased within the limits of the colony, the local value of the different articles being fixed according to the following scale:—

Ivory	10,000 francs,	or £400	per ton.
Caoutchouc....	1,000 „	„ £40	„ „
Ebony	75 „	„ £3	„ „
Barwood	15 „	„ 12s.	„ „
Palm-oil	375 „	„ £15	„ „
Palm-kernels ..	100 „	„ £4	„ „
Ground-nuts ..	200 „	„ £8	„ „
Turtle-shell ..	2,000 „	„ £80	„ „
Gum-copal	200 „	„ £8	„ „
Odika	250 „	„ £10	„ „

This tariff has, with little variation, remained in force until the present time, the local value of ivory and caoutchouc alone having been augmented later *mercuriales*, which are supposed to be revised every four months.

The first four descriptions of produce on the above list can alone be taken into account, the trade in the others being too insignificant for notice; the last one, odika, is a kind of vegetable grease prepared from the kernel of a fruit locally known as the wild mango (*Irivngia Barteri*). By the natives odika is only used for culinary purposes, and is considered by most Europeans an agreeable and palatable condiment; some of the French houses for some time shipped a few tons of it annually to France, where, I believe, it was employed in the manufacture of soap. Some 15 years since, I sent samples of it to England, but the Liverpool Customs authorities, considering it from its appearance a kind of chocolate, charged 3d. per lb. import duty upon it, so that it was left in their hands, and no attempt was made to utilise it. Mr. P. L. Simmonds published an account of it some years ago in the Society's *Journal*, under the name of Dika bread. It can scarcely be deemed at present worthy of mention as an article of commerce at Gaboon. A nut called mpaya is said to yield nearly 80 per cent. of the most fluid oil known. There are also other oil-bearing nuts, and various plants possessing medicinal value.

Merchants pay yearly 800 francs for a license to trade, retailers 400 francs, and grog-shop keepers 600 francs. There is also a *droit foncier* or property tax, and a charge of six centimes per kilogramme on gunpowder, to cover cost of storage in the Government magazine, which is compulsory. In 1871, this tax on gunpowder produced 3,339 francs, thus showing that upwards of 55 tons of gunpowder were imported in that year. A small charge is made for the visit of the health-officer to each ship on arrival in the port. The foregoing, with fines, constitute all the sources from which the local revenue is derived, and which, in all, produce less than 75,000 francs, or £3,000 yearly, which sum is, of course, totally inadequate for the maintenance of the colonial staff, and other expenses, although these have been reduced to a minimum since the war of 1870-71. The deficit is made good by an annual subvention from the Home Government. It is almost absurd that so rich a country as the Gaboon undoubtedly is, should produce so little, as there would be no difficulty in obtaining a sufficient revenue if proper steps were taken to do so, and proper protection accorded to the merchants already established, and others encouraged to engage in business in the colony. I do not propose here entering into the question as to the measures to be adopted to raise such a revenue, beyond stating that the first step would be the substitution of an import duty for the present export duty, as the former would weigh more equally on all alike, and be more just; it would also produce more, and be easier and cheaper of collection. Such articles as rum, Geneva, arms, and gunpowder should also be subject to heavy duties, as their importation tends to demoralise the natives and create disorder in the country.

The local executive is constantly worried by the bugbear of a totally imaginary system of extensive smuggling, for if anything of the kind has been at any time carried on, it must have been on a very petty scale indeed, but even the failure to detect it will not convince the authorities of its non-existence.

The first year for which any official statistics of the commercial and shipping movements of Gaboon were published, was 1862, but these were so incomplete and untrustworthy as to be of little value; palm-oil, coffee, cacao, cocoa-nut oil, and camwood were included in the exports, although purchased beyond the limits of the colony; their value, which is stated at 654,100 francs or £26,164, must be deducted from the total exports as given, viz., 1,624,805 francs, which sum will thus be reduced to 970,704 francs, or £38,828, from which a still further deduction must be made, as a considerable portion of some of the other articles of export were obtained outside of French territory, especially ivory. Much produce was until recently erroneously included in the returns as coming from Gaboon, owing to the fact that most of the merchants trading at that place and making it their central depôt, have factories at many points along the coast for a considerable distance both north and south, and bring the produce bought at such branch establishments to Gaboon for shipment to Europe, their vessels being in nine

cases out of ten despatched from that port, full particulars of their homeward cargoes having to be furnished to the French Custom-house. Another circumstance which tended to multiply the value of all statistics prior to 1869, is the fact that previous to that year there was no fixed scale for estimating the value of produce, each shipper making his return according to his own fancy, one giving the cost on the spot, another the estimated value in Europe, and a third, perhaps, putting it down at native prices, or twice its actual invoice cost. Then, also, a practice existed, which I believe has never been abolished, of granting to all French merchant vessels which touched at Gaboon to purchase a few tons of barwood to complete their loading, a certificate of origin for their entire cargoes, which enabled them to evade the payment of import duties on arrival in France, produce from her African colonies being duty free. Of course, the officials who could consent to be parties to such a system would not fail to include the entire homeward cargo of any vessel to which they gave such a certificate in the returns of exports from the colony. This practice, and the erroneous impression made on the imperial authorities by the absurd system of making no distinction between such proportion of the produce shipped in foreign vessels as was actually purchased in French territory, and what was obtained along some hundreds of miles of the adjacent coast, gave an exaggerated idea of the commerce of Gaboon totally unwarranted by facts. Still, it was for a long time a matter of impossibility to bring the local officials to see things in their true light, the consequence being that when, upon the imposition of export duties, it became absolutely necessary to recognise the distinction between the two classes of produce, which had all along been well-known to the mercantile community and repeatedly pointed out, the difference between the actual exportation from the colony, and the fallacious and erroneous returns which had been made during many years, in spite of the representations and objections of the merchants, was so great and unexpected that the administration would accept no other explanation than that of an extensive and wholesale system of fraud and smuggling, although there was really no foundation for such a belief.

In the same year (1862), the numbers of merchant vessels of different nationalities, together with their tonnage, which entered the port, are given in "Notices sur les Colonies Françaises," for 1866, as under:—

	Vessels.	Tons.
French	15	3,788
English	16	3,346
American	3	646
Portuguese	3	205
Hamburg	1	230
Total	38	8,215

In 1867, French ships had increased to 19, and foreign to 53, of which no less than 45 were English, the total registered burthen for all nations being 23,500 tons.

Towards the end of 1870, the steamers of the African Steam Ship Company, and the British and African Steam Navigation Company, carrying mails and merchandise, extended their voyages to Gaboon and ports to the southward, and have continued to run up to the present time, with more or less regularity, sometimes at monthly intervals; at present the service is limited to one steamer every three weeks. Since merchants have been able to profit by these steamers for the conveyance of merchandise and produce, the number of sailing vessels engaged in the trade has very much fallen off, as might be expected, and now comprises chiefly those which are occupied in the conveyance of coals and salt outwards, and of barwood homewards, but I am not in possession of any recent statistics on the subject. In 1871, 89 merchant vessels (exclusive of small craft under 30 tons) entered the port of Gaboon, of which ten only were French. Mail steamers are included in the total number, but no particulars are given of tonnage or nationality. It must be mentioned, however, that many vessels called at Gaboon more than once during the same voyage, as until recently a system of *cabotage* was carried on by the long-voyage vessels, which frequently remained on the coast six months and upwards, repeatedly visiting the different factories until their cargoes had been exchanged for the produce of the country, when they would take their final departure from Gaboon for Europe; but, of later years, this system has been in a great measure abandoned, each merchant now having one or more small tenders attached to his establishment for the supply of his *succursales* and collection of the produce therefrom, and thus being able to discontinue the former expensive system, and despatch the long-voyage ships after a detention of only a few weeks. The majority of these tenders are sailing vessels, and the remainder small steamers, with steam-launches for the Ogowe trade, in which is also engaged Dr. Livingstone's old craft, the *Pioneer*. A very considerable falling off in the number of merchant vessels touching at Gaboon during the past two or three years was occasioned by the arbitrary conduct of the late commandant, and the vexatiously absurd regulations put in force by him, which caused ships to avoid Gaboon, and resort to the neighbouring Spanish island of Eloby, where shipping and commerce were not subjected to such oppressive and ridiculous restrictions.

The commerce of Gaboon was, until the end of 1872, fairly profitable in all its branches, but about that time many circumstances combined to render it not only unremunerative, but even to entail considerable losses on several of the houses engaged in it. These adverse influences included greater competition, with falling prices of African produce in Europe concomitantly with enhanced cost on the spot. The increased competition was mainly owing to the facilities which steam communication gave to persons of limited capital to embark in a trade which had previously been necessarily monopolised by a few houses having considerable means at command, as such firms alone could employ vessels of their own for the purpose of keeping their various establishments supplied with merchandise, and for carrying back the produce received in exchange. But the whole system of trade was almost completely revolutionised by the introduction of steam, which enabled smaller capitalists to engage in a business which was not wanting in attractions, especially to the former *employés* of the large houses, who had gained some experi-

ence and made a business connexion during their apprenticeship, and who probably had formed an exaggerated idea of the profits made by their late employers, whilst at the same time they under-estimated the expenses incidental to such a commerce. At any rate, this increased competition coming at a time when caoutchouc and ivory had attained their highest price in the European markets, and was naturally accompanied by a corresponding higher rate on the spot, only to be followed by a sudden and rapid fall in Europe, of course caused a stagnation of trade at Gaboon, where it was far more difficult to reduce prices than it had been to raise them, whilst to buy at former rates was simply ruinous. The depression was, however, merely temporary, a slow and gradual revival soon taking place, which unfortunately appears to be accompanied by a tendency to over-trading, rendering the ultimate result far from doubtful, unless a more healthy tone be soon restored, and matters placed on a more satisfactory footing. Gaboon is not, however, the only place on the West Coast where trade has suffered from the opening of steam communication and its consequent evils of excessive competition, &c. The oil rivers and other places have suffered in a far greater degree, and the losses of Liverpool merchants engaged in the West Coast trade have been estimated at little less than a million sterling during the last eight or nine years, of which sum the greater part has been absorbed in those rivers.

In a paper of this nature it is desirable to avoid introducing anything approaching a political element, but in considering both the past and future of the commerce of the Gaboon, it is impossible not to take into account the unfavourable influence exercised thereon by some of the commandants; naturally I am adverse to enlarging upon such a topic, but I could not explain the slowness which is so remarkable in the development of the resources of a country which has now been held by France for 33 years, were I to pass over such a subject in silence, for there is no doubt that under the semi-military régime in force in many French colonies, including the Gaboon, the governor or commandant is in a position to do much good or harm to mercantile and other interests, according to the manner in which he may act, and unfortunately, at Gaboon many of the commandants, owing to prejudice, ignorance of commercial matters, and other reasons, have too often elected to act in the way most injurious to mercantile interests, the prosperity of the colony, and to the development of its great natural resources. This has been more especially the case since the late deplorable Franco-German war, owing to the disastrous result of which to France the closest economy has been necessary in all branches of expenditure, and in carrying out this retrenchment the naval command on the West African Coast has been amalgamated with that of the South Atlantic. The admiral commanding-in-chief, who is also superior commandant of the Settlement at the Gaboon and on the Gold Coast, thus having less leisure to devote to those places than formerly, has not been able to exercise that wholesome supervision of the proceedings of the commandant of Gaboon, which was the case formerly, and was so necessary to prevent abuse of power and the ill-advised acts of men often little fitted to rule over even so comparatively unimportant a colony as the one in question. Of course, there have been many honourable exceptions; but then the system of appointing a commandant for the limited term of two years, and not continuing him in office for a longer period when he has proved himself to be the right man in the right place, is so bad, that little progress can be expected until a change is brought about in this respect, as also in the entire system of French colonial administration, which is notoriously bad, and is admitted to be so by all intelligent Frenchmen themselves. I must, however, in justice to the many admirals who have commanded the French naval force on the West Coast during the last fifteen or twenty years, bear testimony to the fact that they have appeared to be actuated by a sincere wish to advance the prosperity of Gaboon, and the interests of the mercantile houses established there; and if they have not always succeeded as they would have wished to do, it has been mainly owing to circumstances beyond their control, and to the fact that the commandants have too frequently, when left to themselves, pursued a course diametrically opposed to the wishes of their superiors. The English and other foreign merchants have, I am sorry to say, not alone been sufferers from the regrettable acts of the commandants of Gaboon, for, although foreigners have too often been the chief objects of persecution, one or two of the commandants have been so far impartial as to make themselves equally insupportable to their own compatriots. The present admiral on the station has been recently investigating the conduct of the late commandant, which was far worse than that of any of his predecessors. The tyrannical, oppressive, and arbitrary treatment of all subject to the rule of this officer is likely to meet with the punishment it merits, and this may possibly deter others from imitating his example. So long, however, as the present system of administration continues, the commerce of Gaboon can never enter upon that course of prosperity which is so necessary and desirable, and which it has a right to look to, nor will the rich resources of the country be developed. The French Government will doubtless see this when it becomes aware that the principal and most respectable French merchant in the colony, after struggling against adverse influences for twenty years, is compelled to liquidate his affairs, and leave the trade in the hands of foreigners. To show that I am not singular in my opinion as to the state of affairs at Gaboon, I will quote a few lines from a letter recently addressed to the editor of the *Journal du Havre* by a French resident, who, speaking of Monsieur di Brazza's expedition to the Ogowe, writes as follows:—

"Il peut se faire que cette expedition, en ouvrant au commerce ce vaste pays, si riche en ivoire, caoutchouc, bois de teinture, et d'ébenisterie, donne un peu de vitalité à la colonie du Gabon, qui, depuis plus de trente années que la France en a pris possession, reste à l'état d'embryon; ce manque de progrès est attribuable non seulement à la perte de protection que le commerce a trouvé jusqu'ici auprès des autorités locales, mais encore à l'esprit étroit et arbitraire des commandants qui ont été appelés à administrer la colonie."

The Marquis de Compiègne (whose recent work on Equatorial Africa is justly regarded by all who

are acquainted with Gaboon, as so complete a caricature as not to be worthy of serious consideration, so replete is it with errors which would be simply laughable were they were not so vexatious and misleading), has also pointed out this want of protection, in the paper on the "Commerce of Equatorial Africa," which he contributed to the "Bulletin de la Société de Géographie de Lyon," wherein he truly speaks of "the incertitude of obtaining efficacious protection in the interior of Gaboon," he might have added, with equal justice, "and at Gaboon itself;" in other respects there is scarcely a single particular of his description of the commerce of Gaboon and of the Ogowe, and of the prices and manufacture of the different kinds of produce, and the various article of barter, which is not egregiously incorrect, as might have been expected from his very limited opportunities of acquiring a knowledge of the subject, and from the false and superficial view he has taken of everything which came under his observation. His gross exaggeration of facts is evinced by his statement that Yousseref, one of my traders, purchased upwards of 100,000 billets of ebony in the Ogowe in one year; the actual quantity purchased by that individual being 25,000 billets. Such glaring and unpardonable inaccuracies have doubtless created in the minds of readers, and of officials of the French Colonial Office, an utterly false idea of the trade of the Ogowe, and are the less excusable as M. de Compiègne might have easily ascertained the truth from myself or my assistants, instead of lightly hazarding an assertion so wide of the truth.

So far as the protection of the interests of British subjects is concerned, there is every reason to hope that a marked improvement in that respect will date from the visit of Commodore Hewett and Consul Hopkins in March of the present year. The recent extension of the jurisdiction of our consul at Loanda to Cape St. John's, including Gaboon, is a step in the right direction, and ought to have been taken years ago. Consul Hopkins will need to be seconded by a resident vice-consul at Gaboon, where a German consul was appointed in 1874, and a United States commercial agent has resided since 1863, although there is only one German and one American house, and no less than six English factories, in whose hands is, of course, the bulk of the trade. A Bristol firm is also reported to be on the point of re-embarking in the trade of Gaboon, which it retired from some years since.

The large tract of country comprised within the French possessions, of which Gaboon is the seat of Government, produces many more articles of commercial value than those which I have described as forming the staple exports. The forests contain numbers of trees, the wood of which is fitted for constructive purposes, and that of others adapted to the use of the cabinet maker. Oleaginous seeds and nuts abound, but no proper steps have been taken to utilise them, for the attempt to introduce odika into the manufacture of soap was not made on a sufficiently large and serious scale, whilst many others are to be found which are more valuable than odika; among the number of these I may mention two varieties of the shea-butter tree (*Bassia nungu* and *B. ujavi*). This product is used for culinary purposes, in the same way as lard, for which it is an excellent substitute. But to leave these little known, and therefore, to a certain extent, doubtful products out of the question, sufficient remains in the four articles now regularly exported to constitute a very important commerce, as their production might be almost indefinitely increased, for although the Gaboon has for so many years been in the hands of a European power, its capabilities are still unascertained, its productions undeveloped and almost unknown, and its geographical features unexplored. The port of the Gaboon is superior as a safe harbour to almost all others on the West Coast, whilst in the Ogowe (to say nothing of other rivers) we have the most important stream between the Niger and the Congo, forming a direct and natural highway into the rich and interesting regions of the interior. That river would not have remained so long a sealed book had it been situated as near an English settlement as it is to Gaboon, for the enterprise of British merchants, and the adventurous spirit of British travellers and explorers, would ere this have penetrated the mystery which has thus far enveloped it. It is a pleasure to be able to record that a serious attempt is at length being made to trace the Ogowe to its source, a well-equipped exploring expedition having been dispatched last autumn under the command of Monsieur Savorgnan di Brazza, from which the most useful and most interesting results may be anticipated. According to the latest advices, M. di Brazza had ascended the river to a distance of about 300 miles, having almost attained the extreme point of his predecessors, so that he was on the threshold of new, and it is to be hoped, important discoveries. But the commerce of this region can never attain any considerable degree of development so long as the system of administration is such as to deter French merchants from embarking their capital in a hazardous undertaking, whilst at the same time it curtails and hampers the operations of foreigners, who, instead of meeting with encouragement, and receiving that protection to which they are entitled, too frequently find every obstacle thrown in the way of the prosecution of their business. Long as the Gaboon has been a French settlement, it is scarcely credible that a civil tribunal is still utterly unknown there, the commandant, as *juge de paix*, alone being entrusted with judicial functions, and in that capacity often deciding intricate commercial questions of great importance to the mercantile community; whilst in a place where the trade with the natives is largely carried on on the trust system, there is no means of compelling payment of a debt, and the inhabitants are practically told that they are under no obligation to pay their debts unless they think fit to do so.

The trust system is, in my opinion, an unmitigated evil, and I believe its abolition would tend more to the restoration of a healthy state of affairs in the colony than almost any other measure. Within my own recollection and experience trust was entirely unknown, except in the case of barwood, and even that could be obtained without giving credit, if necessary. In years gone by, all ivory and other produce was brought to the door of each factory, and purchased on the spot. There is no reason why this practice should not again be the rule instead of the exception, and if the

merchants cannot themselves bring about this desirable change, it is competent for the authorities to do so by forbidding the sending of small craft to traffic in the rivers and creeks beyond certain points, which could easily be defined. By this means the disorders now so common would be avoided, the opportunity of plundering, as well as the temptation to do so would be removed from the Mpanwe or Ba-fant, protection would be more easily and surely given, and the employment of a numerous and expensive staff, as well as of expensive craft, would be rendered unnecessary, and the control and surveillance of his business and of his *employés* remain in the hands of each merchant, instead of, as now, being almost entirely taken away from him.

Another circumstance exercises a most injurious influence, not only on the commerce of Gaboon, but on the well-being and moral character of the native inhabitants. I allude to the unlimited and uncontrolled importation of arms, gunpowder, and spirits, which I have incidentally mentioned before, than which nothing can be conceived more shortsighted, not only on the part of the colonial authorities, but on that of the merchants themselves, who are blinded by present gain to the evil consequences which must inevitably result from the course they are pursuing, and which I do not hesitate to say must ultimately prove most disastrous. M. di Brazza has already experienced the evil effects of the great influx of rum in the Ogowe, where it is even now impossible to obtain the services of labourers and canoemen, or to purchase food without the employment of large quantities of this demoralising and poisonous liquor; but even the rum trade may prove less fatal to the future of the trade than the permitting the whole country to be inundated with many tons of gunpowder, and many thousands of guns annually, thus placing the means of mischief in the hands of all who can command a few pounds of rubber for their purchase. I foresee in this a great danger to the future prosperity of Gaboon, and trust that the French Government will ere long see the bad policy of permitting the trade in spirits, arms, and gunpowder to be carried on to its present unrestricted extent, and either put a stop to it altogether, or confine it within reasonable limits. Although comparisons are generally admitted to be odious, I cannot refrain from the reflection that in no English colony would such a state of things as exists at Gaboon be tolerated for a single day. I may, however, be permitted to hope that should this paper come under the eyes of any of our neighbours across the channel, they will charitably believe that I am not seeking to vaunt the superior morality of my own countrymen, but merely wish to call attention to a matter which twenty-five years' experience tells me ought to occupy the serious notice of the French Minister of the Colonies, and the local executive of the Gaboon. I may, perhaps, be told that during the long term of my connection with Gaboon I have introduced no small quantity of the articles whose importation I am now inveighing against, which is undoubtedly true, but circumstances often compel us to do things of which we disapprove, and I am not alone among those who have been or are interested in the commerce of Gaboon, who would be glad if they were never called upon to sell in that country another gallon of rum, gun, or keg of gunpowder.

With the single exception of Sierra Leone, there is probably no port in the West Coast which is so eligible as Gaboon for the construction of a dry dock, and as being more central and nearer the oil rivers and other resorts of shipping. Gaboon is probably better adapted for such an enterprise than the former place; whilst, had a dry dock been in existence on this part of the coast during the last quarter of a century, numbers of vessels might have been repaired, which have been condemned and broken up for the want of such a convenience. There is a mine of anthracite coal situated at the extreme northern limit of the French possessions in Corisco Bay; were this worked, and a dock constructed at Gaboon, many ships would be attracted to the port, which would thus soon become a place of importance, especially as it is, comparatively speaking, healthy.

This paper has already far exceeded its intended limits, and though I have not alluded to several topics, on which, with more space, I should have wished to say a few words. I am, however, even so unwilling to close it without making some slight mention of the native inhabitants of a region, the commerce of which I have attempted, however imperfectly, to describe. I can do little more, however, than give the names of some of the many tribes which are to be found along the seaboard, and a short distance inland. The Gaboon district is not now inhabited by any one dominant or powerful nation, as would appear once to have been the case, but is peopled by a vast number of more or less numerous and independent tribes, from the mild and semi-civilised, but indolent and sensual, Mpongwe, to the barbarous and cannibal Ba-Fant, or Mpanwe, first heard of by Bowdich, who terms them Päamway. Among the tribes best known are the Orungu, Nkâmi, Ajumba, Mlenga, Igalua, Asyekani, and Bakélé, the latter of whom were described as cannibals less than 60 years ago by Bowdich, but no longer lie under that stigma. The tribes named reside partially or wholly in French territoy, whilst in the more remote parts of the Ogowe and its affluents as at present known, but not yet brought under French rule, are the Ivili, or Bavili, Iveia, Isyira, Isyâgâ, Okota, Apinji, Okanda, Mbangwe, Osyeba, Osyebo, and many others. To the north of the French settlement we have the Benga, Balenji, Mbiki, Mbisu, Nkombe, Bapuku, Campo or Biko, Banâkâ or Batanga, Beundu or Small Batanga, and Malimba or Balimba, all of which are coast tribes more or less brought into direct intercourse with Europeans, and trading directly with them, whilst the tribes within 100 or 150 miles of the coast are innumerable, and but little known to us even by name, nor is it necessary to allude further to them. New tribes are pushing down towards the sea from the east and north-east, the most important being the Ba-Fant and Osyeba already mentioned, who, if they be not identical, are closely allied to each other in language, manners, and customs; they possessed themselves of the head waters of the affluents of the Gaboon and of the Mondah and Muni some years since, and have now seized almost the entire right bank of the Ogowe, ousting

the Bakele and others who had been previously located to the north of that river; against the Bakele and Okanda they wage an unceasing and relentless war. The Ba-Fant and Osyeba are doubtless pushed westward and southward by the pressure of other tribes, who have in their turn been driven forward by the more inland tribes, that are the objects of the incursions of the slave hunters mentioned by Barth in the N.E., and by Livingstone and later travellers in the E. and S.E.

South of the River Bangè and Cape St. Catherine, which, at present limit the French possessions on that side, the tribes are less well known, but I may mention the Ngove, the Kaputa, the Balombo, and others along the coast, until we come to the Ivili or Bavile at Mayumba, where a marked change is noticeable in the language, which, from that place southwards, gradually assumes a nearer resemblance to that spoken in the Congo, the dialects of Tilunga, Kwilo, Loango, Tyinsyansyâ, Malemba, and Kabinda approaching each other as closely as those of the Orugu, Nkâmi, Inlenga, Igalua, and Ajumba approach each other, and the Mpongwe. South of Point Pedras in 2° 42' south latitude the tribes do not appear to be so divided nor to occupy respectively such limited tracts of territory as is the case farther north.

The Mpongwe language appears to occupy in Western Equatorial Africa much the same position as the Kisawahili does in Eastern, being the language of commerce throughout a very extensive district, and being employed as the means of communication with many tribes, not only by traders, but by travellers and explorers. It has been reduced to writing both by the American and French missionaries at Gaboon, but the former have made most progress in the study of the language, into which they have translated a few elementary educational works, many hymns, and considerable portions of the Scriptures. They have also printed vocabularies and grammars of the Bakele and Benga dialects, and translated some parts of the Bible into the latter. The head-quarters of the American Mission is at Gaboon, and occupies the site of some of the old slave barracoons, retaining to this day the name of Baraka. The American missionaries have, till very recently, confined their teaching solely to religious subjects and the three "R's," but are about to commence instructing the natives in some of the useful arts, as the French missionaries have always done at Gaboon, and, as I am glad to gather from Lieut. Cameron's paper recently read before the Royal Geographical Society, their colleagues at Bagamoyo on the East Coast do. On the whole, the American missionaries have met with more success and encouragement at Corisco and Benito than at Gaboon, but they have quite recently extended their operations to the Ogowe, where Dr. Nassau has located himself among the Bakélé (some 15 or 20 miles above the confluence of the main stream with the Ngunie), and in the civilising and conversion of this turbulent and quarrelsome tribe every one must wish him complete success.

DISCUSSION.

Mr. P. L. Simmonds apologised for the absence of his brother-in-law, the writer of the paper, and thanked Dr. Mann for having so ably read it. It was on a subject of great interest at all times, and the more so in consequence of the recent proposals for the exchange of territory with the French. His relative had had such a long experience on the coast, that his knowledge had been availed of by the Colonial-office. He had given a great deal of information on the subject, and those who were not present would find the paper replete with interest, and worthy attentive study, particularly with regard to the sources of barwood and camwood, which were originally supposed to be the product of the same tree. Though they were an allied species, no one could look upon them as the same. The paper also contained a very interesting sketch of the india-rubber trade, which would be of interest to many. Although the natives had been careless as to its supply, yet it was of great importance to the trade to know where it could be obtained, for the Indian Government were now promoting the culture of the elastic-gum yielding trees. There were other matters of deep interest in the paper on geographical subjects, which would be found of service, for his relative had visited all parts of the coast, and knew the country well.

Dr. Mann regretted that he could not go very essentially into the matter brought forward, as he had only seen the paper a few minutes before the meeting. But he would like to draw the attention of the Sectional meetings to the object for which these papers were read. There were two distinct functions performed—one was the circulation of the papers which were read amongst hundreds, and he might say, thousands of the community by the Society's *Journal*, and the other was the reading of the papers on interesting subjects, and the discussion of them afterwards, which often led to very practical and valuable suggestions. They ought never to feel that because there was a small audience and only a little discussion, that therefore the paper was not of much public value, for its printed circulation led to most beneficial results. He believed that the work which was now accomplished by the Society of Arts was of a very wide as well as useful kind. The paper which had been read was a most valuable contribution to our knowledge on the important subject treated of by the writer, containing as it did a good deal of suggested matter for further inquiry.

Mr. Capper expressed himself very much pleased with the paper, and was able, from a residence in the country, to bear testimony to its accuracy in all particulars.

The Chairman said that, with the great desire there was at the present day for information upon Africa, they must receive the paper which had been read as one of the most valuable and able contributions on the subject. It was particularly interesting respecting the French colonists, and bore out all that had been said on the question. The French a few years ago made an expedition to open up one of the rivers, but they got into hostilities, and were obliged to give it up. They were now going in with a determination to fight their way, which he thought was a great mistake, and a striking contrast to the wonderful march of Lieutenant Cameron across the continent, who had left a bloodless track behind. He was very sorry indeed to hear this in connection with the introduction of firearms, which everybody seemed to reprobate, and nobody seemed able to prevent. The paper, being written by a gentleman who had spent twenty-five years in that part of Africa, might be relied on for its accuracy, and their thanks were due to the writer.

A vote of thanks to the writer, and to Dr. Mann for reading it, closed the proceedings.

TWENTY-SECOND ORDINARY MEETING.

Wednesday, May 10th; Edwin Chadwick, C.B., Vice-President of the Society, in the chair.

The following candidates were proposed for election as members of the Society:—

Honeyman, John, 140, Bath-street, Glasgow.
Hopkins, J. Satchell, J.P., M.R. His. Soc., Jesmond, Edgbaston, Birmingham.
Howorth, James, Farnworth, near Manchester.
Hoyle, William, Claremont, Bury, Lancashire.
Whitney, James A., 212, Broadway, New York.

The following candidates were balloted for and duly elected members of the Society:—

Prevost, Edward W., Queenwood College, Hants.
Rose, Frederic Robert, 9, St. Paul's-churchyard, E.C.
Saure, Dr. E., Cassel.
Schauer, Louis Joseph, 171, Rue de Vaugirard, Paris.
Stevens, John Henry, Birmingham.
Wallace, R. W., Chemical Works, Battersea-park, S.W.

The Chairman said—It has long been a conclusion, that the power which here economises the cost of transit on the iron rail, might be made to economise it, and supersede the use of horse power on our streets and urban roads. Steam traction engines have got a footing on some roads, but they are deemed unpleasant, and have not been favoured by the Legislature. Our late regretted member, Mr. Bridges Adams, considered that a hot-air traction engine, upon iron tramways, was the appliance of the future to supersede a considerable amount of horse power in our streets. But though hot-air engines are in extensive use in the United States, for small powers, and although in simplicity, economy, and security they have important advantages, they have not been adapted yet to the special purpose. Our late esteemed member, Mr. Grantham, devoted great attention to the subject, and got a very compact steam-engine adapted to the interior of an omnibus car, which it certainly worked well, but with the inconvenience of some noise and interior vibration, which he said he would get rid of. Other variations of small traction steam engines have been made. In the United States, strong cases of condensed steam have been used, and it is reported with success, but, it is alleged, with some danger. Next, tanks of condensed air are reported to be on trial. Of the substantive merits of these efforts for the attainment of the desideratum, I have not the information to warrant me in pretending to give a comparative judgment. But I have to-night to invite you to consider a plan of the application of a familiar power—to an extent which I own surprised myself—as a great novelty. The power is one with which we are familiar in the watches in our pockets and in the clocks on our mantelpieces, that of the coiled spring, which Mr. Leveaux has undertaken to expand, from the smallest power, the power of a mouse to the power of several horses, for noiseless, smokeless, and safe propulsion, under conditions which those present are now invited to hear and judge.

The paper read was—

SPRING PROPULSION FOR STREET TRAMS.

By Edward H. Leveaux.

In presenting myself before you this evening, to introduce to your notice my invention for the propulsion of carriages on tramways, railways, and other roads by springs, I must crave your consideration and indulgence; firstly, as an amateur in mechanical science; secondly, as one unused to address such an assemblage as the one before me. I should not have presumed to bring this invention before your Society, had I not received a very kind invitation to do so, both last Session and this; and, feeling there is much interest at present existing in both the scientific and commercial world for another mode of locomotion than steam or horse power, I have ventured to accept this invitation from your honourable Society.

It will be my object this evening to condense my remarks into as short a compass as possible, and to illustrate them by a few drawings, and thus, in the simple language of one, as I have before said, uneducated in mechanical and scientific phrases, I hope I may be enabled to lay the matter clearly before you, so that you can judge as to the feasibility of my plan, in comparison with those proposed and at present in use.

I purpose laying the matter before you under the three following heads, viz.:—

Firstly. A slight sketch of the origin of tramways in this country.

Secondly. The modes of locomotion adopted at different times on these tramways.

Thirdly. Description of my invention, my designs for its application on tramways, railways, and asphalte roads, and its comparative cost with the system at present in use.

I.—The Origin of Tramways.

We go back to the reign of good Queen Bess, for the first introduction of tramways in England by some German miners, as a means of easy transit for minerals. Rails were laid down in our mining districts, and heavy loads were moved with ease, as compared with the traction of horse power on common roads; but it was not till the commencement of this century that its introduction was fairly established, when a Mr. Outram (from whom no doubt the name "tram" originated), the father of the late Sir James Outram, the Indian General, established a line between Croydon and Wandsworth for common vehicles, which was completed on the 24th July, 1801. The following interesting account is from an article on "tramways" in *Chambers' Journal*, which was copied from an old paper.

"When the road has been traced at 6 feet in breadth, and when the declivities are fixed, one excavation is made of the breadth of said road, more or less deep, according as the levelling of the road requires. There are afterwards arranged along the whole breadth of this excavation pieces of oak wood, of the thickness of from 5, 6, or even 8 inches square; these are placed across, and at the distance of 2 or 3 feet from each other; these pieces need only be square at the extremities; and upon them are fixed other pieces of wood, well squared and sawed, of about 6 or 7 inches breadth by 5 inches depth, with pegs of wood. These pieces are placed on each side of the road, along its whole length; they are commonly placed at 4 feet distant from each other, which forms the interior breadth of the road. As it does not appear from this description that these rails contain grooves, we must suppose they projected slightly from the surrounding road, as in our railways now, so as to contain the flanges of the wheels, which otherwise would slip off. So effective were these new ways, that one horse, which before could draw but 17 cwt., could now with the same labour draw 42 cwt."

This was a great boon in the colliery districts, and gave a great impetus to trade in general.

Wooden soon gave place to iron rails, when the difficulties of curves were overcome; these iron rails appear to have been first made in England, at the Coalbrookdale Ironworks in Shropshire. In 1802, a Mr. Edgeworth published a pamphlet advocating the practicability of rails being laid along turnpike roads for the use of stage coaches and other vehicles, which might be made to go at six miles an hour with one horse.

In the year 1825, Mr. Edward Pease, of Darlington, laid down a single line in the North of England; at short intervals loop-lines were made, where cars might pass for the use of both goods and passengers. Mr. George Stephenson superintended the construction, and when finished it proved a great success. The passenger cars were made to hold 6 inside and 20 outside, and were drawn by one horse, going at the rate of about 10 miles an hour.

Great interest at the time was attached to this new mode of locomotion, and numerous other projects of the same nature started both here and abroad. Before 1830 a tramway had been laid down in France for goods and passengers; in Germany, between Budweis and Lintz, and in the United States from Boston to Quincey. It was about this time, however, that railways were adopted in this country—when the system of tramways became shelved for a time—the steam engine eclipsing all other powers of locomotion, and since that time a network, as it were, of railways has been cast over these realms, connecting all the great centres of commerce, penetrating both agricultural and manufacturing districts, developing our mineral resources, and increasing to an enormous extent individual travelling, which has become so easy, expeditious, and cheap. Notwithstanding the great development of the railway system, and forming, as it were, a connecting link with almost every town in the kingdom, a want of rapid communication has sprung up in urban and suburban districts. People who could travel from London to Brighton in an hour and a quarter, a distance of 50 miles, with perfect ease and comfort, felt a painful difficulty in journeying from the City to Greenwich, Highbury, or other outlying districts, a distance of five or six miles in a crowded omnibus in the same time.

As London increases her population about 500,000 inhabitants every ten years, equal to the population of Liverpool, other modes of street conveyance became necessary; thus, within the last few years, the great underground railways have been made, and subterranean travelling largely adopted, crowded trains following each other every five minutes, and encircling the busiest parts of the metropolis; thousands of omnibuses overhead threading the crowded thoroughfares in every direction, but still found inadequate to the wants of greater London; tramways now have lent their aid to this busy world of commerce. The resumption of the tramway system in this country after their slight introduction, before 1830, took place, as we all know, by the enterprising American, Mr. George Francis Train, some 15 or 20 years ago. Of course he had to meet the opposition of great vested interests, besides the objections of owners of carriages and other street vehicles, whose property was much injured by the system of tram-lines then in vogue. He fought the battle manfully, which resulted, as is well-known, in his entire ruin, and the relinquishment for a time of street tram-car travelling.

The United States had long adopted Mr. Train's principle, and tram-cars were the favourite mode of transit in the cities of New York, Boston, Philadelphia, Chicago, Cincinnati, and away far West. In a short article, headed "Tramways in New York," in your Society's *Journal* of the 16th of October, 1874, I find the following account of their progress in that city:—

"The total length of tramways in New York is 76 miles; they employ 11,086 horses, moving cars at the busiest times at the rate of one every 47 seconds. The rate of speed per hour is 5 miles, and the average cost of construction three-eighths of a million dollars per mile. The number of passengers carried last year was 192,000,000, being $2\frac{1}{2}$ millions per mile. On some parts the ratio was still greater. The tramway in the Sixth Avenue carried 4,000,000 per mile, and that in the Third Avenue below Central-park, 5,000,000. The average fare on the different lines and their branches is $5\frac{1}{8}$ cents, whilst the total expense for passage is $4\frac{15}{100}$ cents., leaving a nett profit of $\frac{98}{100}$ cents. The business of these tramways has increased 225 per cent. during the last ten years."

So successful were they, that the infection wafted Eastward, across the broad Atlantic, and again appeared in the old country, this time, let us hope, with permanent success.

II.—The Modes of Locomotion adopted at Different times on these Tramways.

With the resumption of tramways in England, a new description of line has been laid, and so constructed as to be less injurious to the ordinary vehicles; this line is laid flush with the road, the wheels of the cars running in grooves, thus avoiding any raised obstructions on the line. Notwithstanding this improvement, great dissatisfaction exists among owners of carriages, who complain sadly—and justly—against the increased wear and tear of their rolling-stock by the wheels of their conveyances slipping in the grooves, and the sudden wrench required to right them again. It was hardly to be expected that any great revolution in street locomotion would take place without injuriously affecting some part of the fraternity; but the great advantage offered to street passengers, by the easy and commodious cars now in use, and the facility of entrance and speedy transit compared with the omnibus system, has almost made tramways a *fait accompli*. One very serious objection, however, has arisen in a humane point of view, and this evil is yearly increasing, viz., the cruel treatment of horse-flesh engaged in this new style of traffic. We have all noticed the severe strain on the horse when the conductor is obliged to pull up suddenly on his journey; instead of using his rein only, as in an ordinary carriage, the first intimation the poor animal gets of his having to halt is a sudden pull of the whole weight of the enormous loaded car on his traces, sometimes nearly pulling the beast on his haunches, and caused by the application of the break power; this action, repeated many hundreds of times during the journies, affects injuriously the spine of the horse; and it is notorious the loss of live-stock annually is one of the great drawbacks to the financial success

of tramway companies. Many philanthropists have written on this subject, endeavouring to alleviate this cruel treatment, and many suggestions have been made to this effect, but without success, as it has been found quite impossible to stop the great impetus given to the car when once in full swing, without the forcible application of the break. Amongst those who have brought this matter forward is the Baroness Burdett-Coutts, who wrote some 18 months ago to the *Times*, giving a graphic account of the terrible sufferings of the horses then engaged on the Edinburgh tramways; the subject has also been taken up by other philanthropists.

I am afraid, however, while horse traction is used no mitigation to such sufferings can take place. Another mode of working the cars has been brought forward, which would avoid the use of horses, and many experiments have been made of late both in this country and in France to develop it on the existing tramways; I refer to the use of steam and compressed air. The late Mr. Grantham's engine is well known, and its trials, no doubt, have been witnessed by many here to night. I shall merely refer to it by drawing attention to the fact that the passengers are placed in the carriage, under the seats of which are carried the fire and boiler, the latter emitting through the funnel a certain small amount of noise and steam, which might prove objectionable to those driving valuable horses on the same roads; the dropping of red hot cinders also, which I cannot see can be avoided in transit, must prove dangerous both to pedestrians and equesterians. The heat of the interior of the car, arising from the hidden fire and boiler, must also prove objectionable to the passengers during the summer months.

The use of steam power in public thoroughfares is also, in this country, prohibited by Act of Parliament, and when a Bill to enable it to be used was introduced some year or two ago in the House of Commons it was thrown out by a large majority.

In respect to the system of compressed air, lately tried in Paris, I am not sufficiently acquainted with its merits to venture any discussion or give any opinion of it here. I believe, however, it can only be used on the ordinary tramways, the weight of the machinery and car, over $4\frac{1}{2}$ tons, precluding its use on the asphalte roads.

Several other patents have been taken out for the purpose of introducing mechanical means for propelling cars on street tramways, but, I believe, up to the present time with no success.

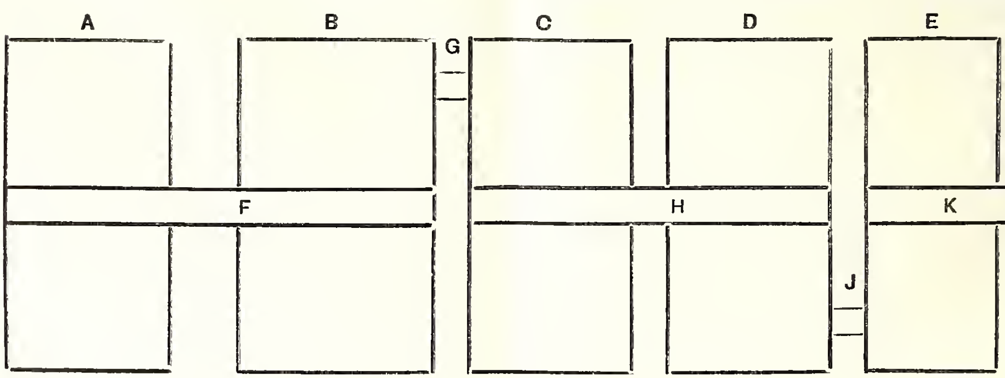
III.—Description of the Invention, and its Comparative Cost with the System at Present in Use.

I now come to my invention for driving cars by means of coiled springs, and must again solicit your kind indulgence in describing it in the language of an amateur in mechanics.

Some years back I was struck with the simplicity of the ordinary toy mouse, which by a few turns of a common watch key in the hands of paterfamilias gives so much pleasure to the younger members of his family; and it appeared to me, with an improved method of spring coiling and tempering, a carriage for passengers might be manufactured to run on the tramways and railways. The following description will, I hope, give an idea of the car and its machinery as patented by me on the 24th September, 1873.

In application to the ordinary form of tramway carriage, I utilise a portion of the space below the floor of the car for an arrangement of drums, or barrels, containing the springs, which may be placed transversely in two groups, or sets, suitably inter-connected so as to form one continuous volute, acting to generate revolutions of the driving wheel, and thus effect the propulsion of the car. At the terminal or intermediate stopping stations, the means of winding up and re-coiling the springs by a suitable fixed steam-engine, or other prime-motor, are to be provided, rotary motion being communicated by a shaft under the roadway to vertical spindles, and geared wheels, which being thrown into temporary connexion for the purpose with the spring barrels, will coil the springs until the requisite tension power is obtained. The means of effecting this temporary connexion of the prime-motor with the carriage mechanism may obviously be varied without affecting the principle of thus providing stored up power, self contained, whereby the cars may be automatically propelled. Adequate break power is also provided so as not only to control and arrest when requisite the spring power, but to hold it in complete suspension when the car is stationary; and furthermore, an arrangement of clutches is interposed between the spring barrels and the driving wheels, whereby the uncoiling motion of the springs, which is constant in one direction only, may be transformed into an ultimate variable rotary motion, giving out the contrary directions as needed for reversing the propulsion of the car.

To obtain distance, the springs are arranged as follows, as I will endeavour to illustrate by



the above diagram. A, B, C, D, and E, are a series of five springs which are being wound up at A, from the outside, and their action will be as follows:—

1st. On the outer end of the spring, A, being moved round, the immediate effect will be that the inner end of the same spring will turn in the same direction; the inner end is connected by a "bush" or arbor, F, to the inner end of the next spring in the series, B, so that the motion imparted to A is communicated to B from the inside. On being wound from the inside, the other end of B follows in the same direction, pulling with the outer end of C, to which it is connected by the pin, G, and thus C is wound from the outside, and the process described in the case of A is repeated till the end of the series.

It will be noticed the power is ultimately given off by the "bush," K, and it is necessary that K should be prevented from turning during the process of winding.

2nd. At any period of the winding all the springs are wound to the same degree of tightness, in fact they are wound simultaneously, and not successively.

3rd. The action during running down is exactly the converse of the above.

4th. To sum up, the action of the series is precisely that of any one single spring prolonged; thus, if in a series of ten springs, each can be wound up 12 times, and give an average pull of 5 or 6 cwt.; the pull of the series is precisely the same, but the number of turns is multiplied by 10, or = 120.

I will now describe more fully the means I employ for winding up the spring barrels. At the starting place, or so near to it as convenient, I provide a small 5-horse engine. The shaft of the stationary engine serves to give motion to a belt-wheel, the belt from which passes to a pulley keyed to a horizontal shaft, which shaft is supported in bearings placed below the roadway, and for the sake of convenience enclosed in a metal casting or tube. Close to one side of the tramway, over which the carriage is intended to run, a box is sunk in the roadway, and through this box passes the shaft; keyed on to the shaft within the box is a spur-wheel, which gears with a spur-wheel carried by a pair of radius arms, which have for their support the shaft. The axle of the spur-wheel is fitted with a sleeve so shaped as to connect with the winding axle of the carriage, and to permit of its instant disconnection thereof when required. The box is fitted with a lid to cover the gearing when out of action; when it is desired to wind up the spring barrels, the carriage is brought up to the required position; the lid of the box is thrown back, and the spur-wheel raised so that the sleeve of its axle can be in connection with the winding axle; the engine is then set in motion, and by means of its connection with the main shaft, it will cause the spur-wheels to rotate, and through the sleeve, or other couplings, give rotary motion to the winding axle, and thereby wind up the spring barrels. To prevent overwinding, a friction-coupling may be introduced at any convenient part of the apparatus, or a means of forcibly disconnecting the sleeve, or other coupling, from the winding axle may be provided. When the spur-wheel has been disconnected from the carriage, it will be returned to its depressed position, and the lid of the box will be closed.

Where the line is three to four miles, I shall require three of the above engines; one at each end of the line, and one in the middle. Where stationary engines cannot be worked, it is my intention to employ portable engines, which can be brought to the winding-up barrels and the process of winding gone through during the collection of tickets and checking the number of passengers. I think it will be advisable that the places where these "wind-ups" occur should be stopping stations, where passengers may alight from or enter the carriages. These stopping-stations are quite the custom abroad, and it will facilitate the working of my spring-cars if adopted where my invention is used.

On country roads, where long distances have to be traversed, I propose using an auxiliary spring engine. This engine will be fitted with the most powerful springs we can obtain, with full reversing and break power. At convenient sidings on the route, and where it is calculated the spring power under the car will be expended, one of these auxiliary engines will be attached, which will draw the car a considerable distance, where another may be in readiness to continue or finish the journey, as the case may be. Should it be desirable on some lines to have several cars drawn at once, I am of opinion the auxiliary engine can be fitted with sufficient power to draw, at a moderate speed, several such light cars with passengers; but this is a matter for consideration after my system has had a fair trial on the public tramways, with the style of car at present in use.

If these illustrations have not been sufficiently clear to explain the working of springs and barrels, I must refer those who desire fuller information to my complete specification, which is contained in Blue Book, A.D. 1873, September 24th, No. 3,123, under the head of "Driving Carriages on Tramways, Railways, and other roads."

I commenced operations about August, 1873, and after trying some experiments on a paper car, with ordinary watch springs, I took out my patent in September of that year. At that time the largest springs made were about 6 lbs. in weight, giving a maximum pull of about 120 lbs., and used for the purpose of lifting "Clark's patent iron shutters." On visiting Sheffield at that time, and seeing several of the most important steel and spring makers, I was informed springs of almost any size might be made, but fresh machinery (and some of a very costly character) and furnaces, &c., would have to be constructed, and none felt inclined to take this risk. I was ultimately introduced to the managers of the Titanic Steel Works, who undertook to provide springs for a rough trial; finding, however, their plant was incapable of turning out the steel required, they handed the matter over to the "Phœnix Bessemer Steel Company." Mr. Thomas Hampton, the enterprising managing director, called on me, saw my model, and after due consideration, he assured me that with practice, and after experiments were made as to the exact quality of the steel required, almost any kind of springs could be rolled and tempered, and he at once undertook the affair.

Early in 1874 large springs were tested, and the car propelled by them on a short line laid down

at my engineer's in the Borough, but after many experiments it was found the original iron barrels, and the machinery altogether, were too heavy to warrant a public trial of the car; sufficient, however, had been done to show the great stride made in spring tempering since the date my patent was taken out. We had already obtained a few springs with sufficient power to propel a heavily built truck, containing the springs, boxes, and machinery, on the short line at the works; and the following extract from the report by my engineers of a trial which took place at this time will show what power had been obtained:—

"EXPERIMENTS ON PATENT SPRING POWER.

"Loman-street, Borough.

"The apparatus is at present attached to a strong frame-work of timber, and altogether weighs 30 cwt. On being released it started off at a rapid speed, and struck a plank placed at the end of the line with such violence as to throw itself off the line; it was replaced, thrown out of gear, and run back to the starting place. The experimental truck was then attached by a rope to the Antwerp tramway-car, which weighs 33 cwt.; and on being put into gear, started the whole weight of 66 cwt. and three persons in the car (which would add about 4 cwt.) with great ease and smoothness; and at the rate of about six miles an hour. This was repeated twice, and during the whole series of trials the machine was not re-wound. On the whole the trial was satisfactory, as proving that the springs were free to exert their full force, and have a sufficient power to propel the car at a proper speed. Had a longer line been available, I have no doubt a much better result as to speed and distance would have been obtained.

"(Signed) "THOMAS MIDDLETON."

Thus it will be seen, spring power in a few months had increased from a pull sufficient to raise up one of Clark's iron shutters (of about 120lb.'s pull) to that required to propel a truck, and one of the Antwerp street cars, weighing altogether about 67 cwt., at the rate of about 6 miles an hour "with great ease and smoothness."

It was rather an amusing scene, however, this first run. Several of the men at the works were kind enough to volunteer as passengers for the first ride, not thinking the machine would develop so much power. On starting, the clutch was removed, and off the truck went; it, however, to use the words in the above report, "started off at a rapid speed, and struck a plank placed at the end of the line with such violence as to throw itself off the line," together with my unfortunate friends, the workmen, who had so kindly given their services for the first trial. They picked themselves up with much good humour, and soon assisted to replace the car, all present being pleased that the machine had shown itself of so lively a character; and feeling satisfied with such a power properly developed, a great future must be the result of these experiments.

Unfortunately about this period, my friend, Mr. Hampton—who was so energetically at work in producing springs for my invention—met with a very serious accident. He and his groom were thrown out of his carriage, the groom killed, and he laid up with a compound fracture of the leg, and confined to his house for nearly 12 months. Thus, at the moment of success, the whole affair became paralysed, the experiments put an end to, and I compelled to seek fresh assistance in spring making!

It was the success of the above experiments, however, that supported me in redoubling my exertions in this extremity, and I had before me the noble example of the original promoters of that great work "The Atlantic Telegraph," who after sinking about 2,500 miles of cable along the depths of the broad Atlantic, succeeded in 1858 in transmitting a message from "The Queen of England to the President of the United States," and his reply. The insulation of the wire, however, having become almost immediately faulty, the power of transmitting telegrams ceased, and it was not till 1866, and after several unsuccessful attempts, that the Great Eastern. commanded by the present Sir James Anderson, succeeded in joining a band of communication between the old and new worlds.

After great and many vexatious delays I induced the well-known spring makers, Messrs. George Salter and Co., of West Bromwich, to take up the matter. They laid down fresh machinery, and built new furnaces, securing the experience of their best hands in coiling and tempering large springs, and I am happy to say with great success. During the year 1875 many sets of springs were made and fixed under the car, which about May last was taken to West Brompton, and tried on the line at the Lillie-bridge Railway works. At one trial we carried about five tons, seven cwt., including car, machinery, and passengers, and at the rate of about seven miles an hour, but having only three barrels at work, instead of twenty-four, we only made a proportionate distance.

Our first run on the rails took place at Lillie-bridge Railway works one Saturday afternoon. The truck with the machinery fixed had, after some difficulty, been placed on the line, wound up and brought to the starting place. It was anything but a pretty affair to look at, painted an ugly iron colour; with its peculiar looking spring barrels underneath, and between the wheels, and its long iron break handle sticking up at one end, a more nondescript looking locomotive had never before, I should think, made its *debut* on the railway. It evidently puzzled the workmen and people engaged on the line, as, although it was Saturday afternoon, and the worksheds closed, a number of men and boys remained for two or three hours, to see what our ugly customer was intended to do; when they discovered a "run" was to take place, and passengers wanted, a rush was made to secure seats, or, as I should more correctly say, stands, for the conveyance was not fitted for passenger traffic. Some 16 men were soon standing in the truck and holding on to each other ready for starting. At this moment I was much amused at the conduct of the engineer and stoker on an engine shunting a long coal train, who had been requested to clear part of the line for my experimental run. They were sorely perplexed at seeing the men standing on what appeared to them a coal truck in difficulties, but no sooner did they perceive it start off with its motley group, without any apparent driving machinery, than they jumped off their engine and ran after the spring-car, climbing on the back, and taking part in its first journey along the line; and a very merry journey we had on our mongrel-looking carriage, the men and boys laughing out-

right at the comical appearance of the whole affair, at the same time expressing their pleasure at witnessing this novel kind of propulsion. "Only think, Bill," says one, "this 'ere truck being drove along by watch springs!"

A very severe and dangerous illness prevented my carrying out further experiments last year till early in December, when further runs took place with six barrels instead of three, and more than double the distance was obtained. Several serious defects, however, were discovered in the machinery, which had been constructed nearly double the weight necessary in consequence of my machinists being misled by one of the early spring makers as to the actual "pull" the large springs were likely to give. Also, the springs used were found to be too large for the barrels, and bound in unwinding. Of course, I have been to a certain extent working in the dark, as neither the spring-makers or temperers had any experience to fall back upon in the manufacturing of such long lengths of steel, and giving them the proper coil and temper best suited for the work it had to do when fully wound up.

When the matter was first laid before the Sheffield steel makers in 1873, it was thought impossible to roll steel bands longer than about 30 to 40 feet of "Birmingham wire gauge." The following extracts from the correspondence of the steel manufacturers will illustrate this part of my paper, and which I am afraid, from its necessarily technical character, will prove a dry and uninteresting subject.

Messrs. George Salter and Co., of West Bromwich, write, 1st March, 1874:—

"We believe if we make springs of steel, 56 to 60 feet long, and 6 inches wide of 9 B. W. G., you will get 7 revolutions, and a power of about 10 cwt."

To show how things have improved since the above was written, Messrs. Salter have during the last few months produced springs 65 feet long, and only 4 inches wide (instead of 6, as named above) giving a maximum pull of over 1,600 lbs.; and as an example of what can now be accomplished, they have tempered a short length of steel 3 inches wide, giving the enormous pull of 3,150 lbs. This band of steel being 1 B. W. G., or about one-third of an inch in thickness; this spring when wound up coils as tight as a Coventry ribbon.

Messrs. Jessop and Sons, of Sheffield, wrote on the 24th March, 1874:—

"We have rolled 70 feet long, by 4 inches broad, 7-32nds thick. We now find we can roll bands 184 feet long 4 inches wide, 17 B. W. G. easy."

Nearly three years have thus been spent in ascertaining the best method of tempering springs, and determining the most useful method of coiling the steel for my purposes. The time, however, has been most usefully employed in trials on my models and the truck and full-sized car at West Brompton. During this period some hundreds of different sized springs have been made and tested, and I may now fairly say all seeming difficulties have been overcome.

Relative Cost.

In the necessarily short space of time that can be allotted, at such a meeting as the present, to the history of my proposed change of street locomotion, and its relative cost and safety to both passengers and the public generally, I feel I must limit my description to another extract, this time from the report of Mr. George Leach, engineer, and Official Reporter on Machinery at the Paris Exhibition of 1867, and London Exhibition of 1871. Mr. Leach was called in to give his official opinion for the guidance of some gentlemen who contemplated connecting themselves with my patent, and is dated "Britannia Works, Leeds, Oct. 19, 1874." After introducing the subject, Mr. Leach writes thus:—

"Although a rumour had reached me previous to our interview, of your proposition to propel tram cars by means of steel springs, I anticipated only a visionary scheme, or a resurrection of antiquated experiments long since defunct in this age of perfected engineering science.

"It required little prescience to remind one that we are daily and constant observers of, and operators in the manipulation necessary to convey a certain amount of physical force for the purpose of storing in the tension of a metal spring motive power or energy for required mechanical work.

"Our pocket watches, and other time keepers, besides numerous other common contrivances, familiarise us with the universal adoption of the most practical, and most useful means of providing an accumulation or reservoir of propelling effort.

"The process of winding up a watch, is, for the sake of convenience, brief in point of time, and the force exerted in this operation is proportionate to the power necessary to keep the machinery of the watch in movement during a given period.

"Ten half turns with the watch key convey from the hand a store of force sufficient for an expenditure of the same equivalent amount of force during twenty-four or more hours, yet the hand as the origin of the power, is occupied but ten seconds. The time requisite for winding up is but the 8,640th part of that occupied in the subsequent expenditure of the power originally contributed, yet no single unit of this power accumulated during the ten seconds is lost. The effect is balanced, and the well-known mechanical axiom enlarged is recognised, that 'what you obtain in power may be expended by its equivalent in speed.'

"The principles chiefly to be noticed and valued in this system of conveying, conserving or storing power in the tension of springs are,

"1st. Practicability.

"2nd. Portability.

"3rd. Convenience.

"4th. Economy.

"It may appear singular at first sight that the propulsion of vehicles by means of 'springs,' or rather the 'motive power' stored in springs, has not hitherto been put in practice and carried to a mechanical and commercial success, seeing, as before referred to, there are so many examples where spring power has been utilised.

"There are, however, many reasons why the previous adoption of the system has not been made, and also why before the patenting of your invention other minds have not been so fortunate in working out the solution of this very important question.

"The necessities of rapid transit from distant places, and the carriage of heavy material, have alone sufficed to promote and establish the success of locomotion by steam power as at present exhibited on our railways. The means are suited to all ends, and require no discussion here. Street tramways, however, offer very different considerations, and in endeavouring to supply to the cars fitted for the traffic upon the same, the most suitable system of motive propelling power, the inventor is reminded of, and met with totally altered and different conditions.

"Before critically reporting upon either the excellencies or defects of your invention, it is necessary that the exigencies of street railway locomotion should be fairly and impartially stated. These may be enumerated as follows:—

"1st. Safety to limb and life.

"Under this head it is not merely the passengers in the cars who must be cared for, but those also occupying other conveyances moving on the public thoroughfares, and in addition to these, the very cattle used in moving the conveyances. Then again, the pedestrians must be protected who may approach the cars. All have equal right of road.

"2nd. Security to property.

"Hitherto, all known attempts to propel carriages by steam in the public streets have exhibited the necessity for adopting high and dangerous pressures in order to economise in the least possible space a sufficiency of motive power for the purpose. The reports of the experiences and the casualties attending the experiments with them, dating over forty years back (all honour be to the worthy attempts made by Hancock, Gurney, Ogle, Summers, and others, who attempted to establish steam propulsion on common roads) suffice to indicate the impracticability of using steam.

"The very escape of steam or smoke, or the accidental fall of red cinder, and even the sensation of heat which must be experienced by both passengers and passers by, and the terrors inflicted thereby on the timid and unreasoning beasts of burden are all objections which forty years ago as now rendered the use of steam engines upon crowded streets as inadmissible as it would be and is at the present day. In my opinion those who repeat the attempt will also repeat the failures.

"3rd. Economy in first cost.

"4th. Economy in working expenses.

"Now by the introduction of your invention I am honestly of opinion that all the advantages enumerated under the last four heads may be secured, and the objections fatal to the use of steam overcome.

"The plan you have invented for connecting a series of springs together into which you can accumulate sufficient force, which can be given out and regulated at will by the conductor of the car (in actuating the driving wheel of the car) is the solution of the problem, and offers the long sought for desideratum.

"The manufacture of such springs, light in weight, reliable and constant in action, and of the necessary strength, has been rendered possible only by the perfection of steel manufacture itself within the last few years.

"The working out of your scheme successfully needs only a careful consideration of detail. Of its practicability you are by your experience already assured. Every particle of the machinery must be so modelled that weight (by the adoption of steel in lieu of iron, malleable cast metal instead of ordinary cast iron, &c.), may be diminished to the minimum, and by this you will obtain, secondly, portability.

"The 'convenience' of your arrangements is acquired by the ability to place the machinery connected with the springs either under the framework of the cars or in a separate tender. The space occupied ordinarily by a pair or two pairs of horses preceding the car as in the ordinary practice will be avoided.

"The 'economy' resulting from your whole scheme is indisputable, and as stated above, whilst adverting to its 'practicability,' careful calculations and planning of mechanical detail are alone requisite to obtain an enormous profit over the present method of propulsion by horse power.

"Your experiments already prove that the power you can store in your series of springs will suffice to propel the car a distance, without stopping, of three miles.

"If, therefore, as is well known, the distances travelled by tram cars without stoppage to put down or take up passengers would rarely exceed many hundred yards, stations might be arranged for winding up the springs at the end of each mile.

"Thus you will ensure a sufficient conservation or reservoir of propelling energy always unexpended in the springs to meet every emergency.

"By suitable and well known precautions the action of the machinery can be rendered practically noiseless, whilst every possible risk from any accidental breakage of the parts can be assured.

"Instead of applying the ordinary friction break in stopping the progress of the car, the momentum the car has acquired may, by suitable gearing and simple mechanical contrivances, be converted into available force, and the same given back to swell the stock, so to speak, of unconsumed power existing in the spring series.

"Many systems of conveying the winding-up power to the cars at the respective stations may be adopted; these however, would be regulated by local circumstances and by the nature of the gradients in the sections of road to be traversed.

"One stationary steam engine of proportionate power might suffice for conveying power by hydraulic pressure and connections to each of the several stations, whatever their distance apart might be. At these stations the power might be held available at any instant, and with any degree of force, by means of the well known accumulators, constructed in accordance to the effort required. By these means the imparting of the necessary power to the springs placed on the car may be accomplished in a space of time proportionate to the distance to be run by the car, and comparable to that instanced before in the case of winding up a watch.

In conclusion, I am impressed with the feasibility of your scheme by the fact of its extreme simplicity and its compliance with all the requirements necessary for tramway car traffic, and I augur for it, if supported by capital and enterprise, a complete mechanical and financial success.—I am, dear sir, yours truly,

"GEORGE LEACH.

"Official Reporter, Paris Exhibition, 1867.
" " London " 1871."

As regards its application to the public thoroughfares, I can add little to the above report, and feel the writer has fully placed the value of my invention before those interested in tramway property. I will merely remark that I trust in a short time to see the spring motion applied to a light steel corrugated carriage, to run on the asphalte roads, or where such roads are not convenient, on the asphalte bands, as lately proposed by Mr. Edwin Chadwick, a full report of which appeared in your Society's *Journal* of the 25th June, 1875. On page 26 of that paper a diagram is given of these asphalte wheel tracks.

My spring makers, Messrs. Geo. Salter & Co., have just completed the springs and machinery for propelling a car to run either on the asphalte roads or the ordinary tramways. Two sets of wheels have been made, which can be changed as required for either mode of transit. The car has been built especially for this machinery, the barrels placed longitudinally under the carriage, and in two sets, which can be worked successively or simultaneously, as the case may require. The spring power can be shut off at any time during transit, so as to take advantage of the impetus given to the car, and can be immediately applied when needed; full break power is provided, also the reversing gear, which has been greatly improved since the experiments made at Lillie-bridge.

The following comparison between the car tried at West Brompton, and the one under construction by Messrs. Geo. Salter & Co., will show the improvements made during the last few months both in spring

power and the style of carriage to be used either on the ordinary tramways or asphalte roads.

The body of the car tried at West Brompton weighed about 23 cwt.	The body of the car now constructed weighs 4 cwt.
The springs each weighed 120 lbs.	The springs each weigh 85 lbs.
The springs were each 65 ft. long, and 4½ inches broad.	The springs are each 38 ft. in length, and 4 inches broad.
And had a maximum pull of 950 lbs.	And have a maximum pull of 1,600 lbs.
Giving (each spring) 4½ revolutions.	Giving each spring over 7 revolutions.
These springs required boxes of 22 inches diameter.	These springs require boxes of 14 inches in diameter.

Thus, it will be seen the new car is about one-sixth of the weight of the one experimented upon last year, while that is nearly double the power and revolutions in the springs, with one-third less weight in springs and machinery. The barrels being arranged longitudinally under the car, give more room for the action of the break and reversing gear.

It is my intention to test this car both on the tramway and asphalte roads, when it will bo sent over to Antwerp for trial, on a line in that city, and if satisfactory, will be at once adopted for the tramway traffic in Belgium.

As regards the important item of cost of machinery for driving a car by my spring-motors, and the annual cost of working a car on any of the London tramways by horse-power, it is estimated the expense of the latter is about £750 per annum, which includes keep of 14 horses, wear and tear and loss of stock (which I hear is very great), harness, stablemen, veterinary charges, rent, &c.; whereas it will be seen, from the following estimate, my car can be worked at less than one-third of this annual expense :—

The machinery for each car (which it is estimated will last many years), about £200.	
Interest on this outlay at 10 per cent.	£20
Proposed royalty on each car using my invention per annum	100
Wind-up steam apparatus divided among cars on one of the metropolitan tramways, say per annum	50
To make up round numbers, may be added for repairs, lubricating, and wear and tear, per annum	30
Total expense on spring-car per annum....	£200
Against £750 per annum for horse traction.	

The price of the spring-motor (£200) is not carried forward into the yearly charges, as it will form part of the rolling-stock of the company. The "winding-up" is managed by a 5-horse power engine in about two minutes. Where the line is over three miles it will require three engines, which will be capable of winding up at least 200 cars daily.

Before concluding, I think it right to refer to some of the objections made by those interested in tramways, and my replies to the same. The first I will notice is the danger of breakage to steel springs during the severe winter weather. I at once put myself in communication with Mr. George Ede, the Government Inspector of Steel at the Woolwich Arsenal, who is well-known for his experience on all matters connected with steel. I quote his reply :—

LETTER FROM MR. EDE, GOVERNMENT INSPECTOR OF STEEL IN THE WOOLWICH ARSENAL.

Woolwich, October 28th, 1874.

SIR,—In reply to your letter asking my opinion as to whether severe winter would act unfavourably upon your springs, I beg to say that so far as my own theoretical and practical knowledge of steel, and observations enables me to judge, no degree of cold that we ourselves could stand could in the slightest degree act unfavourably upon your springs, but on the contrary, would act favourably upon them for your purpose. Winter (cold) as is well known contracts the material, consequently the particles are brought into closer contact with each other, and thereby increases the rigidity and power of the material. The difference, however, is so slight that it would not be worth taking into consideration.—I remain, Sir, obediently yours,

GEO. EDE.

E. H. Leveaux, Esq.

To the objections of turning sharp curves, stopping and starting, springs losing their elasticity, running off the rails, &c., I handed a list of them to Mr. Downs, who had constructed my models, &c., and made the drawings for the machinery of the large car, and desired his report on the same, and which is as as follows :—

REPORT FROM MR. DOWNS OF MESSRS. NEWTON & SONS.

Patent-office, Chancery-lane.

DEAR SIR,—I regret that important business prevented my being present at your trial of model tramway-car on Saturday. I have carefully considered the list of objections to your proposed system which you handed to me, and I can see in them nothing for which provision has not been made in the design as it now stands. With respect to the first objection, viz. :—

1. *Turning Curves.*—Curves of large radius will not materially retard the wheels, and where curves of small radius occur, such as for instance, the turning corners of streets, one plan at present in use with short curves is to run the wheels in a groove on the inner curve only, and at the outer curve the wheels run on their flanges on a flat rail only; another plan would be to mount one of the axles so as to radiate from the centre of the curve, and under the control of the driver.

2. *Stopping and Starting.*—The spring power is divided into two sets, each of which is under the control of the driver, who can, by means of the starting levers, throw either or both sets of springs into gear at will, thus doubling the power.

3. *Springs Losing their Elasticity.*—When springs are properly tempered there is no loss of elasticity if they are not strained beyond a certain point. The diameter of the barrels and arbors must therefore be so proportioned as to prevent undue strain being put upon the springs when wound up tight round the arbour.

4. *Cars Running off the Rails.*—In the event of a car running off the rails, the wheels still remaining on the ground, the ground would act as a break. The power can instantly be shut off, and the car replaced upon the rails, inclined planes or wedges for that purpose being now in use on the "North Metropolitan Tramways." I believe each car is provided with them.

5. *Noise of Machinery.*—With the slow rate of motion required the wheels will run almost noiseless, the last pinions running only at 70 or 80 revolutions per minute, and the rest of the train of wheels 7 or 8 revolutions per minute.

Yours truly,

W. DOWNS.

To E. H. Leveaux, Esq.

I must, in conclusion, once more crave your consideration for addressing you on engineering matters, as I feel my simple description of the machinery employed for carrying out this invention will sound strangely in the ears of many assembled here this evening. I have also to ask your kind consideration and indulgence in respect to the delivery of this paper, feeling the effort of speaking for so long a time increases my difficulty in bringing this import-

ant subject before you in as favourable a manner as I should have desired to do. I must take this public opportunity of expressing my obligations to those practical engineers who have guided me by their advice and assistance in arranging and manufacturing the machinery necessary for the development of my invention.

My models have been made by Mr. W. Downs, of Messrs. Newton and Sons, patent agents, from both of whom I have received the most valuable advice, from the time I took out my patent to the present day. My friends, Mr. Thos. Hampton, of the Phœnix Bessemer Steel Works, Sheffield, and Messrs. George Salter & Co., of West Bromwich, have done their utmost to develop spring making for the use of my invention. Mr. Thomas Middleton, of Loman-street, Borough, took an early interest in my work, and by his kind and valuable co-operation many experiments were carried out at his works, and on the West Brompton line of railway. Indeed I feel, as an outsider in mechanical experience, I have been very fortunate in surrounding myself with such valuable aid and assistance. Thanking you for your kind attention to my paper, I now beg leave to conclude, and will exhibit sample springs for your inspection.

PROGRESS OF SPRING TESTING FOR THE USE OF "LEVEAUX'S PATENT" FOR DRIVING TRAM CARS.—EXTRACTS OF REPORTS AND TESTS OF SPECIMEN SPRINGS.

	Power. lbs.	Length. Feet.
1874. January and February.—First springs obtained from Sheffield were made in 1871, for the Woolwich Arsenal; supposed to have a lifting power equal to the pull of two horses; gave way under test at Middleton's	Broken.	35
Numerous other springs made at Sheffield ...	120-700	35 to 40
April 9.—Messrs. Middleton's report:—"Strain on spring"	728	45
May 13.—Messrs. Middleton's report:—"Number of turns of spring in box 7, pull at end of spring" Note.—Sixth time of winding same spring.	784	45
July 2.—Messrs. Middleton's report:—"The spring supported a weight of about ... ... without any permanent set; number of turns, 8 5."	896	45
1875. Feb. 5.—Messrs. Middleton's report:—"The spring tested this morning (Salter's No. 8 B.W. 9) gave a maximum pull of .. .. without any permanent set after winding. This result exceeds by nearly 150 lbs. any test we have yet made, and the spring is very well finished."	950	46
March 16.—Mr. W. T. Henley's report, Telegraph Works, North Woolwich:—"Test of spring for tram car (Salter's 8 B.W. 9)—maximum ...	1,000	45
March 17.—Mr. W. T. Henley's report:—"Test of spring (Salter's 8 B.W. 9)	1,100	48
February 27.—Messrs. Middleton's report:—"The experimental truck was then attached by a rope to the 'Antwerp' tramway car, which weighed 33 cwt., and on being put into gear started the whole weight of 63 cwt., and three persons in the car, which would add about 4 cwt., with great ease and smoothness, and at a rate of six miles an hour; the power of the two springs, working without boxes, proving that the springs, when free to exert their whole force, have sufficient power to propel the car at a proper speed" ...	7,504	48 to 56
March 1.—Messrs. Geo. Salter and Co., of West Bromwich, writes:—"We believe if we make springs of steel, 56 to 60 feet long, and 6 inches wide, of 9 B.W.G., you will get nine revolutions, and a power equal to 10 cwt."	...	56 to 66
March 9.—Extract of letter from Messrs. George Salter and Co.:—"These springs, six inches wide, will be very long, but we do not see why the steel manufacturers should not send longer steel. We can harden and temper almost any size, but we think the 6-inch 9 B.W.G. will be what you require."	...	...
March 24.—Letter from Messrs. W. Jessop and Sons, steel manufacturers, Sheffield:—"We have rolled 70 feet long by 4 inches broad, and $\frac{7}{32}$ thick; we now find we can roll bands 184 feet long and 4 inches width, and 17 B.W.G. easy."	... ...	70 184

SUMMARY OF THE ABOVE TESTS OF SPRINGS.

	Lifting Power.	Length. Feet.
1873. Woolwich springs and numerous other experimental springs, all tested at Messrs. Middleton's	120-700	About 20 to 45
1874. January to April 9.—Messrs. Middleton's report, "Strain on spring" ...	728	,, 45
May 13.—Phœnix Bessemer Steel Company, Sheffield	784	,, 45
July 2.—Ditto ditto ditto ...	896	,, 45
1875. Feb. 5.—Messrs. Salter's springs, West Bromwich	950	,, 46
March 16.—Ditto ditto ditto ...	1,000	,, 46 57
March 17.—Ditto ditto ditto ...	1,100	,, 48-57
Feb. 27.—First with Salter's spriogs on the Truck and Antwerp Car, at the works of Messrs. Middleton, Boro, springs carried on railway	7,504	,, 48
April and May.—Sunday trials on the railway at West Brompton. Springs carried Antwerp Car full of workmen, and the Truck with machinery with several passengers on it, at a good speed	11,312	,, 48 ,, 57

TABLE SHOWING POWER OF SPRING REQUIRED TO PROPEL CARS ON TRAMWAYS AND RAILWAYS.

Total Weight of Car, Machinery, and Passengers.	Draft on circumference of Barrel.	Effective Draft on Car at Drawing Wheel.
2 Tons	288 lbs.	24 lbs.
$2\frac{1}{2}$,, ...	360 ,, ...	30 ,,
3 ,, ...	432 ,, ...	36 ,,
$3\frac{1}{2}$,, ...	504 ,, ...	42 ,,
4 ,, ...	576 ,, ...	48 ,,
5 ,, ...	720 ,, ...	60 ,,

From the above table it will be seen it requires a draft of 720 lbs. on barrel to propel one of the large street tram cars full of passengers.

Springs have already been manufactured, giving a draft of 1,100 lbs., and Messrs. Jessop, of Sheffield, have rolled a band of steel which, when tempered into a spring, will give at least three times as much power as above. It will be thus seen that the development of spring power is now only in its infancy, and when a commercial demand arises for large springs, the manufacturers will lay down fresh machinery, whereby they will be able to roll steel bars of enormous lengths and thickness. Messrs. Jessop, of Sheffield, write, March 24th, 1875, they had rolled a band of steel 184 feet long, and 4 inches wide—17 B. W. G. This band of steel is nearly four times as long as the springs now propelling the machinery at West Brompton.

When Sir John Brown, of Sheffield, commenced making his armour plates some 25 years back, 6 inches was then thought the maximum that could be accomplished; at present, the Sheffield houses engaged in this trade are manufacturing plates over 32 inches in thickness.

Messrs. Geo. Salter and Co., West Bromwich, write under date March 9th, 1875, "They will be very large springs (70 feet long, 6 inches wide), but we do not see why the steel manufacturers should not send larger still. We can temper almost any size."

DISCUSSION.

Mr. Galloway said he was satisfied that the day was not far distant when mechanical appliances would take place of horses for omnibus and other traffic, but he did not think the motive power would be springs. He had himself taken out two patents for spring power motion, one in 1865, and one in 1873, but he had now abandoned the idea in favour of compressed air, which he was satisfied would be superior in every way, and would not require fixed steam engines.

Mr. Wm. Smith was not prepared to argue that springs were purely Utopian, but he should like to know what was the practical outcome of the experiments up to the present time. Some time ago

he saw the invention at the works of Messrs. Middleton, where there seemed a perfect forest of springs, most of them he thought broken, tons of iron pinions and shafting, and masses of material, and he was led to believe that within a few weeks from that time some useful result would be attained. What he wanted to know was how many tons weight could be carried, how far, and at what rate over a level road or up an incline of a given gradient, with a specified amount of spring power. If some practical information of that kind were given it would add much to the value of the paper. He did not like to discourage an inventor, but he feared it would prove a failure, though at the same time the improvement in the manufacture of springs, which had been effected in working out the invention, was very important.

The Chairman said he did not know who the last speaker was, or what might be the value of his statements, or the authority of his opinion; but it was due, in justice to Mr. Leveaux, to state that his (the Chairman's) attention and interest in the invention had been first directed to it by the spontaneous expression of a most favourable opinion of it by the greatest improver of steel, and special authority on that metal and on mechanics, perhaps, of our time, Sir Joseph Whitworth. Sir Joseph, who was present, had expressed to him a confident expectation that the spring power proposed would prove to be the thing. He (the Chairman) had gone to witness a trial of it in the early stage of the invention, and had ridden in the car, and could attest the actual propulsive power to be so far achieved, and he must so far set aside all question upon it as unfounded.

Mr. Horn expressed himself satisfied with the invention, and that it would introduce a considerable saving in horse power.

Mr Blackie asked if Mr. Leveaux adopted any means for equalising the power of the springs, such as was used in watches and clocks. As a chronometer maker, he had some knowledge of springs, and could assure him that no rolled spring would ever stand so well for a length of time as a hammered one.

The Chairman inquired what size springs Mr. Blackie used.

Mr. Blackie said in large 8-day chronometers the springs were very strong, but they were all hammered, and he had known them last for 50 years. They were used with a parabola fusee, so that the power was the same throughout within one or two pennyweights. These large springs might be easily wound by hand power in the same way as the heavy weights of turret clocks, but he did not think it would answer to wind them by steam power. He was decidedly of opinion, also, that cold weather would render them brittle.

Mr. Hancock agreed with the remarks of Mr. Smith, having been struck with the vagueness of language in which the results were described. He agreed with Mr. Leveaux, with Mr. Grantham, and others, that it was somewhat of a scandal to a mechanical age and country like this that tram-cars should still be propelled by horses; but looking to what had been done by his uncle, Mr. Hancock, on common roads many years ago, when he propelled carriages by steam at the rate of 8, 10, and 12 miles an hour, and drove a carriage from Stratford through the city of London to Paddington, day after day, for a long time, without an accident of any kind, he was surprised to hear it stated that all attempts to propel carriages by steam in the public streets required dangerously-high pressures. His uncle had indeed used a moderately high pressure but the danger was practically *nil*, as was shown by a statement that he had heard from Mr. Bramwell in that room, that he had known one of the carriages to stop suddenly, and on getting down to ascertain the cause, it was found that one of the chambers of the boiler had burst, without any one being aware of it. It was certainly astonishing that more had not been done to utilise steam for cars. He saw that compressed air was now being tried in Paris, and he had frequently heard Mr. Bramwell assert that neither the danger of high pressure, of frightening horses, or of the escape of smoke, need be an obstacle to the use of steam.

Mr. Abbott thought it would be unfair to make any remarks adverse to the scheme which had now been expounded, and which was evidently as yet not much beyond the experimental stage; but he was astonished to hear the disparaging observations made on every other motive power. At the present moment there was a steam-car running in Paris, which was perfectly noiseless and smokeless, and in every way unobjectionable, and the municipality were so satisfied with it, that they had ordered thirty more. At Leicester also, last week, he saw a steam-car going at four or five miles an hour through the High-street, noiseless and smokeless, and satisfactory in every way. This steam-car, which was constructed by Messrs. Merryweather, would, he believed, soon be employed in Liverpool or Birkenhead, and the saving over horse-power would be 30 or 40 per cent. Of course it would meet with determined opposition on the part of the municipalities, as was the case with all new inventions, but, no doubt, common sense would prevail in the end, and probably before another year they would see steam-cars running in London. He feared Mr. Leveaux would find one great obstacle in his way, in the necessity for providing a steam-engine at the distance of every mile, the expense of land in important thoroughfares being very great, and if the car had to go into a siding to be wound up, it would cause delay. There might be a danger, too, of the springs not being strong enough to take the car up an incline.

Mr. Wm. Smith desired to add that a former secretary of the Society, Mr. Scott Russell, when a young man in an engineering firm at Greenock, had tried a series of experiments on steam propulsion, which would, no doubt, have been successful, if they had been continued.

Mr. Liggins said his late friend Mr. Grantham's name having been introduced, he felt bound to say that he believed his steam tram-car was a great success, and that it was only stopped by the Act of Parliament, which was a very different cause to the one suggested in the paper. Besides this, Mr. Grantham's unfortunate death had prevented his bringing it to that perfection which he would no doubt have attained. To him it appeared to succeed perfectly, though it was possible some defects might have been discovered when it came into regular use on the roads. The point mentioned by Mr. Blackie, about the regularity of the spring, had also occurred to him; and, in all probability, if the car had to go up an incline towards the end of the spring, it would stop before it came to the winding-up station. Again, as to breaking of the springs; they knew that watch-springs often broke, and he had only just found that the spring of a drawing-room clock, by a first-rate French maker, which had gone regularly for eighteen years, was broken half way through, causing the clock to stop. He had never heard of any means by which you could ensure that a spring should not break, perhaps at the very moment when most inconvenient. He was sorry to hear, however, that the new car, when finished, was to be sent to Antwerp, and hoped, if successful, it would be kept in England.

Mr. Hancock said there was no doubt the great obstacle to progress in tram-car improvement was the Act of Parliament which forbade any carriage propelled by steam going along a common road at the rate of more than four or five miles an hour. That Act did not exist thirty years ago, and his uncle had often run, on a good clear road, at 12 or 15 miles an hour, and occasionally at 20.

Mr. McComber said he understood that Mr. Leveaux did not create any motive power, but simply utilised a steam engine, and stored up its force in a series of springs, so that he could not get any more power out of them than the steam engine had first put in, minus of course, all the friction.

Mr. Leveaux, in replying, asked if Mr. Galloway's patent included winding up the springs by steam power.

Mr. Galloway said no; he proposed to employ the momentum acquired in travelling to re-wind the spring.

Mr. Leveaux said in that case his plan was quite distinct. He must flatly contradict Mr. Smith's statements as to the broken springs at Messrs. Middleton's. and challenged him to prove it. Two years he ago he sent him a letter challenging in every detail the statements he then made. He then pointed out the springs he employed, and said he had stated in the paper that they had performed a certain amount of work. At West Brompton, with three boxes of springs, they had run easily over quarter of a mile, at the rate of six or seven miles an hour, and when they employed six they went nearly half a mile. In the present car there were 24 boxes, and consequently it would go two miles without any reservation of power; but there was an appliance by means of which they could shut off the power. Last December he had shown the working of the car to Mr. Maudslay, and notwithstanding it was a snowy day, and they had no artificial bite on the rails, the car ran quite easily. During that trial, the machinery being,as he had said, very clumsy, the clutch gave way suddenly, and the whole series of springs ran down in about twelve seconds, making a great noise. It was feared several of them would be broken but such was not the case, and they seemed to work all the better for it on being wound up again. Messrs. Salter had made some hundreds of springs, and he had witnessed the experiments on about two-thirds of them, and to his knowledge only two had gone during the last nine months. Of course there was a maximum and minimum power to a coiled spring, but these were so arranged, that the maximum power was retained from the whole series until you came to the last barrel of the series, and when that was reached they were re-wound. The calculation was that the car would run between two and three miles and it would then be wound up again, which would take about two minutes. This was accomplished by a two horse-power steam engine, which would cost less than £300. Where any difficulty arose in having a stationary engine, he proposed to use a small traction engine, carrying ready coiled springs, which could be transferred to the car; or he could use a portable engine for winding. Messrs. Salter had also arranged a plan by which the springs could be wound by hand in five minutes, and no doubt ultimately this time would be reduced, and this would save all trouble. He regretted that he had introduced Mr. Grantham's name, but he had certainly not intended to cast any reflection on his invention. He could not go into the question of compressed air, but he had lately been in Paris, where he was assured on the best authority that neither steam nor compressed air was going to be used for tramways.

The Chairman said there could be no doubt that by one power or another science would give us a future of smooth and clean roads, noiseless, smokeless, and more secure transit, at less cost than by horse power. If the promise given to-night of smokeless and noiseless spring power could be realised, the prejudice against it would be removed, and it ought to be welcomed and freed from legislative restrictions; but he owned his own most confident expectation from the invention described to them by Mr. Leveaux. He had given much attention on sanitary and other grounds to the conditions of transit, and had been led to propose a construction of asphalted wheel tracks, which had been referred to in the paper, and which would give to any of the promised engines nearly a double tractive power; the same traction power, in fact, as the granite tramways, at half their cost, and at one-third the cost of the iron tramways, without their obstructions, and, indeed, with facilities to other traffic; and also at less cost than the entire covering of asphalted carriage roads. In this metropolis, whilst science proposes amendments, ignorant and incompetent local administration disposes to the continuance of filth and noise, jarring, uncomfortable, and dear transit in the streets. Think of this, that there were a thousand loads of dung deposited, chiefly from the horses of public vehicles, on the streets, which was dried and distributed, and breathed as dust, and as the greater part of the filth befouling the person. A gentleman had remonstrated on the first trial of this English invention being given to a foreign city, but what were the obstructions to such improvement in this British metropolis. An improvement of the nature of this, or of the others proposed, would require a proper trial on a complete thoroughfare. But every suitable thoroughfare, as displayed in the report on street and road formation, maintenance, and cleansing, issued by the Society, which had been received with general acknowledgment, was cut up in some dozen of different independent parochial jurisdictions; the shortest were under two or three distinct authorities destitute of the requisite special science, and manifesting the apathy or the antipathy to improvement of ignorance. But it was frequently the case, that there was not only dense ignorance, but a pecuniary interest to overcome, the firmly seated interest of a contractor in the very sort of material and pavement which it was the object of an invention to remove. What could be more barbarous than the administration which subjected vehicular traffic to the work of ploughing through loose granite, and punching it down, as was commonly seen in their thoroughfares, or the greasy and dangerous conditions in which they were kept by the contractors for cleansing, and all this barbarism at commonly excessive and oppressive rates. Economy of measures, instead of being a recommendation, was with them an obstruction to adoption. The tramway companies could tell of the obstructions they had had to fight through, the expenses they had been put to, and the exactions to which they were subjected, by the contractors of vestries for the maintenance of the roads. Measures proposed by the Metropolitan Sanitary Commission, and by the first General Board of Health, for the metropolis, had borne fruit in Paris, and, indeed, in the provincial cities Manchester and Liverpool, especially as regards the water supply, that, from the conditions chiefly of its administration, had hitherto borne none here. Paris was now designated, as compared with London, "clean streeted Paris." The asphalted roads there were kept so clean that they were preferred, not only for the gain in comfort and in traction force, but for safety, to the common roads. The difficulty of getting good roads was not one of science, which was quite competent to abolish a vast amount of horse traffic with its attendant nuisances, inconvenience, and danger, and with a better administration they might have noiseless transit, easy, cheap and clean. There were inventors who did what they proposed, and there were others who only invented difficulties; of these last he thought they had had some example that evening, and it must be remembered that practical mechanics had always been the greatest obstructors of invention. This was the case with railways, for he remembered a great authority saying that if a locomotive could be got to run by mere adhesion he would eat both it and the rails. Mr. Leveaux had not only put forth an idea; that was an easy matter, but he had worked it out. He would conclude by proposing a hearty vote of thanks to him for his paper.

Sir Joseph Whitworth seconded the motion, which was carried unanimously.

HEALTH AND SEWAGE OF TOWNS.

The Conference on this subject was held on Tuesday, Wednesday, and Thursday last, the 9th, 10th, and 11th inst., the Rt. Hon. JAMES STANSFELD, M.P., in the chair.

The Chairman, in commencing the proceedings, expressed the regret he felt at being obliged to leave before the conclusion of the conference, in order to attend a committee of the House of Commons, of which he was chairman, though his colleagues had consented to postpone the hour of meeting to suit his convenience. After alluding to the necessity for adhering strictly to the rules laid down for the proceedings, in order to get through the business in the time allotted, he said it would be well to consider at the outset the real object of the conference. He was informed that it was not one of the objects to discuss new and untried schemes, or to debate upon scientific theories as applied to the disposal of sewage. These conferences, for it was intended that they should be held annually, were intended to take stock year by year of the experience of the community, with regard to the systems applied within each different locality. The great division was between the water-carriage system of sewage, and the dry systems. In dealing with the first, they would have to deal with sewage farms with or without precipitation or subsidence, and with the influence of those farms upon health. After dealing with sewage farms, effluent waters, subsidence, and the disposal of the solid matter, they would have to consider the experience of those towns which threw their sewage into the sea; and also those who adopted no special treatment. Then would come the dry systems and various foreign systems upon which they hoped to have information. The two great divisions were no doubt the water-carriage and the dry systems. The system of water carriage struck one as most fitted for large and dense populations, and seemed to recommend itself by a certain mechanical completeness and by a certain decency. It hid from sight, if not always from the other senses, the excreta of the population, which had to be disposed of. Assuming that every householder had his closets and pipes constructed in the best method and kept in perfect order, and that the system within the house was efficiently connected with the public drain, and that the mere discharge of sewage at the outfall was a sufficient solution of the problem of dealing with it, there would be something nearly approaching perfection, in theory, at any rate, in the water-carriage system. But, as was well known, the mere construction of drains, and the mere mechanical perfection of drainage from the point of contact with the house to the outfall was a small and comparatively unimportant part of the question; a most important subject was the question of the condition in which the sewage was discharged at the outfall, and the necessity of dealing with it in some way at the point of discharge so that it might not be injurious to public health. In the house itself they had certainly attained that kind of decency which modern civilisation seemed to require, but in so doing they had created new and more insidious dangers in the shape of those sewer gases which were the product entirely of this modern system, and which, going counter to the stream of sewage, went back into the houses, and were the source of diseases which were almost unknown before. He desired to express his conviction, founded on a great deal of consideration of the subject, that you could not hope to have an efficient and safe system of water-carriage of sewage unless the sanitary authorities in charge of it were in charge also of the connection of the pipes and the arrangements within the house itself. It would not do to leave the householder to protect himself, nor was it to the interest of the community to leave him to such inefficient protection as that of his own knowledge. With regard to the dry systems, many persons had been accustomed to think that these systems were too primitive, and from a certain limited point of view it was true; they were not self-acting systems, and so far must be considered to fall short in scientific perfection; but, after all, there was something else in science than mere self-acting mechanism, and he did not know that they were less scientific in the cases to which they were particularly adapted than the water-carriage system, and they had many things to recommend them. In the first place, a dry system did not involve a large capital outlay, and in the present imperfect state of scientific knowledge, he feared there would be many cases of extravagant and mistaken capital outlay. The dry system was somewhat expensive in working, and was troublesome, but it had this merit, that it gave very speedy notice of neglect, and that sign, although very unpleasant, was not so dangerous as the imperfections of the water-carriage system, when they resulted in the creation of sewer gases, and their introduction into the houses. It was the putrescent fermentation of sewage which was the danger of modern appliances, and that was a condition not likely to be found to any extent under a dry system. He hoped this conference would elicit the merits and defects of either system, as applied to the varying conditions of different populations, and another good effect he hoped would be, to check extravagant schemes. Having been first President of the Local Government Board, he had had some occasion to consider the various drainage schemes which that Board had had from time to time to criticise and approve, and for which application for loans of public money had been made; and he feared that, at the present moment, there was a danger of extravagant expenditure which would disappoint those who incurred it. The scientific knowledge of this subject was as yet so partial, and the general result so uncertain, that he hoped the conference would exercise a moderating influence on the action of public bodies, and that the public departments would be satisfied that they should proceed cautiously in the expenditure of public money. This led him to say a word on the true function and policy of the Local Government Board with reference to the question. That department, which might be looked upon as the Home-office of the future, ought not, he thought, to confine itself to simply checking and controlling, but should also help and advise. When at the Local Government Board, it occurred to him to constitute a new sub-department, which he should have done, but that he could find no room in which to house it. The Board now possessed larger premises, so that the same difficulty would not occur; and possibly his idea of having an Inquiry Department might be carried out. He had always found the clerks and inspectors of that department quite willing and, generally speaking, the more able the more willing to afford information to the public who were desirous of receiving it; but he thought they ought to facilitate the approach of the public to the department, and this might be accomplished by the institution of an Inquiry Department, where any one could go to put any question in the interest of the town he represented, and could get the best possible answer to the question. He did not know whether that idea would ever bear fruit, as far as the Local Government Board was concerned, but if the Society of Arts and the representatives of the various urban communities were themselves to institute such a department in that building, the same thing might be accomplished. All that was required was a collection of literature on the subject, specimens of certain appliances, and a person in charge, who should constantly study to keep himself informed of all that was going on, and so be able to inform those who came to inquire of him. Another favourite thought of his with regard to administration had always been this:—We were only beginning to understand and work out methods by which official and voluntary efforts could co-operate for the public good. A man at the head of a public department should of course trust those whom he had to superintend, and he would get the best service if he did so; but he should not be content to look only inside. The fault of men who

deceived themselves was not that of trusting too much to their subordinates, but forgetting that they should look outside as well. The head of a department exercised a *quasi*-judicial function, and ought to weigh all the evidence on any question laid before him before arriving at a conclusion. He could not do this safely simply by trusting to his subordinates, because they could not look at questions from every point of view, but must do so from their own official stand-point, so that it was impossible for the head of a great department properly to fulfil his functions unless he invited and facilitated outside voluntary information and co-operation. During his presidency of the Board he not only acquiesced in the holding of Poor-law conferences throughout the country, but did his best to promote them, and those conferences were attended by the inspectors of the Local Government Board at his express desire. He did not know whether there were any of the Board's inspectors present that day, but he had called at the offices, announced the conference, and proposed that, if it were feasible, an inspector should attend. He was bound to say he found not the slightest disinclination that one at least of the able engineer-inspectors attached to the Board should be present. But they might be disappointed, for, just at this time of the year, those gentlemen were working night and day in completing their report upon sewage schemes with reference to provisional orders, and confirming bills which, in accordance with tho standing orders of Parliament, had to be dealt with before a certain time. He hoped, however, that some member of the medical department would be present. The Local Government Board ought to help and advise the public, and it could only do so in the best way by having, in connection with its engineering and medical departments, a policy of its own. Not that it should be ready with an opinion upon each individual scheme, and certainly not upon those which had not been tried, or had only been experimented upon, but it ought to have a policy. At the present moment he thought that policy ought to be one of conveying information, and enjoining caution and moderation in the expenditure of money on large and pretentious schemes. In conclusion, there were two documents he must refer to, which he had hoped would have been laid on the table, but they were not quite ready for publication. One was the "Report of the Departmental Commission on Sewage," of which Mr. Clare Sewell Read was chairman, which was ready but not signed, and the other was Lord Rosebery's "Return," which was in type, but not yet corrected. He hoped the discussion would be so conducted as to accredit the conference in the public mind, and lead to its annual repetition, to its influence, and to its usefulness.

A full report of the papers and discussions will be issued in subsequent numbers of the *Journal*. For the convenience of those wishing to have the account of the proceedings in a more compact form, the same will also be published as a pamphlet, which can be had (as soon as ready) on application at the Society's House. Price 2s. 6d.

According to the report of the Austrian Chemical Society, Herr Orr has discovered a method of producing a beautiful zinc white by the following process:—The raw sulphate of barium is washed and mixed with the liquor obtained from equal equivalents of chlorate and sulphate of zinc. The precipitate is collected, pressed, and dried; it is then heated and thrown, white hot, into cold water. The object of this last part of the process is to give a great density to the mass. This substance, when washed and moulded, possesses pure white colour.

CORRESPONDENCE.

ON SANITARY PROGRESS IN INDIA.

Sir,—In a paper read by Captain Galton on the above subject, at the Society of Arts, April 21st, 1876, the following statement is reported to have been made:—"The death-rate of the British army in India averaged, in old times, 69 per 1,000."* It has also been stated in the report of the Royal Commission on the sanitary state of the army in India, "the annual rate of mortality has been 69 in 1,000 during the present century," on the average. This was, also, about the rate—63 per 1,000—given by Mr. Annesley, but then, under what circumstances was it obtained? This writer will be the best able to inform us. "The period from 1815 to 1821 (7 years) inclusive, having been that of the most active service which has occurred in India for many years past, has, therefore, been selected for these reports, as it was the best calculated to try the constitutions of the troops. During this time the country was the seat of war, and the troops were obliged to make most harassing marches, and to perform the severest duties of an active warfare. They were exposed to epidemic cholera, which prevailed the greater part of this time, to the influence of seasons more than usually variable, to excessive heat, heavy monsoons, and sudden vicissitudes of weather. During this period, too, the army traversed a space of country from the 8th and 9th to the 25th degree of north latitude, and from the 75th to the 80th degree of east longitude,"† That these rates were exceptional rates, and only observed during a period of war, it will not be difficult to show. Dr. Burke, Inspector-General, states that, in 1826, during the wars in Ava, Arrakan, and Upper India, the deaths in the Bengal army from diseases alone, exclusive of wounds, were 774, but in the three subsequent years of peace the average annual ratio was only 387.‡ being just half. Dr. Burke adds, that in 1830-31-32, the ratio of mortality with H.M's troops in Bengal was 38, 43, and 40 per 1,000 respectively, being an average of 40·33 per 1,000, although these years were not entirely years of peace or inactivity. In 1836, the ratio, in the same army, was 37·60 per 1,000. In Ceylon, also, according to the statistics contained in the first Army Report, 1859, the annual ratio of the white troops for the nine years, 1837-46, was 41·74 per 1,000. In 1859, it was 35·06. The difference between a state of peace and of war will be satisfactorily shown by a reference to the mortality of the European officers of the native army. In the *Madras Courier*, October 21, 1816, the following particulars are given of "the mortality which occurred in the space of three years 1813-14-15 (a period of peace), in a class of the European society, the most exposed to the climate," viz., the officers of the Madras army; strength, 1,366, deaths, 115; ratio per cent., 8·43, being an annual average of 28·06 per 1,000. But of 1,260 European officers in the Bengal army, the deaths, in the year 1820—a time of war—were 74, being a ratio of 58·93 per 1,000.§

With these facts before us, it is easy to account for the low rate of mortality that has been observed of late in India, with a profound peace of fifteen years, more especially when other circumstances are taken into consideration. These are—

(1.) The present short period of service. Before, the European troops of the East India Company, and frequently the royal troops, remained in India twenty-one years. Now, the regiments do not remain above six or

* *Journal of the Society of Arts*, April 28, 1876.
† "Sketches of the most Prevalent Diseases of India," p. 227.
‡ *Edinb. Med. and Surg. Journal*, vol. 41, p. 386—1834.
§ Miles, quoted by Mr. Annesley.

seven years, while many of the men, whose period of service has expired, leave previously. The influence of this circumstance in the prevention of disease will be evident by a reference to the following table, drawn up by Captain Henderson:—

*Table showing the progressive increase of danger with increasing years and residence with British Troops in India.**

Age.	Rate of mortality.
From 20 to 22	2·24 per cent.
„ 22 to 24	4·63 „
„ 25 to 30	5·86 „
„ 30 to 35	5·22 „
„ 35 to 45	6·78 „

This calculation was for the four years of peace, 1830-33.

(2.) Another circumstance is, the difference in the rate of invaliding now and formerly, caused by the present easy and short voyage between the two countries. Dr. Burke states that the loss by invaliding of H.M.'s troops in Bengal from 1826 to 1832 inclusive was, on the average, 1·2 per cent., or 12 per 1,000—the highest in 1826 being 4·7 per cent; caused, principally, by wounds in the wars in Ava, Arrakan, &c. In 1827-28, on the termination of the war, when the same cause, we may presume, was partially in operation, the ratio each year was 13 per 1,000; but in the next four years it only amounted to ·30 per 1,000, or less than one for every 3,000 of the strength. In 1861, the rate of invaliding was 31·68 per 1,000; and in 1868, in the midst of a profound peace, 67·7. If now we turn to the ratio of mortality for the above periods, we shall find that it was 40, 28·70, and 21·71 per 1,000 respectively—a difference that may in a great measure be accounted for by the difference in the rate of invaliding.

(3.) The establishment of railroads will also account to a certain extent for the reduction in the present rate of mortality in India. Nothing, in fact, was more common, formerly, than for troops on march to be attacked with fever and cholera, on encamping for the night in one of the uninhabited districts of this vast continent, and this, too, when no disease existed in the surrounding district.

(4.) Another cause to be taken into account is an improved method of treatment, particularly of dysentery. The old method—that by scruple doses of calomel—was little better than murderous.

We can thus account for the reduction in the rate of mortality in India, irrespective of the adoption of sanitary reform, which could not possibly have had any influence in the production of this effect. If no beneficial result has been produced in England after a trial of 40 years, the general rate of mortality being precisely the same now that it was then, it is not likely that a greater effect will have been produced in India in a fourth part of the time.

Sanitary reform was inaugurated in India by Lord Lawrence, in 1864, the first Board of Health having been established shortly before my arrival in Calcutta in the autumn of that year, but no appreciable effect had been produced in 1871; the average ratio of mortality for the three years, 1861, 1862, and 1863, previous to the inauguration of sanitary reform, having been 24·85 per 1,000; and for the three years, 1869, 1870, and 1871, 23·84, a difference of only one per 1,000. This rate is only what has been obtained previously in India. According to the report of Dr. Henderson, the ratio of mortality in Her Majesty's 48th Regiment stationed at Billary, from December, 1829, to December, 1830, was 22·30 per 1,000.† There has been, it is true, a great reduction since, viz., 16·32 in 1873, and 13·50 in 1874, but then, if this reduction is to be referred to sanitary reform, we should expect to find that some, if not the same effect, had been observed with the native troops, who must also participate in the benefit to be derived from sanitary measure, but this is not the case. Capt. Henderson states, that during five years, 1830 to 1835, one man per annum out of every 135 died in the Bengal native army, being a ratio of 7·40 per 1,000.* In 1836, the deaths in the same army, eomposed of 72,814 men, were 771, which gives a ratio of 10·60 per 1,000.† But in 1873, the ratio of mortality with the same troops was 17·4 per 1,000.‡

As regards the reduction in the rate of mortality in 1873 and 1874, this may be referred, in all probability, to the non-prevalence of cholera, there having been only 12 cases in 1874. It may, perhaps, be argued that this exemption is due to sanitary measures; that, however, would be a very erroneous conclusion, for two reasons; in the first place, epidemics only prevail generally in particular years, and in the next, because if sanitary measures had exerted any influence in the prevention of this modern scourge, it ought, at the same time, to have lessened its malignancy. But the epidemic cholera is three times more malignant and fatal in India than it was formerly. In the Madras European army the ratio of mortality, from cholera, in 1818, 1819, 1820, and 1821, was, calculated on the cases, 18 per cent.§ In the subsequent 20 years, the average was 33 per cent. Even in the fearful outbreak at Kurrachee, in 1846, the ratio with the European troops, was 58·70, and with the women and children, 61·67 per cent. But in 1872, the ratio with the British troops in Bengal, was 70·82, and with the women and children 71·85; in Bombay, the rate, with the men, was 78·26, and with the women and children, 90·90 per cent. In 1874, also, although there were only 12 cases, 11 proved fatal; being a ratio of mortality of 91·66 per cent.

Such are the reasons which induce me to infer, that sanitary reform has exerted no influence in the reduction of the rate of mortaily in India; the validity of these reasons must be left to the decision of others.—I am, &c.,

J. PARKIN, M.D., F.R.C.S.

London, May, 1876.

* Inquiry respecting the law of mortality for British troops in India. 1836.

† *Madras Quarterly Medical Journal*, January, 1841, p. 121.

* *Loc. cit.*

† Report of the Bengal Medical Board.

‡ Report on Sanitary Measures in India, 1873, 1874.

§ Annesley, *loc cit.*

GENERAL NOTES.

The Patent Bill.—The following petitions have been presented to the House of Commons in favour of alterations in the Lord Chancellor's Patent Bill:—April 11, Members of the Faculty of Procurators of Glasgow (The Lord Advocate); April 24, Members of the Philosophical Society of Glasgow (Mr. Anderson); Associated Engineers of Sheffield in meeting assembled (Mr. Mundella); Sheffield Trades Council in meeting assembled (Mr. Mundella); May 1, Inventors and others of Glasgow (Mr. Anderson); Members of the Mansfield Trades Council (Mr. Mundella); May 2, Members of the Bury Trades Council (Mr. Phipps); Members of the Oldham Trades Council (Mr. Serjeant Spinks); May 3 Graduates section of the Institution of Engineers and Shipbuilders in Scotland (Mr. Charles Cameron); Staleybridge Trades Council (Mr. Sidebottom); May 4, Manchester and Salford Trades Council (Mr. Jacob Bright); May 8, Members of the Leeds Trade Council (Mr. R. M. Carter); Birkenhead Trades Council (Mr. McIvor); May 9, Wigan Trades Council (Mr. Knowles). The Glasgow Procurator's petition relates mainly to the assimilation of the law of Scotland to that proposed in the Bill with regard to certain points of procedure. The majority of the remaining petitions pray for a reduction of the fees, an extension of the duration of patents to twenty-one years, the restriction of the powers of the examiners, and the simplification of the mode of making application for the grant of letters patent.

National Health Society.—A course of lectures on the following subjects will be given, under the auspices of the National Health Society, in the rooms of the Social Science Association:—April 11—H. C. Bartlett, Esq., F.C.S., "The Chemistry of Every-day Food." May 10—Miss Florence Lees, "Nurses for the Sick." May 24—Miss Miranda Hill, "The Influence of Beauty on the Life and Health of the Nation." June 7—Samuel Wilks, Esq., M.D., F.R.S., "Our Predisposition to Special Forms of Disease." June 21—W. Eassie, Esq., C.E., "Healthy Houses." Communications to be addressed to the Secretary, 63, Berners-street, Oxford-street, W.

The Vanilla Culture.—The great demand for vanilla that has sprung up during the last few years in the markets of Europe, has given a great impetus to its cultivation. To such an extent have plantations been multiplied in the island of Réunion or Bourbon, that it is reported the crop will probably, in two or three years, amount to fifty or sixty tons, being about three times the quantity exported in 1874. The cultivation is also carried on extensively in Madagascar and the Mauritius. The crop is a favourite one with the small proprietors, as provided the soil be fertile, moist, and shaded, it needs but a small space to accommodate thousands of plants, whilst at the present average price the crop yields to the cultivator a profit exceeding that obtained from any other grown in the island. The cultivators are represented, however, as having been recently very much disturbed by a report which has reached the islands, but which is received with a certain amount of doubt, that a German chemist has succeeded in extracting from the pine tree an essence of which the perfume is identical with that of vanilla, and which can be offered in the market at a very reduced rate.—*Pharmaceutical Journal.*

NOTICES.

SUBSCRIPTIONS.

The Lady-day subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

May 17.—"Railway Safety Appliances," by F. J. Bramwell, Esq., C.E., F.R.S.

May 24.—*The same continued.*

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

May 30.—"The Development of Central Africa," by Edward Hutchinson, Esq., Lay-Secretary of the Church Missionary Society.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

May 26.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood. Andrew Cassels, Esq., will preside.

Mr. Tayler's Paper on "The Wonders of Trees in India," is unavoidably postponed.

Chemical Section.

Friday evenings at 8 o'clock. The following arrangements have been made:—

May 12.—"Salt Cake, with Special Reference to the Hargreaves-Robinson Process." By John Morrison, Esq., of Newcastle-on-Tyne. Mr. W. Weldon will preside.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...Society of Engineers, 6, Westminster-chambers, 7½ p.m. Adjourned Discussion on Mr. Trewman's Paper on "Flues and Ventilation," and on Mr. Pearse's Paper on "The Ventilation of Buildings."
Royal United Service Institution, Whitehall-yard, 8½ p.m. Mr. H. Reece, "Reece's Plan of Raising Sunken Vessels by the Employment of Submarine Production of Hydrogen Gas as a Raising Power."
National Indian Association (at the House of the Society of Arts), 8 p.m. Miss Carpenter, on her "Recent Visit to India."
British Architects, 9, Conduit-street, W., 8 p.m. Messrs. A. Norman and J. Hine, "The New Guildhall at Plymouth."
Social Science Association, 1, Adam-street, Adelphi, W.C., 8 p.m. Mr. E. L. O'Malley, "The Bill to Amend the Law relating to the Liability of Employers for Injuries Negligently Caused to Persons in their Employment."

Tues. ...Royal Institution, Albemarle-street, W., 3 p.m. Professor Duncan, "Geology and Physical Geographies of India, Australia, and South Africa." (Lecture IV.)
Loan Collection of Scientific Apparatus, South Kensington. Conference. "Physics, including Astronomy."
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Discussion on "Economy in Dead Weight of Railway Wagon Stock."
Institute of Mechanical Engineers (at the House of the Society of Arts), 2 p.m.
Statistical, Somerset House, W.C., 7¾ p.m. Mr. William Farr, "The Valuation of Railways, Mines, Telegraphs, and other Commercial Concerns, with Prospective, Deferred, Increasing, Decreasing, or Terminating Profits."
Pathological, 53, Berners-street, Oxford-street, W., 8 p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.

Wed. ...**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 8 p.m. "Mr. F. C. Bramwell, "Railway Safety Appliances."
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Robert H. Scott, "Remarks on the Present Condition of Maritime Meteorology." 2. Mr. James Glaisher, "The Mean Temperature of every day at the Royal Observatory, Greenwich, from 1814 to 1873." 3. Mr. C. N. Pearson, "The Meteorology of Mozufferpore, Tirhoot, for 1875." 4. Lieut.-Col G. E. Bulger, "New Wind Chart."
Pharmaceutical, 17, Bloomsbury-square, W.C., 11 a.m. Annual Meeting.
Loan Exhibition of Scientific Apparatus, South Kensington. Conference, "Mechanics."
Archæological Association, 32, Sackville-street, W., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.

Thurs...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Chemical, Burlington House, W., 8 p.m. 1. Mr. C. O. Sullivan, "The Action of Malt Extract on Starch." 2. Mr. J. W. Thomas, "The Gases Enclosed in Cannel Coal and Jet." 3. Professor Gladstone and Mr. Tribe, "Phenomena Accompanying the Electrolysis of Water, with Oxidisable Electrodes." 4. Dr. Thudichum and W. H. Hake, "The Estimation of Hydrogen Occluded by Copper, with especial reference to Organic Analysis." 5. Dr. Thudichum and Mr. C. T. Ringzett, "Some New Reactions of Hemine."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. Brindley Richards, "Ancient Music."
Royal Institution, Albemarle-street, W., 3 p.m. Professor Tyndall, "Voltaic Electricity." (Lecture IV.)
Loan Exhibition of Scientific Apparatus, South Kensington. Conference. "Chemistry."
Zoological, 11, Hanover-square, W., 4 p.m.
Numismatic, 13, Gate-street, W.C., 7 p.m.
Philosophical Club, Willis's Rooms, St. James's, S.W., 6 p.m.

Fri.......Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m. Mr. C. T. Newton, "Recent Discoveries at Olympia."
Loan Collection of Scientific Apparatus, South Kensington. Conference. "Physics, including Astronomy."
Philological, University College, W.C., 8 p.m. Annual Meeting.
Royal Botanic, Inner Circle, Regent's-park, N.W. 4 p.m. Profeseor Bentley, "Organs of Nutrition in Plants." (Lecture II.)

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. J. Furnival, "Chaucer." (Lecture II.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,226. VOL. XXIV.

FRIDAY, MAY 19, 1876.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The school was opened at 12 o'clock at noon, on Wednesday, the 17th May, 1876, by H.R.H. the Duke of Edinburgh, K.G., who was accompanied by H.R.H. the Duke of Connaught, K.G. There were present to meet their Royal Highnesses, Viscount Newry, Lord Clarence Paget, K.C.B., Lord Alfred Churchill, the Lord Mayor, M.P., Sir Henry Cole, K.C.B., Sir William G. Anderson, K.C.B., Sir Julius Benedict, C. J. Freake and Mrs. Freake, John Bath, Charles Morley, Thomas Chappell, P. Le Neve Foster, W. L. Cole, Alan S. Cole, John Hullah, LL.D., Professor Ella, Charles Hallé, Otto Goldschmidt, W. G. Cusins, Arthur Sullivan, (Principal), Ernst Pauer, Alberto Visetti, J. T. Carrodus, Lionel S. Benson, James Richards, with the Professors—W. C. Alwyn, John J. Barnett, Dr. Bridge, Miss Ferrari, W. H. Monk, Arthur O'Leary, Ebenezer Prout, Franklin Taylor, J. B. Welch, and Rev. J. Richardson (Registrar).

The members of the General Committee, the Board of Principal Professors, the officers of the school, and the visitors received his Royal Highness in the entrance-hall, and the Principal and the Registrar, with the Committee of Management, then conducted him into the various class-rooms, where the scholars in waiting were introduced to their respective professors.

The Scholarship founded by the Vintners' Company was competed for on Thursday, the 4th, and Saturday, the 6th inst., and has been awarded to Miss Heap. There were 10 candidates.

The two Scholarships founded by the Clothworkers' Company were competed for on Thursday, the 4th, and on Saturday, the 6th inst., and have been awarded to Mr. F. Dove and Miss Beney.

The ten Scholarships' founded by the Corporation of the City of London, are being competed for at the Fishmongers'-hall. There are upwards of 150 candidates.

Competitions for Scholarships have been held at Birmingham, where three scholars have been elected, and at Nottingham, where two scholars have been elected.

Two new Scholarships have been founded for London, one by Mr. Berkeley Field, and one by Mr. Howard Morley.

Several persons having undertaken to subscribe various sums towards the establishment of a £40 a-year Scholarship, for five years, the Secretary of the Society of Arts has obtained the consent of these persons to put these sums together, and, as soon as the annual £40 scholarship is completed, to nominate to it one of the candidates already selected by the Society's examiners as qualified Upwards of three-fourths of the annual £40 has already been subscribed, and the Secretary seeks the aid of the members to enable him to complete it, and solicits from them annual subscriptions of one, two, three, or more pounds per annum for this purpose.

MEMORIAL TABLETS.

Tablets have been set up during the past month on houses formerly lived in by the following distinguished men.

Samuel Johnson—17, Gough-square, Fleet-street.
Edmund Burke—37, Gerrard-street, Soho.
George Canning—37, Conduit-street.
Michael Faraday—2, Blandford-street, Portman-square.
David Garrick—5, Adelphi-terrace.
Horatio Nelson—147, New Bond-street.
Mrs. Siddons—27, Upper Baker-street.

The following is a list of tablets previously erected:—

John Dryden—43, Gerrard-street, Soho.
John Flaxman—7, Buckingham-street, Fitzroy-square.
George Handel—25, Brook-street.
Benjamin Franklin—7, Craven-street.
Sir Joshua Reynolds—47, Leicester-square.
Lord Byron—16, Holles-street, Cavendish-square.
Napoleon III.—3a, King-street, St. James.

HEALTH AND SEWAGE OF TOWNS.

The Conference on this subject was held, as announced last week, on Tuesday, Wednesday, and Thursday, the 9th, 10th, and 11th inst. It was attended by over 200 representatives from various localities. The chair was taken in the first instance by the Rt. Hon. JAMES STANSFELD, M.P., whose opening address was given in the last number of the *Journal.* He was succeeded in turn by Lord ALFRED CHURCHILL, Sir HENRY COLE, K.C.B., Captain DOUGLAS GALTON, C.B., F.R.S., and General COTTON, R.E., C.S.I. The discussion followed the programme given in the *Journal* of May 5th. The papers on the various systems

were taken as read, the author of each being allowed five minutes to state its substance. Questions relating to the system under discussion were then answered by the reader of the paper, or representatives of the locality where the system was applied. The first and second days were devoted to the discussion of water-carried sewage, and on the third day the dry systems and foreign systems were treated.*

The following are the papers brought before the Conference which deal with water-carried sewage. They are arranged in the order of their discussion.

FINANCIAL ACCOUNT OF THE BEDDINGTON SEWAGE FARM.

By Alfred Carpenter, M.D.

It will be interesting to this Conference to know the actual cost which the Beddington sewage farm has entailed during the past ten years upon the ratepayers of the parish of Croydon. I obtained the information as to the actual figures from the accounts which have been year by year published according to law by the Local Board of Health, and which accounts have been audited by the Government auditor. They show receipt and expenditure only, and are not a correct view as to profit and loss, such as an accountant would draw out, but they show the real burden which has been entailed upon the parish of Croydon by the utilisation of the sewage upon land. There will not be much difficulty in apportioning the items to their proper position in the matter.

The first portion of the farm was laid out as a sewage farm in the year 1860, it was taken on lease by the Board when they were in great straits and under heavy penalties, the then leaseholder was paid out at some cost, and the land laid down for the purposes of irrigation in the cheapest possible way. It was then leased for a term of years to Mr. Marriage. The accounts as published commence with a simple statement of receipts from Mr. Marriage, and of rents paid to the ground landlord. How Mr. Marriage fared cannot be shown, but if his evidence, as given to the Commissioners appointed to investigate the subject of the utilisation of sewage, is to be considered as correct, he was not dissatisfied with the result. In addition to these simple sums, there is a charge on the one side of wages paid to a herd of foremen employed by the Board, who made a daily report as to the condition of the effluent water at the outfall, and also the costs incurred in straining the sewage of its more solid matter before it passed on the land. On the other side is placed to the credit of the Local Board the sum which accrued by the sale of the solid manure thus obtained.

The year 1871 shows a great increase in the amounts. The rapid growth of the town of Croydon soon made the 300 acres which were used for the purpose quite unable to cope with the quantity of sewage which reached the outfall. It became necessary for the Board to acquire extra land. The negotiations for this purpose were conducted as such negotiations generally are when the negotiators are bidding for popular favour. The shadow is grasped instead of the substance, and the interests of the parish were sacrificed. Everything connected with this negotiation was publicly known, the owners of property knew the position of the Board, and with their own agents among the members of the Board, they knew how much rent it was possible for them to get, without any reference to the real value of the land. The Board, advised by their engineer, declined to deal with Mr. Marriage, but leased the whole of the farm to a company, which was ostensibly got up for the purpose of taking it over, and was called the Croydon Sewage Farming Company. Arrangements were made that the company should pay rent in advance, on somewhat corresponding terms with those under which Mr. Marriage held the land, which appeared to make the Board stand in the position of receiver of rents, paying them over at the end of each quarter to the ground landlords. The company paid no valuation for going in beyond sums for ordinary fixtures and small matters left in the land by Mr. Marriage. The company commenced their work with a real capital of £1,500 (the nominal being £10,000), sufficient to pay the first quarter's rent. They borrowed money of their bankers to pay their wages sheets instead of making calls, paid handsome sums to their directors, clerks, managers, and other advisers; then 15 per cent. dividend on their first year's work, nothing whatever on the second, and collapsed altogether on their third. The Board had then to step in and become the actual managers of the farm, after it had been allowed to get into a ruinous condition by those who were totally incompetent to look after so large an interest. Good fortune, however, even now did not forsake them, for while they paid no valuation on going into the land, the lease had been so drawn that when it ended they were to receive a valuation, according to the custom of the country, and under that clause the arbitrators and umpire again saddled the Croydon ratepayers with an enormous sum as valuation, and in the payments for 1874, figures the sum of £5,238 paid to the receivers of the farming company—a large portion of which ought never to have been paid at all—consisting of items for rye grass cultivation, rents, and fallows, which were not paid for when the company took possession. However, the substantial shareholders in the company were some of the inhabitants of Croydon, and they got back a large part of that which they had invested, notwithstanding the heavy items with which the management has been weighted. The tables show that the receipts which have been obtained by the Local Board, amount to the aggregate sum of £39,317 14s. 3d., whilst on the other side the payments have been £50,605 13s. 4d. This total shows a balance against the ratepayers of £10,891 19s. 1d.; this item, however, may be fairly reduced by the sum of £5,450 2s. 7d., which was the valuation of the stock, produce, and fixtures on the farm, on the 25th of last March, according to a valuation made by the farm manager, and which is on the basis of that allowed to the company. This table gives, therefore, an average loss of £500 a year. I have appended the

* A report of the discussion will be issued in subsequent numbers of the *Journal*. For the convenience of those wishing to have the account of the proceedings in a more compact form, the same will also be published as a pamphlet, which can be had (as soon as ready) on application at the Society's House. Price 2s. 6d.

BEDDINGTON FARM.

CONDENSED STATEMENT OF RECEIPTS AND PAYMENTS.

Year ending Lady-day.	Receipts.	£ s. d.	£ s. d.	Payments.	£ s. d.	£ s. d.
1867	Sewage manure	70 8 0		Rent	1,149 6 4	
	Rent	1,475 0 0		Foreman	70 4 0	
			1,545 8 0			1,219 10 4
1868	Sewage manure	83 10 0		Rent	996 18 0	
	Rent	1,475 0 0		Foreman, &c.	59 8 7	
				Filter Beds	165 4 8	
			1,558 10 0			1,221 11 3
1869	Sewage manure	100 0 0		Rent	1,047 4 0	
	Rent	1,462 10 0		Foreman, &c.	58 16 0	
				Filter Beds	158 10 6	
			1,562 10 0			1,264 10 6
1870	Sewage manure	85 8 0		Rents	1,491 4 5	
	Rent	1,240 0 0		Foreman	52 0 0	
				Filter Beds	158 10 6	
			1,325 8 0			1,701 14 11
1871	Sewage manure	41 5 0		Rent	2,139 14 3	
	Rent	960 0 0		Rates, tithes, &c.	95 13 6	
	Rent (Croydon Farming Company)	1,770 0 0		Valuation, &c.	355 3 7	
	Sales of grass, &c.	2,055 9 2		Cultivation	1,155 10 4	
			4,826 14 2			3,746 2 0
1872	Rent (Croydon Farming Company)	2,000 0 0		Rent	3,103 14 0	
	Cultivation repaid by Croydon Farming Company and valuation	1,532 9 2		Receipts repaid to Croydon Farming Company	1,645 10 5	
	Sales	287 10 11		Works, &c.,	433 13 2	
			3,820 0 1			5,182 17 7
1873	Rent (Croydon Farming Company)	2,207 5 11		Rent and insurance	3,107 1 11	
				Rates, tithes, &c.	45 1 9	
				Planting trees	51 5 0	
			2,207 5 11			3,203 8 8
1874	Rent, half-year (Croydon Farming Company)	1,800 0 0		Valuation	5,238 18 7	
	Interest, &c.	103 2 6		Purchase of stock	910 7 6	
	Valuation, &c.	316 19 6		Allowance for repairs to Croydon Farming Company	180 0 0	
	Fine on surrender	500 0 0		Rents	3,117 4 2	
	Sales, &c.	6,131 16 1		Repairs	105 12 5	
				Rates, tithes, and insurance	418 17 0	
				Cultivation	3,389 19 8	
			8,851 18 1			13,351 19 4
1875	Rents	120 0 0		Rents	3,279 2 6	
	Sales, &c.	7,136 0 0		Rates, tithes, and insurance	568 4 4	
	Milk			Purchase of stock	764 2 2	
	Stock			Fencing and gates	376 14 4	
	Grass			Repairs, asphalting, &c.	239 19 9	
	Manure			Mr. Blake's charges	146 10 5	
	Vegetables			Cultivation and management	5,261 11 7	
			7,256 0 0			10,636 5 1
1876	Rents	140 0 0		Rents	3,530 6 8	
	Sales, &c.	6,620 0 0		Rates, tithes, and insurance	502 19 10	
				Purchase of stock	282 5 0	
				Repairs, &c.	169 10 0	
				Messrs. Blake and West's charges	146 13 7	
				Cultivation and management	4,445 18 7	
			6,760 0 0			9,077 13 8

Receipts.	£	s.	d.	Payments.	£	s.	d.
1867	1,548	8	0	1867	1,219	10	4
1868	1,558	10	0	1868	1,221	11	3
1869	1,562	10	0	1869	1,264	10	6
1870	1,325	8	0	1870	1,701	14	11
1871	4,826	14	2	1871	3,746	2	0
1872	3,820	0	1	1872	5,182	17	7
1873	2,207	5	11	1873	3,203	8	8
1874	8,851	18	1	1874	13,351	19	4
1875	7,256	0	0	1875	10,636	5	1
1876	6,760	0	0	1876	9,077	13	8
Total	39,713	14	3	Total	50,605	13	4
					10,891	19	1

	£	s.	d.
Value of stock and produce on the farm, March 25th, 1876	5,450	2	7
Loss to the parish of Croydon on ten years' working	£5441	16	6

BEDDINGTON FARM.

STATEMENT OF RECEIPTS AND PAYMENTS FOR THE YEAR ENDING THE 25TH MARCH, 1876.

RECEIPTS.

	£	s.	d.
Sale of Milk ..	825	9	11
,, Grass	1,973	0	9
,, Mangold	707	3	9
,, Wheat	126	11	3
,, Straw	52	18	0
,, Cabbages	673	10	0
,, Potatoes	251	19	3
,, Roots	0	10	0
,, Swedes	2	10	0
,, Walnuts	5	14	0
,, Hay	308	0	0
,, Seeds	2	1	0
,, Wallflowers	0	5	0
,, Greens	296	14	1½
,, Parsnips	2	16	2
,, Onions	95	8	1
,, Spinach	24	17	4
,, Rhubarb	76	12	8
,, Brocoli	36	3	4
,, Celery	257	18	3½
,, Sage	73	11	7½
,, Parsley	50	5	0½
,, Herbs	7	0	0
,, Leeks	9	12	0½
,, Radishes	16	2	8
,, Lettuce	4	7	6½
,, Broad Beans	20	8	0
,, French	8	11	6
,, Marrows	10	13	11½
,, Peas	3	14	0
,, Cattle	505	12	0
,, Implements	24	16	6
,, Sewage Manure	15	8	9
Horse Hire	5	12	0
Keep of Stock	141	11	6
Miscellaneous	2	10	0
Rents, Mr. Leeks	20	0	0
,, Moody	100	0	0
,, Shaw	20	0	0
	6,760	0	0½
To Balance	2,317	13	8
	£9,077	13	8½

PAYMENTS.

	£	s.	d.	£	s.	d.
Wages, General Labour	1,699	10	0			
,, Market Garden	993	7	8			
				2,692	17	8
Managers' Salaries				212	6	8
Insurance				16	8	5
Rates, Taxes, &c.				486	11	5
Printing and Advertising				15	19	10
Seeds				279	8	3
Implements				53	2	8
Forage				806	17	5
Coals				10	17	6
Gas				8	13	7
Threshing				34	17	1
Veterinary Charges				48	16	0
Ironmongery				69	15	0
Harness and Repairs				15	9	11
Repairs to Waggons				82	11	7
Purchase of Cows				245	10	0
,, Horse				36	15	0
Repairs				86	18	5
Horse Hire				14	8	0
Smiths' Work				1	16	2
Iron for Smithy				5	1	6
Disinfectants				2	13	6
Bricks, Lime, Cement, &c.				16	6	4
Thatching Rods				8	17	0
Timber				27	0	9
Rick Cloth and Mats				20	10	4
Grubbing Straw				12	0	0
Mr. Blake's Charges (Auction sale charges)				81	6	10
Mr. West's Charges (Legal charges connected with leases)				65	6	9
Commission, Sale of Vegetables				85	14	7½
Sundries				2	8	10
Mr. Quilter, Rent				1,388	6	8
Mr. Beddington, Rent				1,745	6	8
Dr. Shorthouse, Rent				396	13	4
				£9,077	13	8½

RECEIPTS, 1875.

	£	s.	d.
Rents	120	0	0
Vegetables	2,493	5	2
Grass	2,275	5	11
Milk	847	8	1
Wheat	252	10	0
Mangolds	301	7	3
Straw	52	12	0
Tares	33	0	0
Keep of Stock	159	16	6
Sale of Cattle	658	15	10
Sundries	61	19	3
	£7,256	0	0

PAYMENTS, 1876.

	£	s.	d.
Rents	3,279	2	6
Rates, &c.	568	4	4
Wages, &c.	3,135	2	6
Repairs, Fences	616	4	1
Stock	764	2	2
Forage	663	19	10
Commission	122	18	8
Horse Hire	169	5	6
Seeds	240	15	6
Arbitrator &c.	146	10	5
Sundries	466	9	7
	£10,136	5	1

PARK FARM, BEDDINGTON.—VALUATION, MARCH 25TH, 1876.

	£	s.	d.
Cultivation	667	13	0
Rents, &c.	1,169	3	4
Mangolds on hand	160	0	0
Oats	78	0	0
Melon plants	25	0	0
Seeds	5	0	0
Implements	593	8	11
Forge tools	31	16	4
Farm horses	603	0	0
Cattle	1,902	0	0
Manures	125	1	0
Farm fixtures	75	0	0
Timber	15	0	0
	£5,450	2	7

[Number of cattle bred on farm, and included in above valuation 56.]

	£	s.	d.
Value of cattle on farm, March 25th, 1876	£1,902	0	0
Value of cattle on farm, March 25th, 1875	1,127	0	0
Increase	£775	0	0

GEORGE HORSLEY, Manager.

details of the past two years, from which it will be seen that a local board labours under very great disadvantages in carrying on a business like a farm. The wages sheet alone will prove this, for there is no one whose pecuniary interest it is to keep down the expenses. Idle hands are retained, and every man's hand is against the local board, and in favour of the private individual, whilst the managers themselves, as soon as they become aware of the work that is before them, make violent enemies of those men whom they have prevented from fattening on the rates. But they make few active friends among the better class of the community, who decline to take part in local politics. The result is, that at the next election the management is changed, and most of the advantages of former experience are lost. Still, notwithstanding all the disadvantages of the case, and taking the last year as a guide, it will be seen that the balance against the parish upon the working of the farm is £2,317 13s. 8d., but against this may be set-off the increase in the value of stock upon the farms, which amounts to the sum of £775, leaving a charge upon the rates of about £1,542 ; this amounts to the sum of a little more than one penny in the pound upon the rating of the parish.

It is right to mention that no account is taken of the purchase of 65 acres of the land in question, which is now the freehold of the Local Board. For this land £8,000 was paid, and a rental should be charged on account of it. Nothing is charged in the accounts for expenses incurred in laying out the land in the first instance, which cost £4,010 ; and no account is taken of the first outlay for sewers. These would have to be made under any system of sewerage, and should not be taken account of in weighing the pecuniary merits of a sewage farm. If, however, it should be thought right to charge for laying out the land, and a rental for the freehold, a further sum of £750 a-year must be added, raising the total cost of the farm to a rate of something under $1\frac{3}{4}$d. in the pound upon the rateable value of the parish. Against this, however, may be put, as a set-off, the fact that there are expenses which have been incurred in the first years of the farm of the character of unexhausted improvements, which will, year by year, be adding to the income, whilst the expenditure will not again recur. I should have said that the land is leased for 21 years from 1871 ; long before that time is out I trust the utilisation of sewage will be so understood as to render it unnecessary for a renewal of the leases upon the present onerous and unsatisfactory basis. If the whole of the land had been obtained on the same terms as were the 56 acres before alluded to, the whole of the sewage of Croydon would have been utilised without any cost at all to the inhabitants of Croydon; and even now, if the farm could be managed in a satisfactory manner, the receipts would be quite equal to the payments, notwithstanding the rental of £10 an acre, which has to be paid for a large portion of the land.

One word, in conclusion, as to the effect upon the health of the district in which the farm is situated. The last return of vital statistics shows that 26 deaths and 60 births have been registered as occurring in the sub-district during the past half-year. This fact bears a most important relation to the working of the farm. The neighbourhood is yearly increasing in population, rateable value, and general health, notwithstanding the fact that during the past year the farm has had to provide for and utilise the sewage of a very large number of persons who have suffered from typhoid fever—a fever which has been mainly induced in Croydon through an interference with the water supply of the district. The births in Croydon itself for the month ending April 29th last have been 96, whilst the deaths have numbered 35, and typhoid is now entirely absent from the list. The farm has, however, utilised and rendered innocuous all the typhoid excreta from nearly 1,000 cases which have reached it since January 1875, without the least injury to the inhabitants of the sub-district itself; but that part which was retained in badly-constructed sewers in Croydon, and had an opportunity given to it to change the form of its elements, and produced much mischief to those who had the misfortune to live upon the lines of the badly-constructed and imperfectly-ventilated sewers. My own impression is still, that the sooner sewage is conveyed to the country and at once utilised the better for the town. The receipts and vital statistics now published I think prove that it is also no drawback to the land itself. There is one other point worth mentioning as decreasing the value received from the farm; the great amount of water which has had to be dealt with during the past year decreased returns. Excessive flushing of sewer and heavy rainfalls, much of which still passes into the Croydon sewers, have taxed the land to the uttermost. This year will see an improvement in that direction; a large part of the surface water will be abstracted from the sewers and sent into its proper channels. The market gardening also has been given up in consequence of the impossibility of a local board dealing properly with such grounds. I look, however, to the accounts for the year now commencing as likely to give a better idea of what a sewage farm will be able to do under present management than any that has yet preceded it.

NOTES ON THE ETON SEWAGE IRRIGATION FARM.

Eton, with an urban sanitary district of about 3,500 including the school, was the first town on the upper Thames which diverted its sewage from the river. It is drained on the separate system, viz., the exclusion of all surface and storm waters from that of the sewage; this exclusion has been successfully effected, although the exclusion of subsoil waters, owing to broken pipes or imperfect joints, has not been quite so successful. In the case of subsoil water being raised by floods, an addition of about one-fourth the time required for pumping is necessary.

The receiving tank is situated about 1,000 yards below the nearest houses in the district; 600 yards above the tank is an outlet to the river for use only in cases of absolute necessity, but this is not now required, as the engines and pumping machinery are in duplicate. The rising main that carries the sewage to the farm is $1\frac{3}{4}$ miles in length, about 80,000 gallons being pumped through daily, taking on an average from 5 to 7 hours, which time is divided between the morning and the afternoon.

The farm, consisting of about 40 acres, of which some 30 acres only are laid out for irrigation, is situated at a distance of half-a-mile from the river; the soil is very light, with a depth from one to three feet of vegetable mould (irregular from levelling), overlying fine alluvial gravel and sand, the upper surface about 10 to 12 feet above the ordinary level of the river; one-third of the land laid out for irrigation is cropped with rye grass, one-third with root crops, and the remaining third with cereals, this last, however, not being irrigated, thus it will be seen about 20 acres only are irrigated in each year.

The Rev. C. Wolley Dod, chairman of the Eton Local Board, to whom the Council are indebted for these notes, states that the system has now been in successful operation for six years, yielding an annual profit from the working of the farm of about £120, equal to a rental of £3 per acre, excluding in calculation interest on capital and the expenditure for pumping, which alone amounts to about £340. Milk (fed on the sewage grass) is said to be of very good quality.

At a depth of about eight feet more or less the subsoil water is reached, yet under no circumstances is there ever one drop of effluent water from the land. Agricultural pipes laid four feet deep in a road across the middle of the farm never run a drop, in fact, everything put on the land, even in the wettest weather, is absorbed at once; a whole day's pumping of 80,000 gallons has been run upon a space of about three square chains, when all disappeared in less than an hour after pumping had ceased.

It is found very difficult to distribute the sewage evenly; in winter, when no growth has taken place, as also in summer, with the root crops a large proportion of the sewage must escape root action, and descend to the subsoil unpurified, except by filtration through the soil and gravel. What then becomes of it is a problem of great importance, although in the comparatively small quantity dealt with at the Eton farm, on so large a surface, the question hardly arises, yet as towns in the Thames valley seem to be for the most part adopting the system of sewage irrigation, and in consequence of the disappointing results financially of sewage farming, local boards will probably be disposed to put as large a quantity of sewage as possible on a small surface of land.

It is gathered, therefore, from the above-mentioned facts, taking the population of the district in rough numbers at 3,000, that one square chain will absorb the sewage of 1,000 people, thus giving with sufficient pumping power an absorbing capacity of 10,000 gallons per acre in six hours, or 40,000 in the twenty-four hours; but of course this could not last.

The subsoil water is generally presumed to flow in a course more or less parallel to the river, although no positive proof of this is obtainable. It is stated in a paper on the subject by Mr. Menzies, that at old Windsor he found the subsoil water moving parallel with the river at a rate of about half a mile in twenty-four hours; but his experiments, he also mentions, were made when the river was rising rapidly. The question is an important one, whether the sewage, after sinking vertically to the subsoil water, at a depth of eight feet, continues to sink, or at once begins to flow horizontally. The permeable strata underneath are of unknown depth. The alluvial drift is estimated in the Ordnance Geological report at from 20 to 30 feet, immediately below which comes the chalk.

Last year attempts were made at Eton to trace the course of the upper subsoil waters; holes were dug on the farm to the subsoil, and filled with sewage, into which was put chloride of lithium. Samples of the water from the neighbouring wells, examined with the spectroscope, gave no result; holes were then dug within a few yards of the first holes, but the subsoil water from these showed no trace of lithium; it is possible, however, that the chloride of lithium may have been converted into the oxide or carbonate, and so remained fixed. The experience at Eton, therefore, rather leads one to suppose that the width and depth of the volume of subsoil water all round the farm is so great, that the effect of the sewage, so far as analytical tests are concerned, would be lost almost directly, and that samples of the subsoil water taken on the line of its flow, 100 yards above and 100 yards below the farm, would not show and appreciable difference.

INTERMITTENT DOWNWARD FILTRATION.

By J. Bailey Denton.

As my name has been much associated with the process of intermittent downward filtration, from the fact that I was the first to adopt and put to the test the suggestions of Dr. Edward Frankland, I shall probably best respond to the invitation I have received, if I place before the meeting the results arrived at up to this time.

The experience already gained in intermittent downward filtration not only proves that a comparatively small area of suitable soil will cleanse effectually the sewage discharged from towns and villages, and relieve our rivers and streams of pollution, but that by a combination of the process with other modes of treatment the best chance may be secured of a profitable return from them. We have now had sufficient trial of actual works to assure us, first, that the suggestion which Dr. Frankland based upon his laboratory experiments, to the effect that an acre of suitable soil drained six feet deep, and used intermittently, would cleanse the sewage of 3,300 people, can be realised; and, second, that if modified by the arrangement which I have frequently advised of trebling that quantity of land, so that instead of one area three areas of equal extent should be available, each capable of cleansing the whole of the sewage and of growing crops at the same time, the objections Dr. Frankland anticipated when suggesting the process may be entirely removed. Those objections it will be remembered were that—

"1. The process would be entirely unremunerative, the amount of sewage applied to a given area of land being probably in such a case too great to permit of the growth of any ordinary agricultural crop; 2. The whole of the manure ingredients of the sewage would be absolutely wasted; and 3, the collection of solid fæcal matters upon the surface of the soil, with no vegetation to make use of them, would probably give rise to a formidable nuisance, especially in hot weather."

By trebling the quantity of land, it becomes an easy matter to grow crops, and remove all chance

of overcharging the soil and causing a nuisance. Each area (one-third) should be used for the purification of the sewage for one year at a time only, whereby two areas (two-thirds) out of the three would be devoted for two years in succession to full plant growth, while the area in constant use would grow what it could.

The repeated analyses which have been made by the Rivers' Pollution Commissioners, by the Sewage Committee of the British Association, by Mr. Dyke the medical officer of Merthyr district, and by Dr. Paul, of London, of the effluent water from the intermittent filtration areas at Merthyr Tydfil —the first place at which intermittent filtration was designedly adopted—prove not only the soundness of Dr. Frankland's views, but that the objections constantly raised by other persons, that the pores of the soil, when subjected to the cleansing of so large a quantity of sewage, would become "choked," and the land gradually become less active and effective as a filter, were entirely unfounded.

Although experience at Merthyr, Kendal, Walton Convalescent Hospital, and other places, has most conclusively shown that one acre of suitable land will efficiently and for a constancy cleanse the liquid refuse of 1,000 people, a fact, the importance of which cannot be over-estimated in those cases where land is very difficult to get and very expensive when obtained, I may be pardoned for stating that I do not wish to be considered the advocate of dealing with the sewage in such a concentrated form under all circumstances. After devoting thirty-five years to the improvement of landed property with a view to the increase of food produce, I cannot look upon sewage as a substance to be entirely sacrificed, but consider in spite of the difficulties that seem to beset the question and stand in the way of profit, that it is clearly our duty so to treat the liquid refuse of our towns and villages that we may be able to turn to account its fertilising elements wherever and whenever it is possible to do so with advantage to those communities whose money is employed in its removal and disposal.

To effect this, intermittent downward filtration should be combined with surface irrigation in every case where land is resorted to. By this means sanitary authorities may "cut their coat according to their cloth" and use effectively whatever extent of land they can obtain on fair terms. Even in dealing with the sewage of seaboard towns and towns on tidal rivers where it may be better to resort to chemical processes (to precipitate the solid matters and convert them into a portable manure) than to use land, the perfect cleansing of the effluent may in like manner be economically secured by supplementing the process adopted by intermittent downward filtration through a much reduced area of land.

It is the want of the combination referred to in ordinary sewage farming that constitutes the principal reason why it has not found the favour to which it is undoubtedly entitled. Both the practical farmer and the market gardener naturally declined to take upon themselves the obligation of disposing of any quantity of diluted sewage that may be discharged from a town at all times and under all circumstances, for they cannot then be masters of their own proceedings. By combination this objection is removed. A certain proportion of land, say one acre for every 3,300 of the population, is then specially prepared, upon which the sewage may be discharged whenever it may be disadvantageous to the farmer or gardener to apply it to his crops, and he has then no ground for objection.

With these general deductions from past experience, I will now explain the position of the two leading cases in which intermittent downward filtration has been adopted—Merthyr Tydfil and Kendal—merely premising that the number of cases in which intermittent filtration is now being adopted is considerable, and that it is increasing every day.

In the case of Merthyr Tydfil I was put into action by an order of the Lords Justices of Appeal in Chancery in the case of Attorney-General v. the Merthyr Tydfil Board of Health to devise a means of relieving the river Taff temporarily from the pollution caused by the influx of the sewage of Merthyr Tydfil, the Local Board of that district having at the time when the order was given, obtained an Act for the purchase of nearly 400 acres of land, upon which the sewage of the district was to be applied by way of surface irrigation only. It was considered that the execution of the work would take up much time, and the direction of the court therefore was that I should adopt such interim expedients as would remove the nuisance without loss of time. It is necessary that this should be understood, for the works which were devised by me were executed by the local surveyor in such a manner—it may be from a belief that they were only of a temporary character—that nothing but failure could have resulted if a second order had not been issued by the Court to the effect that I should not only direct what should be done, but should actually superintend the execution of the work. It was at this juncture that I conferred with the Merthyr Local Board, and strongly advised them to allow the filtration areas to be completed in accordance with my original report to the Lords Justices, not as temporary works, but as part of their extended arrangements. I am glad to state that this proposition was met in a liberal spirit, and directions were given to complete the areas in a substantial manner.

At the same time, it should be remembered that the Local Board were proceeding with their original scheme of wide irrigation.

Anticipating that the completion of the irrigation farm would be interpreted by the public as meaning an abandonment of the filtration areas, I felt it my duty to ascertain the views of the Local Board upon the subject. A correspondence ensued between the chairman and myself which will at once remove any such impression, and satisfy the most sceptical that the value of intermittent downward filtration is as great in combination with surface irrigation on a wide area as when adopted by itself on a small one. In my letter to the chairman, dated May 11th, 1875, I said:—

"A report has just reached me, by which I gather that it has been proposed to break up the intermittent filtration beds in order that the ground at Troed-y-rhiew may better conform to wide surface irrigation. Knowing how opposed your surveyor, Mr. Harpur, was to my

interference under the order of the Court of Chancery, and how earnestly, and I may say naturally, he has endeavoured to justify the intended purchase of the 393 acres, for which your Board obtained Parliamentary powers, and which necessitated the construction of the expensive conduit conveying the sewage for a distance of five miles below the filtration areas, I was prepared for such a step as that to which my attention has now been called. . . . . .

I should not, however, have presumed to proffer any opinion nor say a word on the subject, were it not more than probable that the public will assume that the filtration areas, which were originally intended by me as a temporary means of relief from nuisance, but which your Board determined to retain as permanent works, have proved to be a failure, and consequently have been condemned by your Board in favour of wide irrigation.

. . . . .

Will you kindly say if your Board has changed its mind as to the retention of the filtration areas as part of its permanent works, and if so, what has led to such change? . . . .

I press this—I hope not objectionably—because it is certain that with a properly devised filtration arrangement in connection with wide irrigation, not only may purification be permanently secured, which cannot as certainly be the case if wide irrigation alone be adopted; but with the capability of turning the sewage into the filtration areas when it is not wanted on the irrigation ground, a better return may be secured from the sewage than can otherwise be the case. . . .

I am glad to find that Mr. Dyke has the same confidence in the permanency of their action as I have. In his letter to me of the 6th May last, he says: 'There is still no evidence of any clogging or oversaturation of the beds.'"

In reply, the Chairman (Mr. Jones) stated on the 21st May last (1875):—

"It will be as well, perhaps, if I here clear up one point with respect to the land taken and about to be taken, which I think is not well understood. The quantity scheduled is 400 acres, divided as follows, viz.:—

	a.	r.	p.
Land under filtration, areas......	20	0	0
,, suitable for wide irrigation..	305	3	13
,, rough and unsuitable	40	0	1
,, under roads and streams	34	0	36
	400	0	0

"I also desire to disabuse your mind that the Board contemplates the abandonment of the filtration areas. It contemplates nothing of the kind, but looks upon them as being that which cannot be described better by any other term than the one you use, namely, a 'safety-valve.' In fact, so satisfied is the Board with the principle of downward filtration as the purifier of a large quantity of sewage on a small area, that Mr. Harpur has just designed for the disposal of the sewage of a population outside our main drainage according to that principle, and we are seeking for powers under a Provisional Order to obtain land compulsorily for that object.

"I may also add that we have it in view, if the land we shall have acquired be found to be too limited for wide irrigation, to lay out a set of filter beds on the Park Newydd Farm, which we have just bought."

To which Mr. Jones added that they had now "adopted the system of wide surface irrigation, combined with intermittent downward filtration; and, having committed ourselves to a combination of those systems, we must direct our attention to carry them through to the most perfect state of completion that we possibly can."

If anything more than this is needed to prove the thorough success of the intermittent downward filtration work at Merthyr, I cannot do better than point to the following passages of a letter from Mr. Dyke, the medical officer of the district, who wrote me as lately as July last in the following terms:—

1. "That the passage of the strained sewage in the carriers and on the prepared areas is effected without creating the slightest nuisance, without any appearance of unsightliness, and without any objectionable odour.

2. "That the effluent water discharged from the main exit is far purer than the water supplied for domestic use to London or Oxford.

3. "That the amount of nitrogenous matter in solution in the water does not exceed one part in two hundred thousand parts, and that this nitrogen is oxidated and is in combination with lime or potass, &c.

4. "That the water may be safely drunk, and that in fact it is used by the men and boys employed on the farm. No ill result has been known to occur.

5. "That the vegetables produced on the areas are consumed by the public resident in Merthyr, and that no evil results have followed, Diarrhœa is a disease which would result from the use of bad vegetables. The Registrar-General drew especial attention to the fact that the mortality due to diarrhœa was less in Merthyr than in any town in the kingdom.

6. "The sewage areas have been at work since the spring of 1871, and there has never been any sign of clogging or over saturation."

I have been thus explicit in the matter of Merthyr Tydfil in the hope of removing any false impression that may have gained ground from the circumstances here relatated.

At Kendal, where there is a population of 13,500, the intermittent downward filtration work has hitherto been confined to about five acres of land, contrary to the advice which I gave the Corporation when first consulted, to the effect that 15 acres should be prepared. The experience gained on these five acres surpasses all expectation. It confirms, nevertheless, the opinion already stated, that the proper proportion of sewage to land should be that of 1,000 persons to an acre. In this view it appears that the Corporation now concur, for the sewage is not always confined to the five acres, but is occasionally applied also to the remaining ten acres which I had proposed should be prepared for filtration. The maximum quantity of sewage diluted with subsoil and surface waters amounts in times of heavy rainfall to 1,800,000 gallons per diem. The minimum quantity is 750,000 gallons, and the average may be taken at 975,000 gallons. The net surface of land to which this quantity of sewage has been daily applied, with occasional relief by distribution to the remaining ten acres, for the last two years is 4a. 2r. 25p., the remainder of the five acres being made up of roads, paths, &c.

The decision come to by the Corporation of Kendal to limit the filtration areas to five acres involved a much greater outlay per acre than would have been the case had the full quantity of 15 acres been prepared, inasmuch as the underdrainage below, and the surface carriers above were made of a capacity, and placed in a position to command the whole of the 15 acres. In spite of this, however, the charge upon the ratepayers, including the instalments to repay the cost of the land (£250 an acre), and the current expenses of labour, seed, &c., does not reach one penny in the £.

are quite at liberty to do so; and what I have stated to you on former occasions is fully confirmed by what I have noticed of the river since.—Believe me, dear sir, yours faithfully, (Signed)

JAMES WESTON.

J. C. Melliss, Esq.

COVENTRY.

By E. A. Purnell
City Surveyor.

In the year 1850, Coventry, like many other places, was compelled to take steps to improve its sanitary condition; the first step was to have a good survey made of the city, which was done by the Ordnance Surveyors; and upon its completion, the late Mr. Ranger, C.E., was engaged to devise a scheme of sewage which was completed in 1854, the outfall being into a small river called the Sherbourne, about one mile from the town. As the private drainage works developed themselves, great complaints began to be made about the foul state of the river, and in 1857 it was decided that filtering tanks should be constructed, which was done, at a cost (including four acres of land) of about £4,000. In 1858 these tanks were completed and used, the sewage passing through vertical filters, composed of coarse gravel, about 3 feet in thickness; in addition to this, the lime process was adopted, but after being tried for some considerable time, it was abandoned, not much benefit to the river being derived from it. As the present drainage works increased, so did the complaints about the effluent water, and in 1865 a meeting of the landowners along the course of the Sherbourne, below the outfall works, was held at the King's Head Hotel, Coventry, and a request made from them to the Corporation requiring an abatement of the nuisance. Things went on in the same unsatisfactory condition until 1868, when the Corporation purchased about 267 acres of land for the purposes of irrigation; this land adjoined the outfall, but the greater portion of it is hilly, and the sewage would have had to be pumped to a height of 150 feet. Mr. Thomas Hawksley, C.E., was employed by the Corporation to report upon the cost of laying out the land as a sewage farm, but his estimate was so high, that the Corporation shrank from embarking in so serious an undertaking, and matters still remained as they were. In 1869 the Corporation advertised the farm and sewage to be let on lease, unavailingly, for although several applications were made, nothing came of them. In 1870 proceedings were threatened by the landowners adjoining the river, and the Corporation entered into negotiations with the Peat Engineering Company, and also the A B C Company; but after long correspondence they were abandoned by both companies. At this time Dr. Anderson commenced experiments at the works, and in 1872, the General Sewage and Manure Company, having arranged with the Doctor for his patents, made arrangements with the Corporation, for a concession of the sewage to the company for 20 years. In 1873 the works were commenced, and in April, 1874, they were completed. A detailed description of the buildings, and mode of manipulating the sewage, will be found in the *Builder* of the 26th of February last.

The works have now been in operation for two years, and during that time no complaints have been made by the landowners, in fact the company's operations have had a most beneficial effect upon the river. With respect to the financial results I am unable to give any information, as, although the company have placed their books at my disposal, at any time, I have been unable to avail myself of their offer.

A few facts concerning Coventry may not be uninteresting. The population of the city is 40,000; rateable value, £101,000; cost of sewage, £33,000; number of water-closets, 4,510; number of privies, 800; and the effluent sewage as ascertained from gaugings, extendinging over a period of fifteen months, was 1,800 gallons per day; this quantity, in consequence of building operations, and a great improvement in the city, no doubt amounts now to 2,000,000 gallons per day.

The city is supplied with water from artesian wells, sunk in the new red sandstone, four in number; one of 410 feet, one of 300 feet, and two of 75 feet in depth. Thus water rises in a tank, 100 feet in diameter, and 16 feet in depth, and is pumped to a height of 140 feet into a service reservoir, commanding the highest part of the city. The number of houses supplied is 8,419, and the average quantity of water 700,000 gallons; no charge is made for water-closets. The cost of the waterworks was about £36,000.

THE PHOSPHATE SEWAGE COMPANY'S PROCESS.

By W. Keith.

The Phosphate Sewage Process is based upon the use of specially prepared phosphates of alumina and lime with sewage. The action of the prepared phosphates upon the sewage may be familiarly described as a curdling or coagulation of the fæcal matter in the sewage, giving it thereby a greater tendency to separate itself from the general bulk of water with which it has been intermixed. The next step is the use of lime, and this draws from the sewage the soluble phosphates which have been added in the process, forming therewith what is known as precipitated phosphate. The formation of this precipitated phosphate not only has the effect of recovering from the sewage water the soluble phosphate it contained, but it also carries down with it the curdled or coagulated fæcal matter. The sewage having been thus prepared, a separation of the solid matter is readily accomplished by means of "precipitating tanks," constructed so as not to interfere with that quiet condition of the water which is necessary for the deposit of a light and flocculent precipitate.

By these successive steps the deodorisation and defæcation of the sewage are accomplished, so that, whilst a flow of sewage enters at one end of the works, a stream of clear, bright effluent passes away at the other, leaving in the precipitating tanks a deposit of the solid matter which has been separated from the sewage. This solid matter is discharged into shallow beds, where it is allowed to dry, and it is either moulded into bricks and dried in the air, or simply turned over and the drying completed without further trouble, which is undoubtedly the cheapest course of procedure.

Manure obtained under the phosphate sewage

process has many and great advantages over the ordinary sewage manures, which, from their inferior quality, are difficult of sale. As a matter of fact, it has been found more economical to purify the sewage by the use of a better and more expensive class of material, which, when it has accomplished the duty of purifying the sewage, adds to the utility and market value of the manure made. The manure produced under this process enables it to be compared favourably with other manures. The average composition of the manure made from London sewage is about $2\frac{1}{2}$ per cent. ammoniacal matter and 22 per cent. precipitated phosphates, and, consequently, it is a really valuable manure.

The sewage of Hertford is one of that class which offers especial difficulties, consequent upon its having to be discharged into the Lea, which is largely drawn upon as a water supply, and is for this reason very jealously guarded.

The sewage of this town has been continuously treated by this process for about 18 months, and it has so far complied with the stringent conditions of producing a thoroughly good effluent water, that the Corporation have given an official certificate testifying to the satisfactory character of the effluent water discharged.

Professor Wrightson, in his report to the Cirencester Chamber of Agriculture upon one of the most complete series of field experiments of modern times, says of this manure :—

"It is advertised at £4 per ton, delivered in railway trucks, and I can speak most approvingly of the fine, dry condition in which it is sent out, in strong bags of 1 cwt. each. Last year I spoke of its uniform action over many of the farms upon which it was tried. It did not produce so great an increase as superphosphate, but then it was sold at a lower price. Reducing its effects to a money standard, I found last season that it produced its increase over unmanured plots, taking the average of the entire series, at 3s. $2\frac{1}{2}$d. per ton, whereas superphosphate, valued at 6s. per cwt. produced its increase at 3s. per ton. The results of 1875 are certainly favourable to this sewage product, as may be readily seen by consulting the table showing the increase per acre of the fertilisers used over the average unmanured plots. It rivals superphosphate in several cases, especially at Stratton, where it gave a distinctly better result. In other cases the popular manure, superphosphate, is run very hard by it. Twelve shillings per acre is some vantage ground when compared with the 18s. per acre at which I have valued the superphosphate, and, applying the rule for finding the profit from any fertiliser, I find strong evidence, now extending over two seasons, of the usefulness of this substance."

LEEDS SEWAGE TREATMENT.

By George Tatham,

Chairman of the Streets and Sewage Committees, Leeds.

Prior to the year 1842, no general system of sewers existed in Leeds: what drains there were being mostly old and inefficient, having been constructed from time to time in various places, mostly to meet the necessities or convenience of private inhabitants; and for many years the River Aire and its tributaries had been becoming more and more polluted from the increased quantity which they received of fæcal and liquid matter from dwelling-houses, and of refuse from manufactories.

At this time, 1842, the present sewerage system was commenced, replacing old and inefficient sewers with new and efficient, or providing such where none previously existed. The original idea was to collect all the domestic sewage into one culvert at the lowest part of the borough, and there manufacture it into manure, and realise a large profit. The former part of this idea has been carried out, and the most populous parts of the borough sewered at a cost of £280,000; but instead of realising the contemplated profit, the sewage was allowed to pass away into the River Aire at Knostrop, without any attempt at purification or recovery of value therefrom.

Other towns above Leeds, on the same streams, pursued the same plan of turning their sewage into the nearest water-course, the consequence being that the river became nothing better than an open sewer, unfit for domestic or manufacturing purposes, and of this the landowners and others below naturally complained.

When a proposal was made to extend the drainage of Leeds by adding another district which had become so populous as to require further drainage facilities, the landowners below Leeds combined, and on the 18th November, 1869, obtained an injunction from the Court of Chancery, restraining the Corporation from "causing or permitting the sewage of the borough of Leeds, or any part thereof, to flow or pass through their main sewer, or any other outfall, into the River Aire, unless and until the same shall be sufficiently purified and deodorised as not to be or create a nuisance, or become injurious to the public health," and "to be a perpetual injunction."

The committee of the Leeds Corporation, having charge of these matters, had had this question under their anxious consideration for two years before the date of this injunction, and had appointed in November, 1867, a special committee to consider the whole subject and to report.

This committee accordingly inspected every feasible plan which they heard was in operation at any place, including—

1. Worksop.—Precipitation by lime system.
2. Croydon.—Irrigation.
3. London.—A portion irrigation at Lodge Farm, Barking, the rest pumped into the Thames.
4. Hertford.—Chloride of lime.
5. Rugby.—Irrigation.
6. Bradford.—Holden's process, lignites, clay, and lime. H. A. Bonnewell's patent.
7. Harrogate.—Irrigation.
8. Leicester.—Lime process.
9. Birmingham.—Subsiding tanks.
10. Coventry.—Filtration; not successful; then about to commence irrigation.
11. Leamington.—A B C process.
12. Stroud.—Sulphated clay.

This refers to 1869-70; since then, some of these places have adopted other modes, as—

Hertford.—Phosphate sewage.

Birmingham.—The lime process, with manufacture of portion of the sludge into cement by General Scott's process.

Coventry.—Sulphate of alumina. Dr. Anderson's process.

Bradford.—Lime and filtration through coke.

Subsoil drainage and earth-closets had the attention of the committee, but were dismissed as not likely to meet their requirements; whilst for

sewage works were commenced in the month of May, 1873. They were placed in operation in April, 1874, and have been kept continuously so ever since, though they have but recently reached a final state of completion.

Coventry is a manufacturing town, containing a population of 40,000; it is well sewered, has a good water supply, and the quality of its sewage is extremely foul and polluting; it receives fæcal matter, &c., from about 5,000 water-closets, but its foulness is principally due to the large quantities of refuse liquids, &c., which are discharged from various dye and varnish works which exist in the town, and are connected with the sewers. This manufacturing refuse, mixed with the ordinary sewage, renders it of a character not only most offensive, but extremely difficult and costly to defecate; experience shows that its presence increases the cost of purifying the Coventry sewage just one-third. The dry-weather average flow amounts to about two and a quarter million gallons in twenty-four hours, but it is often in excess of this quantity.

Previously to the construction of the present works, the whole of this sewage was, in an undefecated state, cast into the River Sherbourne, at a spot a mile from the town. It rendered this stream black and disgusting, and a terrible nuisance to the neighbourhood, as well as a great source of danger to health, inasmuch as the sewage, at some few miles distance, found its way into the source of the water supply to the town of Warwick. All this has now been remedied; the River Sherburne has been so purified that fishes have returned to its waters, the Corporation of Coventry has been relieved from litigation and annoyance over its sewage, and, with the surrounding landed proprietors, is perfectly satisfied with the results obtained.

The following brief account of the operations will explain the works and various processes by which this has been accomplished.

In selecting the site, advantage has been taken of a small fall (about 6 feet) in the nature of the ground, to avoid the costly expedient of pumping the sewage, and to work it throughout by gravitation. A narrow strip of comparatively valueless land along the border of the Sherburne, in extent about thirteen acres, has been thoroughly drained, embanked against the rising of the river during floods, and made available for the whole of the works. The sewage is subjected to four processes, viz.:—1. Strained; 2. Chemically treated and precipitated; 3. Effluent water filtered; 4. Precipitate or sludge, dried and disposed of.

The straining is effected by means of mechanical strainers, known as "Latham's Solid Sewage Extractors." The solids thus removed form a rich manure, which, at the present time, is used in the orchard adjacent to the buildings of the works. The strained sewage thus free from all its grosser contents, and, therefore, in a better condition for chemical treatment, next passes through a block of buildings, where it receives continuously an addition of a solution of sulphate of alumina, manufactured and prepared in a cheap way at the works, which contain all the necessary appliances for this purpose. The sewage next receives a small addition of milk of lime, and, after the addition of each chemical, the whole mixture is thoroughly agitated. The mixture then passes on to the precipitating tanks, of which there are four, three being in use at the same time, while a fourth is being cleaned out daily. Precipitation takes place in these tanks, while the effluent water flows in a thin sheet from the surface, first, over weirs extending quite across the tanks, and secondly, over weirs which extend half way across each tank. An arrangement of sluices and valves exists at the end of each tank for drawing off the water from the precipitate or sludge when a tank has to be emptied.

The effluent water is conveyed from the tanks by a culvert and open carriers to filtering beds, of which there are three, each three acres in extent; the water then percolates through a depth of five feet of earth, and is afterwards discharged through three 15-inch mains into the river. This water is clear, bright, and of a good standard of purity, and, according to analysis by Dr. Voelcker, contains in each imperial gallon, 45·22 grains of solid matter, and only ·630 of a grain of free (saline) ammonia, and ·042 of a grain of organic (albuminoid) ammonia.

The filter beds are used intermittently, and are cropped with osiers and rye-grass. The latter is pleasing to the eye, and assists in keeping the beds in good condition.

The sludge or deposit found on the bottoms of the precipitating tanks, after the water is drained off, contains about 85 per cent. of moisture, and amounts during 24 hours to about 25 tons. It is one of the chief characteristics of this process, that scarcely any solid matter is permitted to enter with the chemicals. The sludge, therefore, is almost entirely derived from the sewage, and is thus reduced to a minimum bulk. This fact renders it much less difficult, and less costly to dispose of than the large quantities of sludge, which result from the lime and other precipitation processes, which require large quantities of chemicals with their solid portions to enter the sewage.

The sludge is swept from the bottoms of the precipitating tanks into underground chambers placed below their level, in which simple arrangements exist for drawing off supernatant water; it is then elevated by ordinary chain and bucket elevators, and passed through Milburn's continuous sludge-filters, which, without the application of heat, remove about 20 per cent. of moisture, and reduce its bulk to about 10 tons per day. The sludge in this somewhat stiff condition, containing about 65 per cent. of moisture, is next subjected to a comparatively small amount of heat in Milburn's sludge-drying machines, which remove a further 5 per cent. of moisture. It is a remarkable fact that this sludge thus treated, and having been once subjected to heat, continues afterwards, when placed in heaps, to part with its moisture until it retains only 9 or 10 per cent.

By these means the daily precipitate at Coventry is converted into about 4½ tons of a dry manure. This manure, according to analysis by Dr. Voelcker, contains, in addition to other fertilising agents, 1·67 per cent. of ammonia, and 3·75 per cent. of phosphate of lime, and may be valued according to chemical values at 35s. or 40s. per ton.

The whole of the sludge is not, however, reduced to a dry condition in the manner just described. Some portion of it is, after passing

the non-heating continuous filter, fortified and dried by the addition of chemicals and fertilising agents; thus producing a good manure which is brought up to an average value of £5 or £6 per ton, and competes well with the best artificial manures produced in this country. A considerable quantity of the sludge is also, in the stiff and semi-dry state in which it comes from the non-heating continuous filter, bought and carted away by the landowners in the neighbourhood. By these several modes the whole of the sludge can be disposed of, partly by local and inland arrangements, and partly by exportation, and thus is avoided the one great difficulty of all other precipitation processes.

The sale of sewage manures has undoubtedly been slow and gradual, they did not at once find a ready sale, but now that the price demanded is a fair one, and confidence in their value, so long disturbed by exaggerated statements, is restored, there is every reason to believe that the whole of the sludge can be utilised and sold.

The cost of purifying the entire sewage of Coventry, in the manner thus described, inclusive of rent of land and interest on capital, and without deducting any receipts for sale of manure, is about 1s. 7d. per head of the population, per annum. Taking, however, into account the chemical value of the manure produced, the cost would be about 2d. per head per annum. In either case, the primary cost of purifying sewage at Coventry is considerably less than that of disposing of it by irrigation. There are many instances which prove this, but the following will at present suffice. The sewage of Warwick and Leamington is disposed of by irrigation; neither of these towns have a manufacturing population, and consequently a sewage less costly to purify than that of Coventry, but in the former town the cost appears to be 3s., and in the latter, exclusive of the privilege of putting the sewage on to a thousand acres of Lord Warwick's land, about 1s. 6½d. per head of the population, per annum. In other places the cost appears to be as follows:—Banbury, 1s. 7d., Northampton, 1s. 8¼d., Tunbridge Wells, 5s. 3d., Croydon, 2s. 1½d., Merthyr Tydvil, 1s. 8¾d., Norwich, 3s. 6d., Eton, 5s. 1½d., per head of the population, per annum.*

The success attending the purification of the Coventry sewage is testified to by those having property along the banks of the river, tenants of Lord Leigh, Lord-Lieutenant of the county, and others, as the appended correspondence shows.† It is also strikingly evidenced by the fact that two manufacturers at Kenilworth (one a tanner, discharging 5,000 gallons, and the other a fellmonger discharging 50,000 gallons, of refuse daily into the Finham brook, which, like the Sherbourne, is one of the tributaries of the River Avon) have taken a license of this company, and are now erecting the necessary works to purify, at their own expense, their refuse by the same processes as are used at Coventry. The cost of purifying the tanner's refuse will be about 10d., and that of the fellmonger's about 2s. 6d. per day, leaving altogether out of consideration the value of the precipitated matter.

The town of Nuneaton, where also the process of this company is adopted, contains a population of 7,000. It is not to any extent a water-closeted town, and has no regular water supply; but the volume of its sewage, about 350,000 gallons per day, is very large, in consequence of an extensive fellmonger's establishment, which casts its refuse into the sewers, and it is also thereby rendered exceedingly foul and costly to deal with. The operations at Nuneaton are almost similar to those at Coventry. The works were partially erected three years ago by the Local Board of Health of Nuneaton, and were unnecessarily placed on a height with a view to admit of irrigation if found preferable, thus involving the necessity of lifting the whole of the sewage 40 feet by pumping power, at an annual cost of £300. The rapid increase of the quantity of the fellmonger's refuse, and of subsoil water leaking into the sewers, has led to a considerable amount of dissatisfaction and litigation over the sewage of Nuneaton, but they have never seen occasion to entertain the process of irrigation, which was estimated to cost £30,000, and at the present time the sewage is being successfully purified at a similar cost to that of Coventry.

* These figures are obtained from a return of sewage purification compiled by the Corporation of Rochdale, the published accounts of Local Boards, and other public documents.

† See Appendix.

APPENDIX.

Copy of Correspondence.

Finham-park, Kenilworth,
July 14th, 1874.

My Dear Sir,—In answer to your inquiry as to the pollution of the River Sherbourne, I beg to say it has very considerably abated since the late alterations at the sewage works. I have not seen a dead fish since, but have noticed large numbers of them enjoying themselves by flirting out of the water during the late hot weather. There is a considerable quantity of mud on the banks, the accumulation of past time, which, no doubt, the winter floods will carry away, and then, I have no doubt, we shall find a still further improvement.—Believe me, dear sir, yours faithfully, (Signed)

James Weston.

J. C. Melliss, Esq.

Finham-park, Kenilworth,
December 22nd, 1874.

Dear Sir,—In reply to your inquiries as to the present state of the river, I am pleased to say it continues satisfactory. The mud-banks are considerably diminished, though it will take some time to effect their complete removal. The late floods did not accomplish nearly so much in this respect as they would have done, owing to the flood-gates at Stoneleigh being kept down, because we who have meadows on the banks of the river like to have the first floods over them, as they always contain the most fertilising properties. In consequence of this they did not wash the mud down as they would if the water had had its clear course down the river, which it will have in future. I should think that the flood-gates on the river have a great effect in causing the accumulation of mud above them.—Believe me, dear sir, yours faithfully. (Signed)

James Weston.

C. Melliss, Esq.

Finham-park, Kenilworth,
February 23rd, 1875.

Dear Sir,—I laid your note of the 19th inst. aside, and did not think of it until to-day.

Respecting putting my communications in print, you

of the best probably, of all manures) for thousands of years without germinating, but which germinated immediately on being placed in the moist soil of East Lothian. My mind, therefore, rebelled against the notion that the dilution with water instead of with sand necessarily precluded the possibility of converting the same proportion of nitrogen contained in sewage, as of that contained in any dry manure. But agricultural chemistry, besides, being an obscure science, requires a long time for the observation of even a few points; for a complete agricultural experiment can hardly be conducted in a less period than one year. Nevertheless, I set myself to work to watch, to observe, to experiment, and to measure, and the result has been that which I anticipated, namely, that by the intelligent application of sewage, the manure contained in it may be converted in the same proportion, and to the same degree, as the manure contained in any other of the more usual materials used in agriculture.

Fortunately, this statement does not rest on my own authority only. When I took a lease of the farm at Romford, and made a contract with the Local Board for the district of Romford, for the supply to that farm of the sewage of the town, I immediately suggested to my colleagues on the British Association Committee, that it would be a rare opportunity for observing and recording the whole history of the sewage from the time that it arrived at the farm to the time that it left in the form of crops, or in the form of effluent water, whether pure or impure, and what I now tell you is to be found recorded in the annual reports of the committee. The sewage that has come on to the farm since a very short time after I took possession of it, has been carefully measured and recorded. Samples have been carefully taken, in proportion to the gaugings, and these samples have been analysed, the soil has been analysed, and the crops have been carefully weighed and measured. Materials, therefore, have thus been obtained for a complete balance-sheet in nitrogen.

I do not say that the results that I have obtained are quite equal to those obtained in careful laboratory experiments, but they are very fair results, and specific disturbing causes fully account for the difference. Therefore I claim to have proved that the manure contained in sewage has precisely the same producing power as the same ingredients contained in any other description of manure; in other words, that the intrinsic value inherent in town sewage, which was accurately stated by Chadwick and Liebig at in round numbers 10s. a head per annum, can be got out of it by its intelligent application direct to land, in conjunction with the ordinary operations of farming.

Again, I must ask you to pardon me if I beg that you will not misunderstand what I mean and what I say. I do not say that any one can ever afford to give 10s. per head per annum for the sewage at the sewer's mouth; this depends entirely on local circumstances. But I say that this is the value of the ingredients contained in it, according to the price current of other manures, and that I have proved that the manure in town sewage is as available for vegetation as the same ingredients are in any other manure.

I repeat this so often, because I have so often been, and so continually am, misunderstood. But I trust I have now stated my case in such a way that I cannot be misunderstood, and I now ask what does this imply, and what is the present practical bearing of these facts? Surely this, that as I have often said, there is no difficulty in the sewage question, if municipal authorities will only throw aside quacks and address themselves to sober science. If the full equivalent in vegetation of the manure contained in sewage has been extracted in one place, it can be extracted in all, and if so extracted, we have at once the basis of calculation in considering what we are to do with the sewage of any given town. Of course, in the case of one town with plenty of cheap land, at a short distance, or at a level commanded by gravitation, there ought to be a handsome profit from the application of sewage, whereas, in the case of another town, its purification may necessarily involve an annual loss. That, I imagine, the Society of Arts has nothing to do with, nor do I wish to go at length into the question of whether anything else can be done with sewage than its utilisation as manure. More than once in the fifteen years that I have worked at the question has it been announced with a flourish of trumpets that the sewage question was solved, because some one or another had made illuminating gas out of it. This is just like the solution of the Irish peat bog difficulty by the man who proposed to condense the peat bogs into candles. Of course, it is a chemical possibility, but it does not deserve serious consideration.

Now, admitting that sewage is a manure, and must always remain a manure, it is obvious that any manipulation of it between the town and the land is to be avoided if possible. If we can apply it simply, at once, and direct, to the land, that must be the more economical course. But I say, frankly, that this, although possible, is not desirable. In the first place, it is imperatively necessary to store the sewage during the night, so that the earth may not be washed away from the plants in one place, or the plants drowned, and the soil swamped and made sodden in another, and the moment you have storage, you have deposition of the matter in suspension. Moreover, the spreading of a quantity of solid matter in suspension over the surface of land in which crops are growing has a tendency to choke the pores of the soil; and further if the land to which the sewage is applied is in a populous neighbourhood, or surrounded as it often is with villas, spreading undissolved sewage matter over land is objectionable to the nose, and possibly to health; therefore, for all these reasons it ought to be taken out before the matter in solution is distributed over the surface by irrigation, and its extraction should be made compulsory by Act of Parliament.

Having said this, I must say a few words about the various precipitation processes. Many of them are effectual in clarifying the sewage, and therefore many of them would fulfil the conditions required for health and navigation, in the case of towns situated upon the sea or on tidal rivers. But none of them precipitate the ammonia in solution, and when we examine into their pecuniary results, we find that with the exception of a very few, they are all based upon the old and exceedingly simple

calculation that two and two make five. The matter in suspension in ordinary town sewage when dried may be taken to have an intrinsic value of 30s. a ton, that is to say, this would be its value to the farmer if delivered to him upon his field.* Yet the Phosphate Sewage Company was started upon the assumption that by adding to this ton of stuff worth 30s., another ton of stuff, namely, phosphate of alumina, which the company themselves only valued at £3 10s., a result would be obtained of two tons of stuff worth seven guineas a ton, or 14 guineas in all. But £3 10s. and 30s. only make £5, and how the mere addition of these two is to give them a jump to 14 guineas is one of those things that no fellow can understand, at all events no chemist or arithmetician.

It is needless to go through the long and wearisome list of similar processes, for as I said before, they are all based on the proposition that two and two make five. Nevertheless many of them might be usefully used in conjunction with irrigation to clarify the sewage, the sediment obtained being buried from time to time in the same land as the water; but it must be borne in mind that the bulk of the potass and phosphoric acid will be found in the matter in suspension and not in the matter in solution; and, consequently, if you take the matter in suspension out, the nitrogen which already existed in excess will there exist so much in excess that a large quantity of it will be wasted, and yet the nitrogen is by far the most expensive and difficult to procure of the three. Not only therefore should the solid matter in suspension, if taken out, be afterwards restored to the soil, but those cheap ingredients may usefully be added in many cases so as to prevent the valuable nitrogen ceasing to be the measure of production.

I have said that I have devoted 15 years of my life to the elucidation of the sewage question, and I confess that it was with pain and humiliation that I read the proposals of Sir John Hawkshaw to expend a million and a-half sterling in throwing the sewage of Glasgow into the sea. But of course Sir John Hawkshaw has no personal knowledge of the facts which I have been endeavouring to place before you.

Now a Conference like the present, in which a mass of people are brought together having a little knowledge of a number of different points, is to my mind quite as likely to be mischievous as useful. It may perhaps be necessary, if so it is a painful necessity, for to a man possessed of exact knowledge of any particular subject nothing is so painful as to listen to one person after another, either ignorant or possessed of a little superficial knowledge, giving utterance to one foolish idea after another, the audience being absolutely unable to estimate the value of such ideas or to ascertain the truth.

I come before you stating that in the published records of the Sewage Committee of the British Association, you will find that I have succeeded in proving that the manure contained in town sewage has the same producing power as the same ingredients in any other kind of manure, and if this is so there is surely an end to the sewage question. Therefore, I would venture to ask you to nominate a committee, a small but competent committee, to ascertain whether I am telling you the truth or talking nonsense, and if the former to confer with with the Government, and to urge upon them the immediate passage of a Rivers Pollution Bill.

Do not suppose I want such a Bill to enforce sewage irrigation; quite the contrary. All I desire to see is an Act of Parliament forbidding the pollution of rivers used for drinking purposes, the blocking up of our tidal rivers, or the pollution of our sea beaches used for bathing, by sewage. In the case of rivers used for drinking purposes, evidently the highest standard of purification should be insisted upon, and this can only be attained by means of irrigation. This fact, admitted by chemists for years, is now gradually being admitted on all sides. But in the case of tidal rivers and the sea, clarification would be enough for public purposes, if the towns desire to throw away money as well as to throw away their sewage, for I warn them that they never will be able to precipitate sewage and extract the matter in suspension except at a loss. But any such Act of Parliament should also contain provisions of the nature sketched out by Mr. Smee, in his paper read to this Society on the 1st December last, for of all dangerous nuisances a badly laid out and badly conducted sewage farm is likely to be the worst in a populous neighbourhood. I do not mean to say that I go quite so far as Mr. Smee, but as I said in a letter which I addressed to Dr. Letheby on that occasion, I go quite as far as Mr. Smee or any one else in condemning the improper use of sewage by irrigation, and there would be no difficulty in framing a few general rules for the conduct of sewage farms. Nor would there be any hardship; for complete purification and complete utilisation necessarily go hand in hand.

In looking back for the last fifteen years, I am afraid to say how many papers I have read on sewage, or how many pamphlets I have written, but often have I made an effort of this kind, in the belief that it was to be the final effort, to drive the truth into the minds of those in power, whether in municipalities or in the Government, but hitherto I might as well have scratched the dome of St. Paul's, in the belief that I should thereby tickle the Dean and Chapter. Yet I almost venture to hope that if I have succeeded in making myself understood to the present meeting, this effort may at last be productive of some good, that you will appoint the committee which I have suggested, and that that committee will lose no time in pressing the question upon a Government whose motto in opposition was *sanitas sanitatum omnia sanitas*.

* The Secretary regrets that a paragraph, reflecting on a Sewage Company, was inadvertently allowed to appear in copies of this paper distributed in the room during the Conference.

THE TREATMENT OF SEWAGE, ACCORDING TO THE PROCESSES OF THE GENERAL SEWAGE AND MANURE COMPANY, LIMITED, AT COVENTRY, NUNEATON, AND KENILWORTH, IN THE COUNTY OF WARWICK.

By C. J. Melliss, A.I.C.E., F.G.S. F.L.S.

After the Corporation of Coventry had tried several methods, each without success, and had been deterred from establishing a sewage-farm because of its enormous cost, the present Coventry

him, because he departed from the only true scientific method, namely, measuring everything with which he proposed to deal, and gave reins to his naturally powerful imagination, and so wrote against what he imagined I proposed to do with the sewage of London, and not against that which I really did propose to do; consequently he was unable to defeat my scheme.

Now in agriculture it is the chemist who first, by careful measurement of land, crops, and manure, traced out and completed the circle of nature by which the excreta of one set of animals, by being passed through vegetation, becomes the food of another series of animals, and it is by this careful quantitative and qualitative measurement, and by this alone, that every ton of so-called "artificial" manure is now sold in the whole civilised world. Of course there are plenty of dishonest persons who sell fraudulent adulterations of manures above their value, but even these pretend to sell them according to their analytical composition. It is, therefore, a strange thing for a chemist to say, that any kind of manure, no matter what, can be judged of from any other starting point than its chemical analysis. But do not mistake what I mean. The analytical chemist will certify that a given sample of manure is worth £15, or 15s. a ton, because it contains so much per cent. of nitrogen or potass, or phosphate of lime, or all three. But this must be taken to be its approximate value placed upon the land. In the case of a manure worth £15 a ton, the carriage to the land from a railway station two or three miles off, and the sowing by hand or by drill over the field is a mere trifling addition to the cost, making the cost, we may suppose, as an outside figure for a distant out-of-the-way farm, 15 guineas, which would be an addition of 5 per cent. on the prime cost, but to the same farmer on the same farm, the additional cost of a ton of manure, intrinsically worth only 15s., would be no less than 100 per cent. instead of 5 per cent. Therefore, although the farmer can afford to pay £15 a ton for the expensive manure, he cannot afford to pay 15s. a ton for the cheap manure, for, supposing that he were to apply a full dressing of each, he would in the one case apply one ton per acre at a total cost of 15 guineas, and in the other he would have to apply, to produce the same result, twenty tons at a cost of £30. The cheap manure would, therefore, cost him £14 5s. an acre more than the expensive manure, and yet I ask by what other conceivable means could he possibly arrive at a sound judgment as to which manure to buy except by chemical analysis?

We are told in a certain book which enjoys a considerable authority in this country, that we should count the cost of our house before we build it. But how is the farmer to count the cost of his manure unless by chemical analysis? Manifestly there is no other gauge or standard of value but chemical analysis. Yet, here we have Dr. Letheby saying, that he was sorry that Baron Liebig should have lent his name to what might be termed such a false notion. By what other means than that of the most careful, delicate, minute measurement did Dr. Letheby himself determine the quality of the gas supplied in any given town? The fact is, that in touching upon this question of money value he was travelling beyond his own sphere in two ways, as he was going into agricultural chemistry, when he was not an agricultural chemist, and he was going into a farmer's question when he was not a farmer.

It is not too much to say that when a man is called upon to deal with any given substances, of which he is bound to receive and to dispose of a given quantity in each 24 hours, the only rational or possible method by which he can ever arrive at a trustworthy result is by commencing with a scrupulously exact measurement. He must measure, weigh, and analyse everything that he has to deal with, and when he has completed such exhaustive measurements he then knows what is the problem he is called upon to solve. Otherwise he is merely stumbling in the dark.

By the careful and minute observations alluded to, Chadwick and Liebig and a host of other chemists and physicians ascertained what were the manurial constituents, in both quantity and quality, with which they had to deal under the name of town sewage, and what were the corresponding market values of those ingredients in any of the ordinary forms in which they were met with in commerce.

There was the basis of a reliable calculation, because it was a hard fact, and there the province of the chemist, physician, and statistician ended. It was for them to show what was the manurial power contained in this matter they were called upon to purify. It was for others to ascertain how that manurial power can be turned to account. But that the manurial power—which means from another point of view money producing power—exists, is a hard, dry, chemical truth which cannot be shaken. Just as a ton of guano is worth so much money because it will produce so much extra vegetation worth so much money, so the proportion of town sewage due to each inhabitant for a whole year contains ingredients capable of producing increased vegetation, worth so much money, and it was only so far that the chemists went. They did not say that it would be safe for any person to buy the sewage of a town at the outfall, convey it away, distribute it over prepared land, and pay for it, on receiving it at the outfall, at the price determined by its chemical analysis. This was a commercial question. It might or it might not be prudent or profitable to do so, just as it might or might not be prudent or profitable for any particular farmer in a given locality to purchase a ton of guano. With such circumstances science has nothing to do. But the particular farmer in the given locality, when a neighbour or a dealer advises him to buy a ton of guano, has no other means of coming to a sound conclusion, or making a safe calculation except falling back upon pure science to ascertain what it is that he is buying, and what it is that he will obtain by the use of that substance. He then makes his own commercial calculation, and comes to his own commercial conclusion. Hence the motto of the Royal Agricultural Society, "Practice with Science."

Of course the fact that the manure in town sewage was diluted with enormous quantities of water instead of moderate quantities of sand, was a fact which everyone, whether chemist or not,

could not avoid taking into consideration, and accordingly when I first commenced to frame a scheme for dealing with the sewage of London 15 years ago, I found that the majority of chemists were not only fully alive to this difference, but they gave it undue weight, for they said that although the value in question existed in the sewage, experience appeared to show that it could not be got out. And here I must call your attention to the fact that the chemists meant not that persons could not buy the sewage at the full value shown by analysis, but that they could not extract that value, that is, that they could not obtain returns in vegetation proportionate to those which they would obtain from the same ingredients applied in other forms. This, and this only, is the cause of doubt and hesitation in their minds at the present day. There is no doubt, for there can be none, as to the value, the *bonâ fide* intrinsic value, which exists in the sewage.

Now, that being so, I have devoted 15 years, I am sorry to say, to ascertaining and trying whether or not the manure contained in sewage, and diluted with water instead of sand, could or could not be converted into vegetation in the same proportions as the same ingredients in their ordinary commercial forms. Here I must remark that agricultural chemistry is a very obscure branch of that most complicated science, and there are comparatively few chemists who are aware that nitrogen, which is the most expensive and difficult to procure of all manurial ingredients, cannot be converted unit for unit into vegetation. Numerous minute quantitative and qualitative experiments show that, to speak in round numbers, in order to convert into vegetation one unit of nitrogen another must be wasted. Nevertheless, I remember at a meeting of the Chemical Society, a very eminent analytical chemist found fault with the work of the Sewage Committee of the British Association because they alluded to results obtained on my farm in the conversion of nitrogen from manure into vegetation as satisfactory when, as he said, more than the half was wasted. It is, therefore, not surprising that the outside "lay" public have difficulty in comprehending all the bearings of so obscure and difficult a subject.

But it is manifest that if you require to use two units of nitrogen in guano to produce one unit of nitrogen in vegetation, and if the concurrent chemical and commercial experience of the world fix upon a given sum as the value of each of those units, the same must be the value of corresponding units of nitrogen in whatever form they are applied to the land—once they have been so applied. Again, I must call your attention to the fact that I am talking of the value delivered upon the land. If to some persons I appear unnecessarily to repeat myself, I must, as an excuse, say frankly it is because I have found such absolute and complete ignorance to exist among persons who are otherwise not only well-educated, but even well-informed on the sewage question itself.

If nitrogen, in the form of wheat or any other crop, is worth in London so much a unit, then the farmer can afford to pay so much a unit delivered upon the land for the nitrogen that he buys in his manure; and, once that nitrogen is delivered upon his land, it makes not the slightest difference to him with what substance it is mixed up, provided always that these substances are not injurious to vegetation, and that its combination with those substances does not render it insoluble finally, and that it is unable by any means, no matter what, to escape from the land without doing the work that it would do if mixed with the ordinary substances with which it is sold in commerce. Fifteen years ago, as I have already said, I found that the state of the sewage question was this. The chemists of the world —not only Liebig, Way, Miller, and a few others with whose names you are most familiar, but I say broadly the chemists of the world— were agreed as to the quantitative as well as the qualitative analysis of town sewage, and therefore a reference to any price current of the day established its inherent value. A ton of guano or a ton of sugar of a given quality, is worth so much money on a given day in the market of London. The chemist tells you what is the quality, the broker tells you what is the price per unit, and these are hard undeniable facts. In them you have a solid foundation of truth from which to start and on which to build. But the fact that a ton of guano or a ton of sugar of a given quality, is worth a given sum of money on a particular day in London, has nothing to do with the question of whether it will pay a colonist in a distant colony to ship and send that ton of guano or that ton of sugar to London. It is certain that if sold on a particular day, the ton of sugar and the ton of guano will produce to him the particular sum of money, but it may cost him double or triple that sum to deliver it in London. Nevertheless, if he has discovered guano, or finds that his soil and climate will produce good sugar, he cannot possibly proceed in his calculation of whether he should go in for trading in guano or sugar by any others means than ascertaining from the chemist the quality, and from the broker the price of his particular commodities. He must then make his own calculations of what it will cost him to get these commodities to market.

Now this was the condition that I found the sewage question in fifteen years ago. The chemists and the brokers were agreed as to the price of the ingredients in their ordinary merchantable form. That is, they were agreed as to the intrinsic value, the money-producing power. But the chemists said that owing to the dilution with water, it did not appear that that money-producing power could be got out by the farmer. Now, when they stated what that money-producing power was, they were stating a definite and positive fact within their own personal knowledge as chemists; when they said that it did not appear that the value could be got out, they were not stating a fact, but were merely repeating the opinions of uneducated farmers. And, although at first I never ventured to question publicly the dictum so laid down, I never accepted it in my own mind, because I reasoned that water was a more convenient medium of adulteration than sand, inasmuch as a fertile seed might be buried in a chemically dry manure, mixed with sand for an indefinite length of time, and it could never germinate, whereas, if moisture were added to the manure and sand, it would germinate at once; and I instanced the grains of wheat found in the Egyptian mummy, which had been in contact with human flesh (one

upon a farm of 84 acres under the sewage from a population of some 9,000, and can show a ledger account of each crop, wherein rent, taxes, &c., are charged at the rate of £5 per acre, with a profit and loss balance-sheet on the whole farm giving £81 18s. 6d. as the year's loss, including a charge of five per cent. for interest on all floating capital embarked in the concern. Five acres of Swedes, being perpetually hoed during wet weather, and producing hardly any crop after all, stand for £39 loss; and failure of potato crop upon other six acres not under sewage accounts for £20 more; so that, if these two fields were eliminated from the general account, the total loss would stand at £22 8s. 6d."

The second, third, and fourth year's working, however, has each shown a considerable profit (detailed accounts given below); thus in 1873, after deducting for rent at £5 per acre, interest on capital at 5 per cent., and 5 per cent. on cost of permanent improvements, to form a sinking fund calculated to repay the amount expended on such works within the term of lease, a profit of

BALANCE-SHEETS FOR YEARS ENDING FEBRUARY 2ND, 1874, 1875, 1876.

1874.

Dr.	£	s.	d.
To balance of sundries account	56	10	3½
,, ,, rent and taxes account	12	3	9
To interest on capital, viz.:—			
One year at 5 per cent. on £1,193 7s. 4½d. £59 13s. 4d.			
Half-year at 5 per cent. from July on £150 ... 3 15 0			
Sinking fund at 5 per cent. on £334 18s. 5½d. ... 16 14 1			
	80	2	5
Balance profit	186	3	3
Total	£334	19	8½

Cr.	Acres.	£	s.	d.
By balance Italian rye-grass crop	8	122	1	4
,, ,, black oats crop	5½	34	13	3
,, ,, mangolds crop	6	30	17	5
,, ,, potatoes and carrots	6	25	3	0½
,, ,, tank account (solid manure)	1	10	12	6
,, ,, filter-beds (market-garden)	2½	11	19	0½
,, ,, permanent pasture	44	14	10	9
,, ,, wheat crop	6	9	5	6
,, ,, khol-rabl	1½	0	0	0
Total acres	80½			
,, ,, garden		0	11	10
,, ,, dairy (and stock acccount)		69	13	0
,, ,, 1872 crops account		2	19	2½
By profit by dealings with Agricultural and Horticultural Association		2	12	10
Total		£334	19	8½

1875.

Dr.	£	s.	d.
To balance of sundries and implement account	32	4	0
,, ,, rent and taxes account	0	9	8
,, ,, barley crop (*Couch field)	15	18	6
,, ,, 1873 crops	3	17	3½
To interest on capital, viz:—			
One year at 5 per cent. on £1,830 ... £91 10s. 0d.			
Sinking fund at 5 per cent. on £479 ... 23 19 0			
	115	9	0
Balance of profit	276	4	6½
Total	£444	3	0

Cr.	Acres.	£	s.	d.
By Balance Italian rye-grass account	13	184	16	10½
,, ,, mangolds crop	5	46	8	10
,, ,, filter beds (market garden)	4	20	15	10½
,, ,, permanent pasture	41	58	8	4
,, ,, oat crop	2½	11	5	6
,, ,, wheat crop	6	56	10	11
,, ,, potatoes	2	2	6	4
,, ,, carrots	1½	0	17	9
,, ,, tank account (solid manure)	1	17	17	0
,, ,, barley crop (couch field), from Dr. side	6	0	0	0
Total acres	82			
,, ,, dairy and stock account		44	15	7
Total		£444	3	0

1876.

Dr.	£	s.	d.
To balance of sundries and implement account	37	4	0
,, ,, oat crop (*couch field)	48	6	1
,, ,, 1874 crops	19	9	4
To interest on invested capital, viz.:—			
†Three months at 5 per cent. on £1,900 £23 15 0			
†Nine months at 5 per cent. £1,300 ... 48 15 0			
Sinking fund at 5 per cent. on £550 ... 27 10 0			
	100	0	0
‡ Balance profit	271	18	6½
Total	£476	17	11½

Cr.	Acres.	£	s.	d
By balance Italian rye-grass account	17	275	1	1
,, ,, mangolds crop	5	28	0	3
,, ,, filter-beds (market-garden)	3	17	19	3½
,, ,, permanent pasture	56	30	14	4
,, ,, oat crop	4	6	12	6
,, ,, barley crop	4½	23	15	9
,, ,, odd crops (potatoes, turnips, &c.)	5	9	2	10½
,, ,, oat crop (couch field from Dr. side)	6	0	0	0
Total acres	100½			
,, ,, dairy and stock account		67	13	6½
,, ,, tank sludge		13	3	4
,, ,, rent		4	15	0
Total		£476	17	11½

* This field lies out of reach of liquid sewage by gravitation.

† The main part of dairy stock was handed over to present holder on May 15th, 1875, thus reducing Col. Jones' invested capital.

‡ The dairyman's profit is an unknown quantity, in addition to this balance, and he appears contented.

N.B.—All charges, viz., for rent (at £5 per acre), seeds, and labour, have been debited to crops and dairy accounts in ledger, leaving only the above Dr. balance of sundries account which is for repair of implements, tolls, commission, &c., not assignable to any partiular crop. Twenty additional acres were rented, at £2 5s. per acre, from Feb. 2nd, 1875.

£186 3s. 3d.; in 1874, £276 4s. 6½d.; and in 1875, £271 18s. 6½d. In this last year, twenty additional acres were added to the farm, but six acres were out of reach of the sewage by gravitation.

The Local Board seem in every way satisfied with their arrangement, as, in thus sub-letting the farm, they make on their part a clear profit on the rental of £30 per annum, besides getting off their hands an undertaking which had proved to them anything but a success, either in a financial or sanitary point of view.

Colonel Jones states that the sewered area of Wrexham is estimated at about 100 acres, and its surface water being let into the sewers, about 2½ million gallons would be added to their proper contents for every inch of rainfall, if there was no evaporation or absorption by the soil to be taken into account; experience, however, has shown him that the actual increase of fluid due to twenty-four hours' rain, though not so considerable, amounts to at least one million gallons, which is quite sufficient to create a nuisance for the following reasons, viz., the main out-fall sewer is three feet in diameter, but on approaching the tank it is reduced to a 15-inch pipe only, and then to a 12-inch one, which latter can convey to the farm only about 500,000 gallons, all surplus liquid above this maximum (of half a million gallons) being discharged directly into a neighbouring brook by certain fixed storm-water overflows.

The mean daily flow of sewage in very dry weather is about 300,000 gallons, and he considers it would be manifestly impossible, under any circumstances, to purify the relatively large amount of foul liquid (four times greater than the dry weather flow) resulting from so moderate a fall of rain as one inch in 24 hours.

When the rain extends to the sources of the brook, the latter sometimes flows in so large and rapid a current as to carry off all the surplus foul water joining it from the overflow without much nuisance, but when the storm is a local one, confined to the town and its immediate neighbourhood, the foul discharge from the overflow will sometimes amount to nearly half the brook water, and if hot weather succeeds such a sudden flush of foul water, the bed and banks of the brook become laden with black sewage matter, which causes a very serious nuisance to the surrounding district, as the water subsides, and the natural process of putrefaction sets in.

The plain and simple remedy for this serious evil pointed out by Colonel Jones, is exclusion of rainwater from the sewers, and he states that the inhabitants of Wrexham are rapidly becoming convinced of the truth of this fact. They are fortunate in natural advantages in the site of the town on ground sloping on both sides towards the central course of the brook, so that the remedy can be applied at a comparatively small cost.

As a proof of Colonel Jones' confidence in the advantages of sewage irrigation, it may be added that he recently offered to take a lease of the West Derby Farm (200 acres, with sewage from a population of about 20,000) at the usual rent of adjoining land, proposing to occupy his spare time in superintending this new farm in addition to the one which he has now got into pretty regular working order at Wrexham, although the two places are separated by about thirty miles of railway.

CAN SEWAGE BE UTILISED AS WELL AS PURIFIED.

By Lieut.-Col. W. Hope V.C.

When I undertook to write the present paper, I did so in the full hope and expectation that I should have the benefit of the criticism and answer, and, as I trusted, the confirmation, of a great pioneer of sanitary science, whose views, as expressed on one occasion, it is my principal object to combat. But although it seems only the other day that I listened to his words in this very room, he being then apparently in robust health and in the full vigour of his intellect, the name of Letheby has already become a recollection of the past, and he has been cut off abruptly in the middle of his work.

I say that although it is my principal object in the present paper to combat the views put forward when he presided in this room but a few weeks since, I nevertheless trusted that my paper would have had the benefit of Dr. Letheby's confirmation, and I do not know that I can pay a higher tribute to his impartiality of mind.

It will be in the recollection of those who followed the recent discussion, that Dr. Letheby, as Chairman, closed the discussion, to the surprise of many of us, by a strong, vigorous denunciation of the idea that sewage utilisation could ever be made to pay; and at first sight it might seem presumptuous on my part to join issue with him on this point. But it is not really a chemical point, as I shall proceed to show. He said:—

"About forty years ago, when Mr. Chadwick first started the sewage question, the public mind got impressed with the idea that sewage might be made to pay the rates and taxes, and it was in consequence of that false impression that nothing had really been done with the sewage question, which had been looked at rather as a money than a sanitary question, and therefore it was that the subject was in its present and unsatisfactory condition. Baron Liebig, when he made his report, fell into the same mistake as Mr. Chadwick and his party did, by founding his estimate upon the condition in which it would be merchandisable, instead of upon the condition in which it would be when it came into the hands of the engineer who had to deal with it."

And he then went on to describe how those pioneers, Chadwick and Liebig, ascertained by observation the average proportion of men, women, boys, and girls, in an ordinary town population, and then how they ascertained by careful and minute observation the quantity and quality of excreta to be derived from a given population, and after careful measurement and analyses they worked out that town sewage, on the average, should be worth 10s. 1½d. per head of the population per annum.

I listened to the concluding remarks of him, who was then our chairman, with surprise and regret. When Sir William Thomson read his inaugural address at the meeting of the British Association at Edinburgh, in 1871, he told us that discovery was, as a rule, the reward of patient industry, that great discoveries were not "happy thoughts" suddenly made by chance, or the result of an offhand effort of a brilliant intellect; but that they were the result of long continued, often repeated, careful, minute, exact measurement. Now Liebig was the father of agricultural chemistry. I myself was unfortunately opposed to him and by him on this very sewage question, and I defeated

It will not be out of place if I now compare the cost of intermittent downward filtration with other modes of sewage disposal, remembering that with natural soil as the cleansing medium, those sanitary authorities who resort to land, gain a property which increases in value the longer they possess it, and that if they do not let the sewage go out of their own hands they retain the power at any time to adopt such means of disposal as science may develop, or future experience show to be more profitable. If we look at facts from a money point of view, as they affect existing ratepayers, it will be found that in no case will any process be so economical as intermittent downward filtration, when adopted in its simple form. To make this clear we will assume an ordinary case of a town of 30,000 inhabitants discharging sewage amounting to about a million gallons daily, and compare the cost of treating that sewage by intermittent downward filtration *per se* with, (1) wide irrigation *per se*, (2) with irrigation and intermittent combined, and (3) with chemical precipitation involving the construction of tanks and the means of manufacturing the solid portions into a portable manure.

Intermittent Downward Filtration per se.—A town discharging a million gallons of sewage daily, from a population of 30,000 people, would, as already explained, require one acre of land to 1,000 persons, if the character of the soil be suitable; *i.e.*, 30 acres.

OUTLAY.

Purchase of 30 acres of land at £250 per acre..	£7,500
Preparation of land, under-drainage, deep trenching, and formation of surface	5,250
	£12,750

ANNUAL CHARGE.

Amount required for repayment of £12,750 with interest in 30 years, viz., £5 8s. 9d. per cent.	£694

ANNUAL INCOME.

Return by rent, if let, or by crops, if farmed,.. 20 acres at £10 = £200; 10 ,, in use —	£200
Difference to be met by rates .... or 4d. per person = 1s. 8d. per house of five people.	£494

(1) *Irrigation per se.*—With a town of the same size, the extent of land required for irrigation would, according to general practice, be at the rate of one acre to 100 persons or 300 acres. Judging from past experience, this land would not be obtained and compensation paid to tenants, together with all costs and charges, for less than £200 an acre, if it be situated within a reasonable distance of the town discharging the sewage. In the majority of cases it is the proximity of the land to the discharging town that gives it a suburban character and raises the price.

TOTAL OUTLAY.

Purchase of 300 acres of land at £200 per acre	£60,000
Preparation of surface, construction of carriers, underdrainage, alteration of farm buildings, &c.	12,500
	72,500

ANNUAL CHARGE.

Interest, &c., on £72,500 at £5 8s. 9d. per cent., as last	£3,942

ANNUAL INCOME.

Rent of land, if let, or return if farmed by the local authority	£1,500
Difference to be met by rates .... or 1s. 7½d. per person = 8s. 1½d. per house of five inhabitants.	£2,442

(2.) *Irrigation and Intermittent Downward Filtration Combined.*—The quantity of land utilised by a combined system would necessarily depend upon the capability of obtaining land, when the quantity would be regulated by the price to be paid for it. If twice as much land as the net quantity required for filtration can be economically obtained, it will amply suffice, though more would be desirable, if it could be got at a fair figure. The excess would not only provide against increase of population, when the area used for filtration would be extended, but by being utilised for surface irrigation in the meantime, it would materially assist in securing an increased income from the whole. The figures would then stand as follows:—

TOTAL OUTLAY.

Purchase of 60 acres of land, at £225 an acre	£13,500
Preparation, underdrainage, &c.— 30 acres at £150; 30 ,, ,, 50	6,000
	£19,500

ANNUAL CHARGE.

Interest, &c. on £19,500, at £5 8s. 9d. per cent. (as before)	£1,061

ANNUAL INCOME.

Return, if farmed by authority, or rent, if let	£390
Difference to be met by rates .... or 5½d. per person = 2s. 2½d. per house of 5 inhabitants.	£671

These comparative figures show, that with the price of land as high as stated, and with an absence of a greater return than is at present obtained from sewage farming, an immediate loss results from each mode of treatment, which the ratepayers must make up, amounting in the case of—

Intermittent downward filtration *per se* to	4d. per person.
Wide irrigation *per se* to	19½d. ,,
Intermittent downward filtration and irrigation combined to	5½d. ,,

When considering these figures it must be borne in mind that, although intermittent downward filtration *per se* involves the least present loss, there would remain at the end of the thirty years taken for the repayment of the capital expended only 30 acres of land for the benefit of future generations, while in the combined mode of treatment there would be 60 acres, and in the case of wide irrigation 300 acres. These advantages for the benefit of posterity fail to commend themselves, however, when it is acknowledged that thirty years may make a great difference in the treatment of sewage, and that there is a possibility that the land may not be required at all.

In each case given I have taken the worst view both as to cost and return. In many cases it is to be hoped that land will be obtained at less than £200 an acre, and that more than £5 an acre will

be obtained by way of rent or profit, though up to this time there has not been much encouragement that such will be the case.

(3.) *Chemical Precipitation.* — Comparing the cost and the charge for intermittent downward filtration, involving an annual loss of £494, with the outlay and charge resulting from the use of the necessary tanks and appliances for the chemical precipitation of the same quantity of sewage, it will be found that the rate in the latter case will be more than double that in the former; for, from the experience already gained, it may be assumed that the annual instalment to repay with interest the outlay in tanks, &c., together with the subsidy or royalty paid by a town containing 30,000 persons for the adoption of one of the patent processes now in use, would amount together to £1,000 a year.

But as this is a supposititious case, the two modes of treatment may be more advantageously compared by reference to two towns of almost the same size in the valley of the Thames—say Aylesbury and Abingdon.

At Aylesbury, where the population is about 7,000, a patent precipitating process, one of the most reliable, has been just introduced under favourable circumstances to the town, and the annual charge to repay the cost of tanks and appliances, added to the "subsidy" to be paid by the town, will involve a charge on the ratepayers of 1s. per person.

At Abingdon, with a population of about 6,000, the works which are just commenced include the preparation of 8 acres of land for intermittent downward filtration, and 20 acres for irrigation. The annual charge on the town for land and works will amount to £390, towards which there will be a return from the land of at least £150, leaving a deficiency of £240. This is equal to a rate of 9½d. per person.

The comparison, however, does not end with the charge upon the ratepayers, for if the tank arrangements at Aylesbury should be abandoned, and their removal necessitated, the materials would not realise more than a nominal sum, whereas if the 28 acres of land at Abingdon were disposed of at a future time, it is not improbable that with the growing value of land very nearly the amount of money paid for it, though in excess of its present selling value, would be recovered. We must not lose sight of the fact too that the chemical process may require to be supplemented by intermittent filtration, in order to make certain that the condition of the effluent shall always come within any standard adopted by the Government to regulate admission of waters into running streams.

NOTES ON WREXHAM SEWAGE FARM.

Hafod-y-Wern Farm, Wrexham, which was hired from the Wrexham Local Board, in Feb., 1872, by the present occupier, Lieut.-Col. A. Jones, V.C., A.I.C.E., who has furnished the Society of Arts with the following particulars, had been for the two years previous to this date under the management of the Local Board; and, although some steps had been taken to level part of the land, it had suffered considerably from neglect and mismanagement during these two years, which resulted in a considerable loss, and made the Board anxious to get rid of their charge.

The farm has a gross acreage of 84 acres, from which, after deducting 2 acres for roads, tanks, &c., there remains 82 acres available for cultivation. On taking possession of the farm, Colonel Jones was assured by every one that the land was saturated with sewage, that a larger extent was required for irrigation, and that grass produced was rank, and unfit for cattle. Subsequent experience, however, has proved to him that these statements were incorrect. One grave defect in the previous management of the farm was the public nuisance caused by the use of a wide, deep, and uneven ditch for a sewage carrier, running as it did immediately beside a public footpath which traverses the whole extent of the farm; for this was at once substituted a 12-inch sanitary pipe in the adjoining field, with a syphon across a road, and slide junctions at intervals for letting out sewage as required, thus removing all cause of nuisance.

About two acres of this farm were prepared and used as filter beds, on the Merthyr plan, during the first year; but it has subsequently been found unnecessary to waste any of the liquid sewage by such means, as it can always be used to greater advantage in wide irrigation.

The subsoil at Hafod-y-Wern is generally open; and, drains having been laid where necessary, one application of the sewage ensures sufficient purity of effluent, but it is sometimes repeated. As a rule, the sewage is passed through depositing tanks, which yield about 600 tons of sludge per annum, but for application to fallow land in winter, and on some other occasions, the whole sewage (sludge included) is allowed to flow on to the land without passing through the tanks.

The greater part of the sludge is sold to neighbouring farmers, at a rough estimate of 1s. 6d. per ton, after about three weeks' air-drying by the side of the tank, but the remainder is carted and spread upon adjacent land which lies above the level of the sewer mouth. Colonel Jones' experience coincides with the analytical relative values commonly assigned to sludge and liquid sewage, and he finds, as might have been expected, that the latter produces its best results upon a good root of Italian rye-grass. This has yielded seven or eight crops per annum, with a nearly constant net profit of £15 per acre over the whole area in Italian rye-grass, which has expanded each year with the market for this new community, from 3 acres in the first up to 17 acres in the fourth year from its introduction to the notice of Wrexham horsekeepers.

The following extract from a letter by Colonel Jones, dated May 26th, 1873, and which was published in the *Gardeners' Chronicle*, June, 1873, will give a fair summary of the result of his first year's experience:—

"Last season was most unfavourable to agriculture generally, and more especially to sewage farms, so that a bare comparison between receipts and expenditure, such as that which you quote from a Parliamentary return, could not be expected to encourage enterprise in sewage irrigation; but, when due allowances have been made for the circumstances, there is no reason to despair as regards the future. In February, 1872, I entered

flue branch. By such an arrangement are the cylinders, as it were, encircled within a heat envelope of a very uniform temperature, for on the front side, where the heat is strongest, it only affects the ironwork by radiation from the sides of the ascending flues; but afterwards, when a sufficient portion of its energy has been expended, it is admitted into direct communication with the cylinders, and freely impinges on all parts of their tops and sides.

But there is an additional provision made in the top of each converting vessel for admitting the products of combustion directly into the freshly charged salt when it is desired to get up the temperature rapidly. When this arrangement is in use, egress is furnished by means of a damper in the discharging door mouthpiece side, which, through a passage left for the purpose, opens communication with the smoke-flue. The soot deposited in the salt does not, it appears, prove injurious, being entirely consumed by the time the cylinder is finished.

The tops of the cylinders are covered to a depth of some 8 or 9 inches with ground rock salt to diminish the loss of heat by conduction from the ironwork, &c., and the various syphons are protected in a similar way. Salt is used partly for cheapness, but principally for convenience. If a little gets into a cylinder it is of no consequence.

The whole twenty cylinders are charged by means of an overhead traveller, which picks up the waggons of salt—holding about four tons each—as they come from the drying stoves or beds, and conveys them rapidly to their destination; while the discharging will probably be accomplished through the agency of a pair of portable twin archimedean screws, which, mounted on wheels on the fire-escape principle, can be quickly run into any cylinder under its grids with the assistance of four or five men. It will be driven by a small portable engine, and the salt-cake will readily fall to the screws as soon as the central grids—which are simply long loose fire-bars—are withdrawn.

The pyrites kilns or burners, 56 in number, are equal to a weekly consumption of 150 to 170 tons of ore, and are placed in two double rows, end on to the cylinders. They are simply ordinary burners built more substantially than usual in front to avoid heat losses as far as possible.

The flues enter one common stack at the end of the kilns adjoining the cylinders, which conveys the gas mixed with the steam from the superheating pipes to the SO_2 pipe or flue previously described. Should it be necessary, by means of suitable dampers, either of the double rows of kilns can be shut off, and also, I may add, if required, may the cylinders be worked either in two sets of ten, or as at present in a single series of twenty.

The gases passing off each cylinder are at regular intervals tested for HCl and SO_2 to ascertain the absorption, and what is termed the "strength" of the gas, the latter with a view to the detection of inward leakages of atmospheric air; and so soon as the absorption in No. 1 has become reduced to about 3 per cent. of the ingoing SO_2, the cylinder is isolated from the rest by the closing of communication with the SO_2 flue and No. 2 cylinder. Then when the proper syphon has been arranged to admit the SO_2 to No. 2, the remaining 19 cylinders will keep working away till No. 1 having been discharged and refilled is reunited with the rest. Now, however, its position is reversed, for having yielded up the strong cylindership to No. 2, it falls to the rear of the series and assumes the position of weak cylinder. And as such it is coupled with No. 20, from which the connection with the HCl flue is transferred to it. A similar procedure takes place as each successive cylinder is finished, all in rotation becoming strong, weak, and intermediate.

Suppose the cylinders at work; No. 1 is the strong one in communication with the SO_2 flue connected with the burners, and No. 20 that most recently charged with salt and open to the HCl flue. Those intermediate are in "circular" communication.

The manufacturing details are then apparently—as indeed they are in reality—quite simple, though in common with other chemical processes certain points require careful attention and supervision.

One secret of successful working is at the outset perfectly dry salt. Damp salt is the source of many troubles. Not only does the moisture during its conversion into steam absorb heat, rendering it latent, but portions have a tendency to collect and condense in cool parts of the freshly-charged cylinder, and so by dissolving the salt, to stop up interstices and create large impenetrable and inconvertible lumps.

It is likewise important to keep up the plant to its full working capacity. In several cases mishaps have arisen from one, two, or even three cylinders in a series having been kept empty and isolated from the rest for days together, the effect on reuniting such cylinders and raising the temperature by heavy external firing, being their more or less complete fusion owing to the great development of heat, caused by subjecting such large masses of raw salt all at once to the action of the hot sulphurous acid gas. A steady uniformity of temperature is also very essential, for with great inequalities, the bulk of the work of a series is, perhaps, thrown upon one or two cylinders, and those the most strongly heated, and the chances of fusion of the salt-cake from the too great energy of the decomposition are thereby materially increased.

It is scarcely necessary to add that a sharp outlook should be maintained on all dampers and openings on the cylinder tops, to see that they are properly closed and secured, otherwise there will be a risk of an inward leakage of air, which will cool and weaken the gas, and retard the decomposition. And, of course, unnecessary dilution of the HCl with permanent gases, likewise means inefficient condensation.

The formation of the sulphate beginning at a temperature of about 750° Fahr., gradually increases in rapidity with the steady elevation of the latter, and the only practical limit to the heat is the fusing point of the salt-cake. The margins usually preserved are 900° to 1,100° Fahr.

In the strong cylinder (that connected with the SO_2 flue) there is a tendency, if the temperature be not kept sufficiently elevated, to the formation of bisulphate from a small quantity of sulphuric acid produced in the burner flues, but as this salt is decomposed at or below the temperature of

950° Fahr., it is an easy matter to prevent its formation at all. Once present, however, the chances of good salt-cake, so far as that cylinder is concerned, are but poor indeed, for with its ready fusibility, a slight elevation of temperature is sufficient to cement the whole into one solid cake.

A trace of SO_2 is generally maintained in the exit gases, for if the supply of this gas be exhausted before arriving at the last cylinder, and the pure HCl be allowed to pass over the heated salt, it will, in presence of oxygen, be decomposed—perhaps from the catalytic action of the ferric oxide present—and chlorine formed. It is likewise requisite to preserve a certain excess of moisture, the best amount in practice being from 10 to 15 grains per cubic foot.

When an incompletely finished cylinder is drawn, it exhibits a red appearance from the presence of ferric oxide, originating from the chloride of iron always contained in Cheshire salt, which is decomposed at the high temperature, but is not until the complete conversion of the latter transformed into ferric sulphate.

So much then for the practical part of the business.

To the more purely theoretical details Mr. Hargreaves has given great attention, devoting especially much time and labour to experiments and calculations on the radiative powers of, and losses from, different portions of the apparatus.

Through his kindness I am enabled in a few words to compare the heat energy of the two processes, the working details of which I have attempted to describe. In the old one, that is to say in the salt and sulphuric acid reaction, it seems that only some 3 or 4 per cent. of the total necessary heat is developed, or 39·02 British thermal units per pound of sulphate, while a very considerable overplus is withdrawn as previously explained. But in the direct process a very different condition of things is maintained. For to each pound of sulphate formed, 1426·6 heat units are developed by the combustion of the pyrites in the burners, and 869·7 by the conversion of the sodic chloride into sulphate into the cylinders. Total, 2296·3 units. And if we suppose the exit gases (of normal composition) to be 600° Fahr., and the sulphate in the finished cylinders 1,200° Fahr. above the atmosphere at the moment of isolation from the rest, there would be withdrawn on the former case 336·8 units, and in the latter 315·6 units per pound of sulphate, or a total of 652·4. So that dividing the unitial heat development by the unitial abstraction, you obtain 3·519 as the number of units developed by the reaction per unit mechanically withdrawn. Consequently, excepting to supply radiative and other similar heat losses, the process is entirely independent of fuel.

I have studiously avoided speaking more than casually of the muriatic acid condensers, for being quite apart from the process, I didn't care to mingle two distinct subjects. I need, therefore, merely state in passing, that less condensing power seems to be required than in the case of the old process, partly from the greater concentration of the gas, but chiefly from its much more regular emission from the cylinders.

Summed up then, the advantages claimed by the patentees over the old indirect process appear as follows:—

Firstly. Better "production," or quality of sulphate from a given amount of pyrites and salt.

Secondly. Quality of product independent of manipulatory skill.

Thirdly. Nitre unnecessary.

Fourthly. Less fuel.

Fifthly. Less condensing plant.

Sixthly. Stronger muriatic acid secured, the bulk of it being recovered in a sufficiently concentrated condition for the manufacture of bleaching powder.

Seventhly. Less labour necessary, and of a less skilled description.

And Eighthly. Less wear and tear of plant per ton of product.

But whether or not as regards the whole of these items the present anticipations may eventually be proven realities, I will not presume to say.

I have now given such a practical account of a process which has created some little stir in the chemical world—as from my engineering connection with the "Atlas" works—would, I think, naturally fall within my scope. When I selected "salt-cake" as my subject, I scarcely knew what precise form this paper would assume, having, indeed, a vague impression that it would develop into some sort of general history of the manufacture, and would therefore necessarily include an account of the "Hargreaves" process; but I speedily began to see that to give at all an accurate idea of the latter would, of itself, involve the production of a paper of sufficient length, without adding much else. So, imagining that from the comparative novelty of the process, if from no other cause, a tolerably complete description of the plant and working details, however matter-of-fact, might not prove uninteresting, I have been led to produce the paper which I have now ventured to read.

I have, beyond giving a faint outline, made no pretence of discussing the theories and the thermal questions to which the process has given rise. Were I, indeed, able to enter upon such a subject, I should feel myself trespassing on a field peculiarly Mr. Hargreaves' own. And the truth is I fear too, that not a few of us who are daily occupied in, and earn our daily bread by, the carrying out and the carrying on of chemical processes, are prone to shirk everything beyond a merely superficial consideration of theories, and to look upon the teachings of science as a sort of disagreeable medicine. I will not say we despise them, but somehow we have an innate tendency to regard them with a kind of antagonism and distrust, and to apply them to our needs, not as a first, but as a last resource.

We unconsciously, and almost in spite of ourselves, worship a god which we call practical experience, in whom we secretly imagine we live and move and have our being. We fancy that a thing must be, simply because something else has been, and we are, apparently, so satisfied with things as they are, that we do not welcome new ideas as the offspring of scientific reasoning, but regard and treat them—unless indeed they be our own—in the light of new-fangled and impossible notions. And though, happily, such opinions are raipidly disappearing before the steady and irresistible advances of modern thought, there is still, I think, something to be done in the way of

chamber steam, which latter is, be it remembered, first developed on the boilers, then condensed in the chambers, and finally reproduced in the salt-cake furnaces to be again driven off along with the acid vapours.

Mr. Hargreaves' plan then was to pass the mixture of sulphurous acid, oxygen, and steam, through a series of brick chambers or vessels charged with salt in several retrogressive stages of decomposition into sodic sulphate, the gas entering first the chamber containing salt in the most advanced stage, and finally one containing the fresh or newly charged salt, for by such means would the energy of the reaction between strong gas and pure salt be counteracted, and the temperatures of the chambers controlled. So after the usual run of preliminary failures and disappointments, in the course of which brick chambers were tested and found wanting, results were obtained which encouraged the erection of an experimental plant on a manufacturing scale. This consisted of a series of four cast-iron cylinders (soon expanded to six) each ten feet in diameter, and the same number in height. It was arranged for the gas and steam to enter at the bottom, and traversing each vessel in rotation in an upward direction, to pass off at the top. But this plan worked very badly. The cylinders became so many chimneys, and the gas took stated courses or channels upwards. So it was speedily reversed, the inlets being placed at the top, and the corresponding outlets at the bottom. And excepting in a number of working details, and an increase in size of the cylinders, the later plants have been simple repetitions of the original one. The steam at first entered direct from a boiler, and the ultimate adoption of exhaust steam superheated by the waste heat passing off to the chimney is but a natural development of the process, as is also the simple arrangement (now being introduced in Messrs. Sullivan and Co's extension plant) for admitting the superheated steam at pleasure into any particular kiln, the object being to furnish means of reducing the temperature of the incandescent pyrites should it become too much elevated, and to secure a more thorough control over each individual burner, without the disadvantage of detracting from the efficiency of the steam.

Were the cylinders and connections absolute non-heat conductors, fuel would not only be unnecessary, but some artificial means of cooling would be essential. In practice, however, that is very far from being the case, so that to make good radiative losses, and to heat up the freshly introduced and cold salt, a certain amount of external heat is requisite.

Each succeeding plant has, however, I believe, been found to work with a less fuel consumption per ton of salt-cake than its predecessor, so that Mr. Hargreaves is very sanguine of being able by judicious improvements to do away ere long with cylinder fires altogether.

The ability to heat up such great masses of material to the necessary temperature, regularly and uniformly without considerable waste of fuel, was seriously doubted by many practical men, and regarded by others to constitute an important hitch, and an effectual barrier to success. But like many another difficulty the thing looked worst before it was encountered, and was with but little grappling triumphantly overcome.

Before entering upon a description of the plant most familiar to me, as well as the most recent and largest yet erected, I must say a word or two about the salt.

This it was originally attempted to employ unprepared. But the impracticability of the idea was quickly demonstrated, so that the preliminary treatment of the salt has been one of the most important problems of the whole process. A solution of the difficulty was at one time sought in the utilisation of "pan scale," or the chippings from the bottoms of the brine evaporating pans, but this was far too dense for gaseous penetration. Then stalagmites, formed by dropping concentrated brine on to hot plates were proposed, but eventually ordinary salt slightly moistened and dried over suitably heated flues covered with iron plates was resorted to. For salt treated in this way caked into a solid mass of considerable hardness, the latter quality being much increased when ground-rock was substituted for the ordinary or manufacturing salt. But the worst thing was, the drying process caused the salt to adhere with such surprising tenacity to the metal, that the most violent means were necessary for its detachment. And this was not a peculiarity of cast or wrought iron, but was also observed in the case of lead, copper, glass, porcelain, and every other material tried.

Fortunately, however, the remedy was at hand. An intermediate layer of perfectly dry salt placed next the plates solved the difficulty. So that this plan of stove drying has until quite recently been in universal use. It is carried out as follows:—Upon a 2 to 3 inch layer of fine dry salt nicely levelled over, a 4 to 5 inch moistened one is placed, smoothed over with a shovel, and notched or divided roughly into squares about 8 to 12 inches in diameter, the latter with the double object of facilitating the escape of steam, and the after removal of the dried salt. The thoroughly dry blocks or cakes are, between a pair of coarsely serrated rolls, reduced to about the size of road metal, and when the dust produced by such an operation has been sifted out, the salt is ready for the cylinders.

Though rock salt has the advantage of hardness when dried, added to that of cheapness, it possesses several corresponding drawbacks. The particles or granules are very dense, so the gas penetrates them but slowly. Then the resulting salt-cake is of an inferior colour, and, not least, it contains a certain amount of insoluble. Consequently a compromise has been effected by the use of ordinary salt mixed with about 10 per cent. of rock—a compound which satisfactorily answers every purpose.

To practical men, however, the drying of salt in such fashion has all along been evidently, for operations on an extended scale, but a crude and unsatisfactory method of procedure at the best. For not alone do the drying floors monopolise a considerable quantity of, in many cases, very valuable ground, but a large percentage of dust is being continually formed and reformed. Also the labour and fuel questions are important. Something different was therefore earnestly sighed after. Mr. Robinson's proposal was to dry the salt upon a revolving annular bed or ring, heated by a suitable furnace, through the annular flue attached to

which it would travel. An experimental apparatus was therefore constructed. A self-acting feed was arranged to supply the salt continuously, and which in the course of a single revolution became thoroughly desiccated, while a kind of automatic plough was devised to remove the dry cakes from the slowly rotating bed. The feeding and discharging apparatus was of course arranged over a small segment of the bed left uncovered by the flue for the purpose.

This furnace was calculated to answer its object remarkably well for salt prepared as described; but about this time Messrs. Stevenson and Williamson, of South Shields, had demonstrated the possibility of forming the salt into balls by compression, and for these it was not quite so suitable. Now, the moulding of the salt has the obvious advantage of being direct, as well as of avoiding the formation of dust, while the spherical or spheroidal form is undoubtedly the best, for it ensures equality of interstices, and consequent equable distribution or percolation of the gases. And then balls run more freely to the discharging apparatus than irregular lumps when emptying the cylinders. The compressed balls are, by Mr. Stevenson's arrangement, delivered mechanically and continuously on to the travelling bed or endless band of a large biscuit oven at one end, and are discharged over the further end into waggons placed conveniently under the drum. The speed of the bed and its length are so arranged that a single passage through the oven is sufficient, and the results from the experimental use of this apparatus have been so satisfactory, that something similar will in all probability be the plan of the future.

Such, then, were some of the preliminary difficulties and main obstructions to the success of the process, and these having been in a measure solved, that is to say, the preparation of the salt, and the best forms, dimensions, and method of heating up of the converting vessels, the next questions related to labour and fuel in their varied applications, or, in other words, to the costs of production.

It was evident that the process was one of conservation. You had first to reach a certain temperature, and then to maintain it regularly with a minimum fuel expenditure; and as the cylinders themselves are simply so many immense radiators, it was necessary to protect them in the most perfect possible manner, also that the double operation of charging and discharging should be effected in the least possible time. And how these varied objects have been accomplished in the "Atlas" Works I am now about to describe.

The works have been designed for a weekly production of 300 to 400 tons of salt-cake.

Twenty flat-bottomed, double-topped, cast-iron cylindrical vessels, 15 feet in diameter, and 12 feet in depth, are disposed in two parallel rows, and buried, or encased rather, to their own depth, within an almost solid rectangular mass of brickwork and concrete, rising some 17 feet over the ground level, and in no place less than 4 lateral feet in thickness.

Tunnelling under the centre of each row are the smoke flues communicating with the chimney, and provided with the necessary dampered openings under the centre of each individual cylinder, while a few feet in front, on both sides, but hidden underground, are the cast-iron HCl gas pipes or flues, with their moveable lids opening up to the bottom of each discharging door mouthpiece.

The twenty fireplaces are arranged within the front brickwork on either side, and these with the discharging openings and the ascending flue sight holes are all that, with the exception of the bare brickwork, can be seen of the plant, on walking round it. The cast-iron SO_2 gas flue runs between the two lines of cylinders near the top, and between each individual and opposite pair has a valved branch.

The cylinders rest, not exactly on the solid masonry, but on short brick pillars rising from it, which admit of the egress of the products of combustion from the fireplaces by the smoke flue branches. The double tops consist of two flat covers, united, but kept 9 inches apart by several collars or necks, fitted with moveable covers. These necks constitute the charging holes, circulating and SO_2 gas inlets, &c.

The discharging openings are, of course, in the cylinder fronts near the bottom, and are provided with the cast mouthpieces (previously alluded to), extending to the outside of the brickwork. On the removal of the doors from these, the salt-supporting grids can be seen within the cylinders, a few inches from the bottom, as also, on looking very closely under the grids and towards the back, the "circular" gas exits. These latter communicate with a dampered stand pipe, external to, but adjoining each cylinder, and rising up within the general mass of brickwork. By means of permanent cast-iron valved bends or syphons, "circular" communication (*i.e.*, from cylinder to cylinder) is established or cut off, and through the agency of others similar, but moveable, any cylinder may be put in communication with the SO_2 flue, while communication with the HCl pipe is set up by the removal of any of the lids in the discharging door mouthpieces. The two HCl flues are directly connected, at their further extremity, with a pair of large Root's blowers, which create an artificial draught through the plant, and deliver the gas into the condenser cooling pipes. The exhaust steam from the engines driving these machines is conveyed in pipes along the smoke flues (being superheated in its passage) to the burner flue, which it enters, and uniting with the SO_2 gas, passes with it into the cylinders.

The brick encasement before spoken of i not built close up to, but, on the contrary, five inches clear of the cylinders all the way round and up, and in front of every cylinder, about 18 inches apart from each other, and separated by half a brick length, or $4\frac{1}{2}$ inches, from this annular or cylinder surrounding flue space, rise up within the brickwork six vertical—or, as they are termed, ascending—flues. They emanate from a horizontal flue underneath, which communicates with the fireplace. Into this flue the products of combustion first pass, and thence entering the ascending flues, rise to the cylinder top, find their way into the space between the two covers, and after playing round the various necks, finally thread their way into the annular surrounding flue on all sides, and so between the supporting pillars under the cylinder bottom, to the smoke-

shown that we must not expect to make money by manufacturing manure out of sewage; we must pay for getting rid of our refuse just as for any other necessary of life. What is wanted is, a system which shall carry out this necessity, at a cost which shall be within the reach of local bodies, and possibly within the requirements of ratepayers' associations.

I have before stated that at Edmonton and Tottenham an effluent sufficiently pure for all sanitary purposes is now discharged; there is also an absence of nuisance at the works such as I have not met with elsewhere.

I do not wish to condemn systems upon which no doubt much will be said, or to bind myself to anything in particular. The lime process and its residue were abominations. The Whitthread process, apart from the smell of the sludge and the cost, was an improvement. The Phosphate Sewage Company do not state the cost of their process, and I cannot help saying that it will be difficult to find a more efficient, harmless, and economical means of treating sewage than that introduced into my watershed by Mr. Hille; should a better system exist, I shall only be too glad to hear of it; and if in the future the Lee watershed and its sewage treatment be pointed to as a model for the country, my ambition will be fully satisfied.

CHEMICAL SECTION.

A meeting of this Section was held on Friday, May 12th, W. WELDON in the chair.

The paper read was—

ON THE MANUFACTURE OF SALT-CAKE.

By John Morrison, F.C.S.,
Chemical Engineer, Newcastle-on-Tyne.

The only salt-cake producing process of any special degree of practical importance, so far as I am aware, has until recent years been that consisting in the decomposition of common salt with sulphuric acid, and the first English manufacturer by this process was, I believe, the late Mr. Losh, of Newcastle-on-Tyne, who, in company with Lord Dundonald, erected sulphate of soda plant at Walker, in one of the very early years of the present century. The Lancashire branch of the trade dates, I think, from the erection of Mr. Muspratt's works in Liverpool, on the repeal of the salt duty in 1823.

The quantity of salt treated at one operation was at first limited to some 2 to 3 cwts., but gradually, with increasing improvements in the apparatus and mode of manipulation, the amount has kept on augmenting till the achievement of the present 9 to 18 cwt. batches.

The whole decomposition was originally completed in a simple sort of hollow-bedded reverberatory furnace, but afterwards in a compound furnace, consisting of a dished part, in which the bulk of the reaction was accomplished, and a second portion, heated to a higher temperature, in which the batch was finished; and this, practically, is the form still employed.

But a great stride in advance was made on the introduction of cast-iron pans to substitute the portion hitherto simply dished and constructed of fire-bricks. The early ones were only adapted for surface heat, but ultimately, as a greater degree of perfection was reached, they became available for direct heating, through the agency of fires placed underneath. These, therefore, are the shallow circular pans (or pots, as they are termed in Lancashire) in present use. They are about 9 feet in diameter and 2 feet in depth, and of a thickness gradually decreasing from 6 inches at the bottom to 2½ inches at the edge. They are supported upon a circular brick wall, built up to their margin or rim. The fireplace beneath is arranged in many different ways, but the object is invariably the equable distribution of the heat over the under surface of the vessel, and the prevention of concentration upon any one particular point. A brick dome surmounts the pan, and is constructed with the necessary charging, discharging, and HCl. gas exit openings. The last is at the top, and the second directly communicates with the drier or roaster.

This is of two distinct kinds, each being the type of its district, and having advantages peculiar to itself. The "open" one is an ordinary reverberatory furnace, the flame playing over the bed, but as it draughts through the condenser, it is, of necessity, fired with coke. The "close" furnace is of similar shape, but larger, and is provided with a double arched top; and, through a space left between the two arches, the products of combustion pass to the end nearest the pot or pan, whence, after taking a downward course, they return along flues arranged under the bed or sole, and so proceed to the chimney.

The Lancashire pot charges are much heavier than those of the Newcastle district, but a considerably longer time is occupied in working them off. The manipulatory details are, however, pretty much alike in both localities, and are roughly as follows:—The requisite quantity of concentrated sulphuric acid and salt having been introduced into the sufficiently heated pan, the whole is kept well stirred for a time, by which means the bulk of the soda is formed into the acid sulphate. A portion of the salt, however, remains unacted upon till, after being at the proper time pushed into the roaster, the batch is subjected to a greater degree of heat, well wrought with a slicer, and the decomposition thoroughly completed. Withdrawn from the furnace, it then forms the salt-cake of commerce, and contains from 96 to 98 per cent. of sulphate, with small quantities of free acid and salt.

It is rather singular that no mechanical method of stirring the mixture of salt and sulphuric acid has, until but the other day, been successfully applied, and the new furnace of Messrs. Jones and Walsh, of Middlesbro' bids fair to establish a new epoch in the history of this process.

By the arrangement of these gentlemen, the hitherto duplex operation has been simplified and reduced to a single one. A flat, circular, upright-sided cast-iron dish, 16 feet in diameter, 12 inches deep, and 2½ inches thick, resting on solid brickwork, is enclosed and arched over to form in effect a capacious reverberatory furnace, with cast-iron dished bottom. At one side is the fireplace fed with coke, and the products of combustion, after playing over the pan surface, emerge by a flue on the opposite side, which draughts to the condenser.

At the back and front are two openings for charging the salt and withdrawing the sulphate. The acid is supplied from a leaden pipe in the usual way. A vertical shaft projects through the arched roof, and rests on a footstep attached to the centre of the pan bottom. It carries two cross arms within the furnace, on which are fixed suitable scrapers and rakes sweeping all parts of the dish; also, at its upper extremity and over the arch, a driving-wheel, for transmitting the requisite motion supplied by a small engine. The shaft rotates once in $2\frac{1}{4}$ minutes, and the furnace is capable of producing about four tons salt-cake in six hours, that being the weight of a single batch.

The advantages claimed by the patentees are as follows:—

Decomposition completed in pan, rendering separate roaster unnecessary.

Likewise effected at a lower temperature, with consequent reduction in loss through volatilisation of sulphuric acid.

Better and more uniform quality of product ensured, the charge being tested at intervals, and more acid or salt added as may be required.

Less fumes given off while withdrawing the batches from the furnace.

Less labour required, one man being sufficient per shift, for the whole of the work.

Less fuel necessary, about $2\frac{1}{2}$ cwts. coke per ton of sulphate being the average expenditure.

Considerable reduction in wear and tear of pans. And finally less condensing power, and more efficient condensation.

The eventual success of the furnace, however, hinges, I think on the last point, namely, the condensation.

Now, on the Tyne, it is customary to have separate condensers for pans and roasters. In the pan condenser sufficiently concentrated acid is recovered for bleaching powder purposes, but the much weaker acid of the drier condensers is, when not utilised for the generation of carbonic acid for the production of bicarbonate of soda, usually allowed to run to waste. In the close roasters of Lancashire, however, the products of combustion are not allowed to intermingle with the escaping HCl. vapors, and so the bulk of the acid can be secured of a sufficient strength for bleaching powder in a single tower.

Consequently the advantage claimed for the mechanical furnace in condensing *power* must only be understood to apply to the Tyne.

Then, as regards its condensing *efficiency*. Practically the Jones' apparatus is an open furnace, and as such can hardly be much different in its working results from the old open furnace, excepting from two isolated facts. The first being that the absence of hand manipulation obviates the necessity of frequent openings of the working doors, and must in consequence, considerably diminish the dilution of the generated vapours with atmospheric air; and the second, that as the whole decomposition is completed in a single operation, the proportion of the gas driven off from a given weight of material is much greater than in case of the old open roaster, in which the concluding part only of the reaction is accomplished, and that, therefore, the mingling of permanent gases with the escaping HCl. is not nearly so deleterious. These two items of superiority will, however, never, I imagine, be sufficient to raise the condensing efficiency to an equality with that of the present pan condensation. And whether or not they are competent to effect for practical purposes a sufficient improvement on the ordinary "drier" condensation, I am at present unable to conclude with certainty. If they be not, then it seems to me that some modification of the new furnace will be necessary in the way of isolating the products of combustion and preventing their intermixture with the HCl. vapours, such for instance as the substitution of underside, for the present surface heating.

This, however, I should not omit to state—along with one or two advantages—would unfortunately introduce another evil, consisting of increased wear and tear of the pan, and whether such increase would of itself be more than compensated by the reduced fuel expenditure, a similar experience to that which has long since, in the case of the old furnace, proved that it pays better to sacrifice a pan every eight or nine months, than to submit to an augmented fuel consumption, added to a diminished condensing efficiency, can alone satisfactorily determine.

Such, then, was the salt-cake process—excepting only its most recent phase just described—when Messrs. Robinson and Hargreaves, five years ago, commenced their experiments. It had obvious disadvantages. It was indirect; for to produce the salt-cake you had first to manufacture sulphuric acid, and, of course, with multiplicity of details or processes naturally ensues multiplication of manufacturing or mechanical losses. Seeing, too, that the salt-cake was entirely produced by hand labour, the quality was, in a measure, dependent on the skill of the workmen. But it possessed worse features than these. And Mr. Hargreaves saw that if he could elaborate a process for producing the sulphate by the direct action on salt of sulphurous acid on the basis of the equation $SO_2 + O + H_2O + 2\,Na\,Cl = Na_2\,SO_4 + 2\,H\,Cl$, there would be good reason for looking forward to the accomplishment of the reaction with greater regularity, without the use of nitre, with a much lessened fuel outlay, and in all probability with a large labour economy. For, in respect to the fuel question, the heat theoretically developed in the combustion of the pyrites, and subsequent decomposition of the salt by such a process, would be far more than sufficient to complete the reaction of itself, whereas in the old process, not only is the heat energy of the pyrites for the most part uselessly dissipated, but the heat developed by the salt and sulphuric acid reaction is but a very small proportion of what is essential for the completion of the decomposition, while a considerable quantity of that furnished by the fuel is consumed in work done in the shape of water evaporation, and simultaneous superheating of the steam. For that the latter takes place is certain, seeing the elevated temperature at which the gases leave the furnaces. Consequently a considerable quantity of fuel becomes necessary, not merely for the completion of the decomposition, but to make good radiative losses, and perform such duties as those just described. And besides all this, there is the necessary fuel for the generation of the sulphuric acid

Royal Agricultural Society, 12th April, 1850, in the following terms:—"Burnt clay from its aluminous ingredients has the power of extracting ammonia in the alkaline salts present in sewage, and is cheaply procured."

At Luton the sludge, which like all lime deposit, is very filthy, is lifted by mechanical means from the beds, and mixed with night soil, collected from the portion of the town which is not water-closeted, and the ashes, and then sold to farmers of the district. The works are near the town and smell very badly. My Board has complained of the result of the process in use, but in the face of differing opinions on the subject has not taken upon itself the responsibility of recommending another.

The next pollution worth notice is Hatfield. This has a population of nearly 4,500; the sewage is disposed of by passing it on lands, and no pollution reaches the river.

Hertford, next in importance, with over 7,000 inhabitants, has precipitation works which were constructed at considerable cost by the New River Company some years since. An attempt was made to purify the sewage by liming it. Here again, as at Luton, the effluent, although clear, was not pure, and the adjoining town of Ware, lower down stream, was constantly complaining of the nuisance caused by secondary decomposition, which is invariably set up by the lime effluent. I believe it is a fact that the most dangerous kind of organic impurity is organic matter in process of change or putrefaction. This change is set up, and continues in the effluent after discharge from the works—the condition of the channel between the works at Luton and the stream, and the river at Ware, is evidence of this; thus, in the lime effluent, we have the worst condition of sewage. It is not the presence of organic matter in its original state which is so objectionable in sewage, but those matters which are undergoing change, in fact, putrefaction. The lime process was abandoned at Hertford, and the Phosphate Sewage Company have taken the works under contract with the Corporation. Since then I have received fewer complaints, but the same remark which I made just now as to the necessity of filtering the effluent produced by chemical process applies here. It is true that it may be said filtration is carried on at Hertford, inasmuch as small coke filters are used, but I think the area is too limited. Here again the sewage is much diluted by infiltration of subsoil water.

Ware, with 6,000 inhabitants, next comes into notice. This place formerly sent all its sewage and refuse from maltings, the latter being a liquid rapidly running into decomposition and forming considerable pollution, by several outlets direct to the river; all has now with the exception of refuse from some of the maltings been diverted, and an entirely new system of sewers has been constructed, the sewage is discharged far below the town on to an irrigation farm close to the historically famous Rye House. It was intended that the sewage should be treated by precipitation before it was applied to the land, but that notion was abandoned. The farm is in very low lying ground, and in flood time a large area is under water. I do not think the sewage of Ware can be said to be satisfactorily disposed of in the Rye meads; still it soaks away somehow, and until the land becomes supersaturated, I suppose it will not be easy to discover pollution. I question very much whether sewage "pure and simple" should be permitted to be discharged on to land which surrounds a place of popular public recreation, where thousands of hard worked Londoners go for a little fresh air, and to spend perhaps their only single day's holiday in the course of the year in the country. As early as 1841 we were told, in reference to sewage irrigation, of "the offensive and injurious emanations which the sewer water gives when allowed to spread and stand upon the meadows." In these days there are those who would teach us that the presence of a sewage farm and the odours therefrom improve the health of a locality. Verily there is no accounting for taste.

Waltham Abbey, with a population of over 5,000, the next town on the Lee proper, has lately been re-sewered, and, after trying several systems of filtration with more or less satisfactory results, nothing more than simple subsidence, assisted by "a dose" of lime very minute in quantity, is done with the sewage. It is then pumped on to the town mead, on low lying land close to the river, where it soaks away, and no pollution is for the moment apparent.

We next come to the towns on the Lee below the intakes of the water companies. Enfield, with 13,000 population, has all its sewage taken into the adjoining parish of Edmonton, on to a sewage farm near Ponder's-end, which is fast becoming a pestilential swamp. It is too low, the water level of the district being little more than four feet below the average level of the land. Some time since a company, formed to work the process known as "Whitthread's Patent," which has been fully described in former journals of the Society, put up a precipitating tank, and treated a portion of the sewage. While this was in operation all went well. The effluent was sufficiently pure to be discharged into the river below the water company's intakes. The precipitated sludge was fairly dry, ready for use when wanted, and just so much liquid sewage as the tenants required for their market gardens was periodically supplied. I am informed that the expense of this process, so far as the chemical treatment was concerned, was large. The value of the disposal of sewage by a combined system was, however, fairly demonstrated here while the company lasted, some eighteen months or two years. My Board has strongly protested against the existing unsatisfactory state of affairs.

Next to this is Edmonton, with a population of 12,000. Here about a million gallons are daily discharged. Here is also a sewage farm; but, also, larger precipitating tanks. The following is the course adopted for the disposal of the sewage. On Sundays the sewage is collected in the storage reservoir at the works, which holds 1,500,000 gallons, supposed to be the flow of 36 to 40 hours in ordinary seasons. On Mondays the pumps are worked from eight to ten hours, and the sewage is ordinarily pumped through the first tank on the land, having been first treated with a mixture "for irrigation," composed of precipitated sludge and a portion of precipitating

mixture, according to Mr. Hille's system, which has been in operation here for the last six months. This is occasionally varied, and the sewage is entirely treated by precipitation after Hille's system, and then passed in a condition which analysis proves to be unobjectionable to our streams. The work at the sewage outfall detailed for Mondays is continued alternately, as circumstances dictate. The engines pump 75,000 gallons per hour. A piece of eight acres, adjoining the sewage tanks, is kept as a downward filtration bed; no sewage in its raw state is pumped on any of the land; the sludge, which is perfectly inoffensive, is mixed with ashes from the town, and used on the farm.

We next come to Tottenham, with at least 30,000 inhabitants, and daily increasing. This place is notorious as the birthplace—and in many instances, the grave—of several sewage processes. I will not attempt to describe them, for time does not permit, but merely give an account of what is at present in operation. Here also Mr. Hille is at work, and treats the sewage with results which ought to be satisfactory. Analysis proves the effluent to be unobjectionable, and sufficiently pure to be passed to the river. The sludge is singularly free from smell, is easily dried without artificial means; and I am informed the process is inexpensive. Mr. Hille tells me that according to the accounts of the Local Board, it does not exceed 25s. a day to treat 1,200,000 gallons of this very bad sewage. Tottenham sewage is rendered all the worse by the admixture of refuse from india-rubber works, a portion of which at least finds its way to the sewers, and mixing with ammonia stinks abominably.

We learn here how valuable would have been the provision in Lord Salisbury's Bill of last session, which proposed that manufacturers should treat their own refuse on their own premises, and thus help the ultimate disposal of the sewage at the outfall of the district, a clause which I trust will form part of some future Act.

The principal pollution below Tottenham is West Ham, which, with upwards of 70,000 inhabitants sends its sewage to the tidal portion of the Lee, about 3,000,000 gallons daily. The residents in the neighbourhood of the outfall at Canning Town very strongly object to the treatment of sewage by any chemical means, and negociations have been pending some time with the Metropolitan Board of Works as to the ultimate advisability of joining their system. The tanks here have never been seriously and continuously used, though for some months in 1872 General Scott's system was tried. Several other modes have also been experimented on.

In the tributaries of the Lee much remains to be done, but the work is going on slowly and surely—all pollutions are known; much abatement is delayed by the unwillingness of landowners to part from their land for the purpose of sewage works or sewage farms; and I cannot help remarking here, as the result of the working of our Act of Parliament that in any future legislation which may take place in regard to the general purification of the rivers of the kingdom, that punishment for offences against an Act should be sought at the hands of an independent tribunal, and not, as in our case, be left to the jurisdiction of the local magistracy, themselves in many cases the greatest offenders. I can point to some important districts where prosecutions have entirely failed.

The principal pollution of the tributaries was Bishop Stortford, with a population of about 5,000, and a large malting trade; the whole sewage and malting refuse formerly went into the ditches, which were highly offensive. Now all sewage and malting water, except from one small malting, is taken below the town, collected in tanks, and pumped to a sewage farm situate on high land. The whole principle of a well-laid out sewage farm is here carried out; the effluent is good. Samples of the sewage flow, taken each hour of the 24 showed that during about four hours of the night very little absolute impurity came down. The sewers have a very large quantity of infiltrated subsoil water, and the sewage is very weak, this being the case, and to save pumping, about four or five hours of the night flow is filtered through gravel and charcoal; all the rest is pumped daily, Sundays included, on to the farm. I have not the details of the cost of the farm, but I fear it is a heavy charge to the ratepayers.

The conclusions I have arrived at on the whole question, apart from those already expressed are, that if we are to have our rivers purified, the whole country should be mapped out into districts, each under a competent sanitary officer, who should have large powers; under conservancy boards, formed to legalise his acts. That local authorities should receive advice from head-quarters as to the most advisable means for the abatement of the nuisances of which complaint is made. That local authorities should be officially informed of the satisfaction, or otherwise, with which their efforts to abate nuisance are viewed; thus much needless cost to ratepayers might be saved, and a result sooner arrived at.

That no chemical standard of purity should be enforced, the standard to be that of common sense as suggested by Lord Salisbury, each place being bound to do its best under existing conditions.

That irrigation farms whereon sewage "pure and simple" is discharged is not a mode of disposing of sewage which commends itself for universal adoption. The Mosaic law, 1451 years B.C., pointed to the land as the best purifier of refuse; it is so, undoubtedly, but we must remember that conditions are altered, and although the sewage may be purified by a sewage farm or a filtration ground, if passed without deodorisation on to them, there is an unmistakeable odour which, healthy or not, is by no means pleasant to the senses.

All sewage, in my opinion, should be deodorised before it is applied to the land; thus our air as well as our rivers might be kept pure.

Specially in my own watershed, I think irrigation farms in the low lying districts of the Lee valley are particularly to be deprecated. Sewage constantly poured into a water-logged stratum must in time become a nuisance. The farms at Ponder's End and Rye meads are examples. At Bishop Stortford, where the land is high, no nuisance exists, it is far from any buildings, and the smell is unimportant.

As to chemical treatment, it is easy enough to clarify, and partially purify, sewage; being only a matter of cost.

I think the experience of the last few years has

free ammonia that may be present, and then it is dried in heated revolving iron cylinders, whence it issues in the form of an inodorous, inoffensive powder.

The process having been at work and under inspection for five years, the Native Guano Company claim to prove, by the testimony of many independent authorities, that it fulfils the four great requirements of any sewage process—requirements that must be fulfilled before success can be claimed, and by which every process should be tested.

1st. That the effluent is sufficiently purified to be innocuous and fit to go into a river.

2nd. That this can be effected without creating any nuisance.

3rd. That no material is used which injures or destroys the manurial qualities of the sewage.

4th. That it produces a manure capable of raising good crops of every kind, and that the value of such manure not only covers the expense of the process, but even leaves a satisfactory profit.

The proof that the A B C process fulfils all these requirements is given by the following independent testimony :—

1st. That the effluent is sufficiently purified as to be innocuous and fit to go into a river.

Mr. Keates, the chemical adviser of the Metropolitan Board of Works, after a careful supervision of the process during three months at Crossness, reports as follows :—

"That the effluent water was, on the whole, very good. The A B C treatment so far clarified and defecated the sewage that, looking solely to the physical condition and chemical composition of the water produced at Crossness, I am of opinion that such water was in a fit state to be admitted into any ordinary river without producing a dangerous degree of pollution."

Analyses were lately made for the Leeds Corporation by Dr. Letheby of the effluent from the Knostrop Sewage Works, which prove that it in every particular realises the requirements of the Rivers Pollution Commissioners, and much beyond those of the Thames Conservancy.

No better proof of the purifying of the water can however be given than the following testimony in Mr. Keates' official report :

"For some time after the experiment was begun, the outlet channel was cleaned every morning. On the 10th of September I desired that it should be left untouched, in order that the effect of the effluent water might be noted, and from that date to the end of November, the half of the channel most distant from the outfall of the tank was never cleaned. After ten weeks there was no appearance of sewer fungus or other organic growth on the sides and bottom of the channel."

It is a fact that the presence of sewage fungus is positively unknown in the channels through which the A B C effluent passes.

In the tanks in Paris fish of many kinds, including hundreds of the delicate gudgeon, lived and thrived.

2nd. The entire absence of nuisance throughout the process.

Again I quote Mr. Keates' report to the Metropolitan Board of Works :—

"That during the preparation of the manure, including the storing of the moist cakes of mud from the presses, and the final drying in the drying cylinder, no offensive effluvia were emitted, and that, taking the experience of Crossness as a guide, the 'A B C process' may be carried up to the completion of the manure for the market without producing any nuisance."

And a Leeds certificate states :

"That the whole process, including the preparation of the native guano, is performed without offensive odour or nuisance."

Consequent on this entire absence of nuisance, the works for the A B C process may be safely erected in the most convenient part of a town, and save the cost of a long continuation of expensive main sewers.

3rd. That no material is used which injures or destroys the manurial qualities of the sewage.

No testimony is required for proof of this, as the blood, clay, and charcoal are in themselves useful as agricultural manures.

4th. That it produces a manure capable of raising good crops of every kind, and that the value of such manure not only covers the expense of the process, but yields a satisfactory profit.

Several pamphlets have been issued by the company, containing numerous testimonials from farmers and horticulturists (whose full names and addresses are given), testifying to the successful results of the native guano made from the sewage of residential towns. Over 4,200 tons have been sold, realising £14,000, or nearly £3 10s. per ton. Farmers commencing with trials of one and five tons have continued their orders for 50, 100, and even 200 tons.

The following testimonial proves the power of the process in treating at a very cheap cost, large daily quantities of sewage mixed with dye waters and manufacturing refuse of every kind. :—

"Town-hall, Leeds, 29th February, 1876.

"The Utilisation of Sewage Committee of the Corporation of Leeds, having now had, with intervals, more than three years' experience of the working of the system of purification of sewage by the process of the Native Guano Company, hereby express themselves as well satisfied with the results obtained at our works at Knostrop (especially with the effluent) as compared with the result of any other system which we have tried.

"The sewage of Leeds, as is well known, is very difficult to treat on account of the numerous dyes and waste products which are mixed with the ordinary domestic sewage; the daily flow in dry weather is about thirteen millions of gallons; since the new works have been completed this quantity has been purified at an average cost of about £1 per hour for chemicals, or £1 17s. per million gallons, but with a new description of alum now about to be tried, and with charcoal prepared from the sludge, we confidently expect to be able to reduce the cost. On two recent occasions, samples of the effluent water were taken every few hours for a fortnight (the process being worked continuously day and night); these samples were mixed together and analysed by Dr. Letheby, whose reports show that the water is fit to be turned into any river.

"The sludge has not yet been converted by us into a saleable manure, but four drying cylinders are just ready for use, and will at once be set to work; it remains to be proved whether the sale of the manure will pay for the expenses incurred in the manufacture, but, from replies received from many farmers and gardeners who have used some manufactured at the experimental works, it appears to be well suited for grass land, garden produce, plants and flowers.

"Up to the present time we know of no system more likely to answer our requirements; and if the manure

is saleable at £1 per ton it will pay expenses. Our own trial on grass land at Knostrop shows the value to be £3 10s. per ton as compared with Peruvian guano at £15.

"Signed on behalf of the Committee,
"GEORGE TATHAM, Chairman."

In the course of a few days the A B C process will be in operation at Aylesbury, and its power over the unmixed sewage of a purely residential town will be shown, and the manure produced will be naturally of very unexceptionable quality.

In the early days of the process it was thought necessary to use chemicals of considerable cost, but later experience has proved that this expense may be avoided, and all the materials now used are so greatly reduced in price and quantity that the A B C system is now one of the cheapest precipitation processes, whilst it stands unrivalled in the purity of its effluent, its freedom from nuisance, and the successful results of the manure produced.

SEWAGE TREATMENT; MORE ESPECIALLY AS AFFECTING THE POLLUTION OF THE RIVER LEE.

By Captain L. Flower,
Sanitary Engineer, Lee Conservancy Board, &c.

The Committee of the Sewage Conference having honoured me by a request that I would contribute a paper on this very important subject, involving as it does the purity of the water supply of a considerable portion of London, I cannot do better than give as briefly as possible some notes made during the last few years on the watershed of the Lee, which extending over an area of 600 square miles, and having a population of nearly 750,000 persons has been during five years past under my sole charge, so far as the pollution of the water is concerned, and I believe I may say I am the first appointed and only officer in charge of an entire watershed area in the United Kingdom.

I must, however, state very distinctly, that my Board being very peculiarly placed, must not be considered to be bound by any opinion I may venture to express in this paper; as at present advised it refuses to approve of anything, it merely points out pollution, and orders abatement thereof.

In view of the general purification of rivers, it is a matter for discussion whether such a line of action is or is not one which tends to the consummation of the purpose for which such Boards may in future be appointed; personally I have an idea that it would be well not to draw so fine a line, and that a little encouragement should occasionally be given to willing local authorities. I do not think that Boards should identify themselves with any one special system of sewage disposal to the exclusion of all others, because experience teaches that no one process exists which is applicable to all cases alike, any more than that any one specific will cure all diseases. Each case is governed by the chemical condition of its sewage and the topographical position of its locality. Many schemes for the disposal of sewage have been tried, and some successfully so, in this watershed. It was proposed some time since that a general system of drainage should be adopted, the sewage of the valley concentrated at one point, and run into the Thames; I must say I am not an advocate for such a mode of disposal. I think it is a weak way of looking at the question, and when I find engineers and others of eminence advocating the running out of all this abomination into deep water, and so hoping to see the last of it, I ask, are these the Englishmen of whom it is said that the word "impossible" exists not in their vocabulary, and are these of the same nationality as the men who, by boldly grappling and overcoming so-called "difficulties," have made the name of Great Britain respected throughout the globe? Such "heroic treatment," to borrow an expression from a recent report on the Thames valley, is not applicable to the valley of the Lee. It is much easier to dispose of small volumes of sewage than an aggregated quantity, and as there must be some value in the deposit, even if only used to raise low-lying ground, why throw it away, and allow it to silt up our rivers and pollute our sea frontages? Once cast a thing into the sea, and who can say where it shall turn up again.

In considering the pollutions of the River Lee, I shall confine my remarks almost entirely to water-carried sewage. Dry systems of disposal do not exist to any material extent in my jurisdiction.

So far as pollution of the water goes, we may begin with Luton, which has a population of about 20,000, and is situated close to the source of the Lee proper. Large quantities of chemical matter used in bleaching and dyeing straw-plait mix with the sewage of a portion of this town, and are led to a point, where, in consequence of a compromised litigation with a large landowner, the sewage is subjected to a liming process, and then passed to the Lee. The "tanks" so called are, with the exception of a very small portion, only "beds" dug into the chalk. These works, being of a temporary nature, cannot be called satisfactory, though the discharge of fluid from them, in consequence of the care with which they are carried on, and the enormous dilution of the fluid by subsoil water, is at times fairly admissible into the river; but though clarified it is not purified, and though clear in appearance, is not such as, in my opinion, should be passed into a river out of which drinking water is drawn; moreover, in flood times the pollution is great. It was said some years since, that if sewage were mixed with twenty times its volume of water, the organic matter which it contains would be oxidised and disappear in the course of a dozen miles or so. This is not borne out by fact, and I believe we may consider that there is no river in the United Kingdom long enough to completely destroy sewage by oxidation. It may be said that Luton is a long way from London, but it is also well known that no chemical process can of itself entirely get rid of the effects of sewage contamination, and although Luton is permitted by a special clause of the Lee Act to pass clarified sewage into the river, it is to be hoped that in any future legislation, all towns which discharge into a river, out of which people have to drink, should be compelled to pass their effluent water through land or through an efficient filter before it is discharged into the stream. Burnt clay has been recommended, and was mentioned by H.R.H. the late Prince Consort in his letter to the

irrigation, the sewage would have to be pumped to a considerable height, or carried about 25 miles towards the Humber, before sufficient suitable land could be obtained. The great outlay involved by either of these processes led the committee unanimously to the conclusion that some system of precipitation was the best adapted to the wants of Leeds. Of these, none appeared to offer the same advantages as that of the Native Guano Company, known as the A B C process, and although the report of the Rivers' Pollution Commissioners of 4th July, 1870, was very unfavourable, the committee at that time knew of no other mode which offered any better prospect of success —the company saying they could purify the sewage, and make the manure, at £2 per ton, whilst the commissioners valued it at 32s. If this could be realised, the committee saw that the cost would in a large degree be covered, and they looked, by the help of further inventions and experience, to be able to reduce the cost, still keep up the value of the manure, and effect their great primary object, the purification of the sewage; these expectations have been more than realised, for if a market can be found for the manure at even 20s. per ton, the total cost of working on this system will be covered.

Eventually an agreement was made with the Native Guano Company, the Corporation undertaking to erect works to treat 2 million gallons daily as an experiment; the company to work the process with a stipulated share of the proceeds.

This was done, and the company carried on the work at the experimental tank for a considerable time. The effluent water produced was watched with much interest, and analysed by Dr. Frankland and others. Dr. Frankland's report was, that in this effluent the polluting power was "only slightly beyond the limits proposed by the Rivers Pollution Commissioners," and this standard, it is known, was very high. A fish lived and thrived in the effluent above three months, whilst another, similarly treated, and placed in a glass globe, but supplied with the town water, died about two weeks before, thus proving to the committee, notwithstanding the commissioners' report, that the A B C process would suffice for the purifying of the Leeds sewage, and that the effluent could be no nuisance to the inhabitants below Leeds.

After our experience with the trial tank, the committee resolved, whilst not binding themselves to the A B C, to construct works sufficient to deal with the entire flow of sewage (now between 12 and 14 millions of gallons daily) by precipitation; such works being adapted for any precipitation process. These works have been constructed at a cost, including 25 acres of land, trial works, workmen's cottages, &c., of about £60,000.

The Native Guano Company not being able, in the face of all the opposition they encountered (official, professional, and otherwise), to sell their manure, on which their success depended, were compelled to discontinue working the process, and terms were arranged between the company and the Corporation, annulling the contract between them.

The establishment of the value of the native guano being of vital importance to the company, they published numerous testimonials as to its value, but these failed to create a demand. The committee, to satisfy themselves as far as they could on this point, made trials on six half-acre plots in various dressings, the result showing an advantage of 9s. 1d. on the produce of hay for two seasons, on the plot, in favour of the native guano at £3 10s. per ton, the value claimed for it by the company, over Peruvian guano at £15 per ton, whilst the quality of the hay was the best of any, though calculated all at the same price. (See two reports herewith.)

As the experimental tanks, &c., were at liberty during the construction of the permanent works, the committee advertised, inviting any one who had a better system to propose than the A B C, to test it at the trial tanks, and several responded to the request.

1st. General Scott—Purification by lime and manufacture of sludge into cement.

2nd. Councillor R. W. Moore, for a friend of his.

3rd. Silvester Fulda.—Glauber's salt.

4th. Jackson and Watson, of Great Ayton.

5th. R. Goodall—Estimating cost of material, 7s. 6d. per million gallons.

6th. W. Prange, Liverpool—Whitthread's process.

7th. Phosphate Sewage Co.

8th. Waterson and Co.

9th. Bailes and Crowther, Armley, near Leeds.

10th. John Hanson, Dewsbury.

Of the 2nd, 4th, 6th, 7th, and 8th, it may be said the plans proposed were not tested, the promoters either not foreseeing a successful issue, or not being willing to bear the cost of a trial; and of the others, that they offered, in the opinion of the committee, no advantages over the A B C process.

1st. General Scott did not propose to do more than convert the residuum into cement without loss, the Corporation bearing all the cost of purifying the sewage.

3rd. S. Fulda's effluent was not satisfactory, and he did not fully reveal his process.

5th. R. Goodall proposed to purify the sewage at a cost of 7s. 6d. per million gallons for material, but it proved to be £4 6s. 6d. on the experimental tanks, reduced to 53s. 4d. on the large works, where he experimented at his own request for some months. The Clarifying and Utilisation of Sewage Company, Limited, now represents this process.

9th. Bailes and Crowther's was not successful.

10th. Hanson's process as first used was not successful in discharging the colour when the sewage was impregnated with dye-water, but by subsequent experiments, and using a fresh ingredient which he calls hœmasite, he finds he can purify the sewage at a cost for about 22 tons per day for ingredients of 14s. 6d. per hour for the total daily flow of 12 to 14 million gallons, being about 29s. per million gallons, or £17 8s. per day, or £6,200 a year. The A B C being about 24 tons, 18s. 3¾d. per hour, or £22 1s. per day, equal to £8,048 a year.

Against the advantage of Hanson's reduced cost, there is no off-set for value of residuum, no price for it having yet been established; the inventor claims that it is of equal or greater value than the native guano.

To determine the value of the native guano as far as possible by actual experiments, quantities

varying from ½ a ton to 5 tons were given to agriculturists, farmers, market gardeners, and others, on condition that reports should be furnished to the committee of the results obtained in each case. Sixty of such reports have been received up to this time, and of these, 40 are favourable, having been tried on grass, turnips, and other root crops and garden produce, thus :—

4 on turnips.
20 on general produce.
6 on grain.
—
40

The values given vary from 7s. to 80s. per ton, only 9 give a money estimate ; the average appears to be 37s. per ton. Twenty were unfavourable ; tried on grain, grass, turnips, &c., but only in four cases on garden and general produce ; the estimated value is from nothing to 27s. 6d. per ton.

From these returns it would appear that the native guano is best adapted for garden produce. Many of the farmers remark that the season was unfavourable, being too dry.

The position in which we stand in Leeds to-day, May 1, 1876, may be thus summarised :—

There is no difficulty in purifying sewage by precipitation, so as to render it admissible into a running stream, especially one like the River Aire, below Leeds, without causing a nuisance, or being injurious to public health, but this is done at a cost. Whether or not this cost can be covered, or a profit made by the sale of the residuum, remains to be seen. The best prospect we have of such return is from the A B C process. We have at present to choose between this and Hanson's; if his residuum is of equal value with the native guano, and will sell as readily, his would have the advantage; or, if the Native Guano Company can reduce the cost of their ingredients and working to that of Hanson's, they will have the preference, unless Hanson's residuum sells as well as that of the native guano ; but if both can be reduced to the same cost, and have the same return for residuum, then the preference will be for that producing the best effluent, and if these be alike, the two processes will be of equal merit.

Although this may be taken as the position with us to-day, we are in hopes that further inventions and discoveries may be made, and that the vexed question of the profitable treatment of town sewage may in the course of time receive a successful solution.

A B C PROCESS FOR TREATING SEWAGE. NATIVE GUANO COMPANY.

By C. Rawson, Managing Director.

This process derives its name from the initial letters of the ingredients made use of, viz., aluminic sulphate, blood, clay, and charcoal, the three latter materials being specially intended to deodorise and purify the sewage waters, and the former to precipitate the impurities. An experience of over five years has proved that the A B C mixture removes from the sewage nearly the whole of its nitrogen, except that which is found in stale sewage in the form of free ammonia, and it even reduces this. In fresh sewage but little free ammonia is detected, and the other nitrogenous matters are precipitated in the native guano produced by the process. The little ammonia left in the effluent is in the form of sulphate of ammonia, and, therefore, as harmless as common salt. The process also removes from the effluent, and adds to the manure, every trace of phosphoric acid, a most important circumstance as regards the immunity of the effluent from future putrefaction. The effect of the A B C mixture is so instantaneous and complete, that from the moment it mixes with the sewage it is deodorised, and throughout the remainder of the process, even through the hot cylinder drying, or through many months' exposure in the open air, the deposit is entirely free from all nuisance ; and the effluent water has been kept for years without any change of appearance or the least taint of smell, and that, too, without any filter being used or required. By the addition of a small quantity of carbolic sulphite (for the sole use of which valuable agent the company have made satisfactory arrangements), all living organisms and disease germs are effectually destroyed, and by the paralysis of organic ferments, subsequent putrefaction both in the effluent and in the deposit is entirely prevented. It has also been incontestably proved by many months' trial at Leeds, that the mixture of dye water and the refuse of many kinds of manufactories do not interfere with the proper working of the A B C process. Notwithstanding the mass of such impurities coming down daily at Leeds, the effluent continued for months, night and day, to run off in a clear transparent cascade, free from smell or colour. Each chemical ingredient of the A B C mixture has its direct and intentional functions to perform, as follows :—

When sulphate of alumina is brought into contact with sewage—a slightly alkaline liquid charged with nitrogenous organic matter—the alumina is separated in flocks, and by virtue of its remarkable affinity for dissolved organic matter, each particle seizes hold of and drags down with it a corresponding particle of nitrogenous impurity.

But the precipitated hydrate of alumina is light in character, and although it would ultimately settle, leaving a clear liquid above it, the slightest agitation causes it to float up, and thus renders it difficult on the large scale to drain off the mud.

The difficulty, however, is overcome by the introduction of the clay. This substance has a curious physical property; when finely ground up with water it forms a creamy emulsion which takes many days to settle, but on meeting with sulphate of alumina it, like albumen, coagulates and settles down, in heavy granular flakes.

Now in the process under consideration, the triple precipitation occurs at one time, and the three reagents becoming closely locked together, the heavy character of the clay gives density to the mass, and causes it to settle rapidly and remain in a compact form at the bottom of the tank. Any foul gases that may remain in solution in the water thus cleansed are attacked and rendered innocuous by the charcoal.

The purification process being completed, it remains to prepare the resulting manure for the market.

To the mud is added a small proportion of sulphuric acid, in order to prevent the loss of any

scientific education, with an especial view to technical and practical uses, before they shall be entirely eradicated and driven into the regions of the past.

DISCUSSION.

The Chairman said he must confess he had not been enabled to follow quite all the details, his acquaintance with the process being entirely theoretical and not practical, but he saw several gentlemen in the ro m who had had experience in it, and no doubt they could offer some valuable remarks.

Mr. Brock (of Widnes) said Mr. Morrison had stated very correctly the main points of the process. The British alkali works at Widness were very early in the field, and had paid the penalty which generally fell upon those who took up a process early in its history, finding many great improvements required to be made. They started with eight cylinders in one row, and they found that the heat losses from the row thus arranged were so large, that the salt-cake could not be made with the same amount of fuel as by the old process. They were now doubling the plant by erecting another row of eight cylinders, arranged much in the same way as those on the diagram, the pipe leading from the barytes burner passing down between two rows of cylinders, but with this difference, that many of the ascending pipes were on the outside. No doubt it would be better to have them all on the inside to avoid loss of heat, which was the most important point of the whole process. He believed with Mr. Morrison that with proper attention being paid to that point, the process could be worked very nearly, if not quite, without fuel. There could be no doubt as to the quality of the material turned out, for although they worked under great disadvantage, they had no difficulty in turning out salt-cake from 98 to 99 per cent. Of course sometimes they had cylinders not quite up to the mark from various causes, but as they got to understand the practical details better, they would, no doubt, avoid all mishaps of that kind. Hitherto they had been caking the salt and drying it on solid beds, but he thought by and by, following Mr. Stephenson's steps, they would be able to prepare it in balls or little cylinders by machinery, which would no doubt be preferable.

Mr. James Stephenson, M.P., was very glad to have heard such a clear and distinct paper regarding this most important process. He should not have ventured to have gone into it unless he had come to the conclusion that it must be the process of the future. The enormous advantage of discarding entirely the most costly and in some respects the most troublesome departments of a chemical factory, that of the sulphuric acid chambers, was an improvement amounting to a revolution: and being able to apply a sulphurous acid in a gaseous state directly to the conversion of common salt in its solid state, without getting both those articles into the liquid state, was on the face of it a very great simplification, and ought to be an economy. Mr. Morrison had clearly pointed out the practical difficulties of the process. They were the conservation of the theoretical amount of heat developed in the process, and, secondly, the preparation of the salt of suitable density and shape for being surrounded equably, and penetrated by the sulphurous acid in order to its conversion into sulphate. As far as his conclusions went they were far yet from having solved the problem of conserving all the heat naturally developed in the process, for it took more coals—when it ought to take none whatever—than were required in the less theoretically perfect operation, which had the advantage of being perfected by long experience. However, he hoped it only wanted the experience of the Hargreaves process to realise the economy which ought to be produced. In his own case, one cause of the excessive use of fuel was the very slow process of decomposition, from the too great density of the compressed balls of salt which they had been working with. They were so much compressed that there was a smooth skin formed outside, and a very hard stratum just inside, which made it extremely difficult for the gas to penetrate it. Of course, it was simply a matter of time, but time involved slowness of combustion, and that was what took place inside the cylinders. If you had too slow a draught for burning anything the fire would go out; and, in the same way, the very slow decomposition of these hard salt balls by the gas was equivalent to a slow combustion, and necessitated the application of external heat. There was, no doubt, a great mechanical advantage in being able to produce the salt in blocks of a somewhat spherical shape and uniform size. The equal presentation of the surface of these blocks to the gas was an immense advantage, because the whole of the cylinder would come to maturity about the same time, and you could fill it at one point at its upper surface without difficulty, as the balls freely rolled over each other. He was now trying to mould the salt in a less condensed condition, and in a rough cylindrical shape, which some irreverently termed sausages. He had no doubt if they could succeed in doing this the salt would be more easily penetrated by the gas, and consequently would be more rapidly converted into sulphate. One point Mr. Morrison has not mentioned, and he feared it had been somewhat neglected. At a certain stage in this process—it might be between cylinders 2 and 3—there was a considerable formation of sulphuric acid. It might be an advantage, or it might not, but he had reason to suspect that when the testing for sulphurous acid at the tail end of the whole process showed none, there might be some sulphuric acid there which was not generally looked for, and that might account for the theoretical product of sulphate of soda, which ought to be derived from the pyrites, not being obtained. He considered it very important to superheat the steam, but he had not ventured to do so in a flue underneath the apparatus, as it would be rather risky. He had, therefore, taken the steam direct from a high pressure boiler, and passed it through a series of cast-iron pipes, placed in a furnace so as to heat it sufficiently to secure there should be no loss of temperature by cold steam. The process was extremely interesting and valuable, and he thought only required to be persevered in to prove a great success.

The Chairman said that on one point just mentioned by Mr. Stephenson, a letter which he had received that morning from Mr. G. Davis, the new manager of the Runcorn Company's works, might throw some light. The letter stated the following facts as having come under Mr. Davis's experience:—That the cost of the plant for the working of the new process is about the same as that of the old; that it requires from 8 to 17 cwts. of fuel per ton of salt-cake produced; that the absorption of sulphurous acid averages 99·6 per cent.; that the gas leaving the cylinders contains 130 grains of hydrochloric acid per cubic foot, and leaving the condensing towers 2·8 grains, and that the condensed acid contains ·68 of an ounce of sulphuric acid per cubic foot. Mr. Davis also states that there is very little loss of sulphuric acid, and that the labour and wages are less than in the case of the old process, and the repairs considerably so. The desiderata seem to be, first, a method for crushing the baked salt into pieces of a suitable size without making much small; and second, a means of heating a mass of 40 tons with great regularity. Although he (the Chairman) was individually deeply interested in this process from several points of view, he had no practical experience either of the process or of any of the details, and could not, therefore, criticise the paper, but he had much pleasure in proposing a vote of thanks to Mr. Morrison.

Mr. Morrison, in reply, said he believed Mr. Stephenson's remarks very just. It was, perhaps, an omission on his part not to have mentioned the matter, but, as he observed, he had only given a description of the process from an engineering point of view. On the face of it, it did seem rather strange that sulphuric acid should pass away from a cylinder containing nearly raw salt, at a temperature of from 800° to 900°. It seemed impossible that any great amount should pass through the cylinder at that temperature.

Mr. Wills proposed a vote of thanks to the Chairman, which was carried unanimously.

TWENTY-THIRD ORDINARY MEETING.

Wednesday, May 17th, T. R. Tufnell, Member of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Dawbarn, William, Elmswood-hall, Aigburth, Liverpool.
Dunn, Andrew, Millbrook-villa, Guildford-road, S.W.
Grey, Albert, St. James's-palace, S.W.
Hicks, George Matthew, 51, Rutland-gate, S.W.
Hill, Alsager Hay, 15, Russell-street, Covent-garden, W.C.
Holden, John, 64, Cross-street, Manchester.

The following candidates were balloted for and duly elected members of the Society:—

Graham, George, 20, Lancaster-gate, W.
Knobel, W. R., Conservative Club, St. James's-street, S.W.
Monckton, John Braddick, 44, Wimpole-street, W.
Stiff, Ebenezer, London Potteries, High-street, Lambeth.
Tarn, William, 21, Lancaster-gate, W.

A lecture was delivered on—

RAILWAY SAFETY APPLIANCES,

By F. J. Bramwell, F.R.S.

Mr. Bramwell, in commencing his address, said that he had a twofold object in view; one was to endeavour to explain and, if possible, to interest the meeting in safety appliances on railways; and the other was to vindicate the engineer from the aspersions sometimes cast upon him, that, having devised a railway and invented the machinery, he thought he had done enough for mankind, and put his engine to work regardless of the safety of the passengers. He knew that was the view occasionally entertained as regarded the engineer, but it was not true. Ever since railways had been in existence, engineers had been devoting themselves to find out how they could be made more safe and more speedy; safety had been one of their earliest and most constant considerations. With respect to the different causes of accident, he could not do better than refer them to the table on the wall,* which had been taken from Blue Books. It showed the causes of railway accidents from 1870 to 1873, and the percentage out of 100 accidents due to each cause. They were arranged in order of gravity; 58, nearly 59 per cent., were due to collisions of various kinds; 12 per cent. arose from trains being turned on to wrong lines or split; 9 per cent. from leaving the rails; 9 per cent. (he took no account of the decimals) from defects in the rolling-stock; 4½ per cent. were from inclines; 1 per cent. arose from entering stations at too high a speed; and 4½ per cent. were from miscellaneous causes. The deaths of passengers from causes beyond their own control averaged 35½ per annum; the journeys, exclusive of season-ticket holders, were over three hundred and ninety-seven millions per annum, so that there were eleven million journeys for each death of a passenger from causes beyond his own control. No doubt there were more deaths from people entering trains while in motion, but any one who did this was guilty of great negligence, and must take the consequences; after all it was better that one or two men per annum should be killed, than that annoyance should be suffered by all from the locking-up process, as in France. Having given them the total of the causes of accident, he would attempt to deal with the miscellaneous causes. Entering stations at too high a speed was a very slight item, and caused something over 1 per cent., and spoke therefore for itself. As to leaving the rails, the third cause of accident, he would endeavour to show briefly what had been done with the object of, as far as possible, preventing that cause. There was a natural force tending to induce trains to leave the rails at curves. When anything was swung round, there was a centrifugal force tending to draw it from the centre. A rider in a circus leans towards the centre to avoid this effect, and in the same way the engineer by elevation of the outside track sought to overcome the same tendency. That elevation could only be accurate for a particular speed, and a uniform speed had therefore to be assumed. One rule was enough for all practical purposes. It was this: that for one mile an hour on an ordinary 4 feet 8½ inch narrow gauge they required the rail to be $\frac{1}{16}$th inch higher. For any other speed a greater and proportional height was needed. That was the precaution that the engineer took to prevent trains from leaving the rails at curves, but when the curves were very sharp, the elevation was not sufficient, and he placed a check rail higher than that upon which the carriage wheels were borne. Another cause of accidents was the imperfection of the joints. In the early days of railways, joints were made as people would naturally suppose they would; a rail was taken as long as convenient and laid in chairs, which supported it at intervals, and there was a chair at the end; the ends were thus supported in a chair. That way was attended with many disadvantages. As they would see by the sketch, when the weight of the wheel came on, say, the left-hand rail, it would depress it, and that would depress the left-hand side of the chair, and push the sleeper into the ballast. The mere effect of a train approaching would cant the sleeper into the ballast, and every time a wheel passed over a sleeper it would cause a rocking that would in time grind the ballast to powder, the particles of which would be washed away. Many people tried to get rid of that difficulty, and amongst others Robert Stephenson took out a patent for what was known as the rocking-chair. He thought that if the means were provided for rocking in the chair, the chair itself could be stopped from rocking. So, by putting in the chair a cheese-shaped saddle, he hoped that the saddle would rock in the chair, while the chair of the sleeper would keep still. But that did not answer. Another attempt

* See p. 649.

was made to get rid of the joints in the chairs by brazing the rails together, and doing without any joints whatever. That did not allow for expansion and contraction, and had to be given up. Then a portable furnace was carried about to make the joints of the rails as they lay on the line. That was tried, but had to be given up, as the rails were too rigid. There was another defect which existed in the ordinary joint of the chair and rail. The end of the rail, which was subject to the knocking, was beaten by continual hammering into a sort of fan shape. If a man was given a rod of iron, and the task were set him to beat it down to half its thickness at any point, he would naturally not begin at the middle, but at the end, where the particles of metal were supported at one instead of at both sides. The result of the continual hammering to which they were subjected caused the end of the rails to be beaten out into a fan shape. Such was the condition of things when Mr. Bridges Adams invented his fish joint. Mr. Adams commenced by doing what everyone had said could not be done. The mass had rested upon an anvil, as it were, and he said, "Avoid having any anvil under it. Put the joint where you have nothing underneath it." He put the joint half-way between two chairs, and the result was that when the wheel came along it no longer depressed the rail. There was no longer an anvil underneath, no longer a rocking sleeper. [Mr. Bramwell made this clear by the aid of diagrams.] He contended that that was one of the greatest improvements that had ever been made in the permanent way of railways, and the saving might be reckoned in this country by millions. The next thing he would touch slightly upon were the accidents upon inclines, and those amounted to $4\frac{1}{2}$ per cent. for the whole. In certain cases there were provided special safety appliances, such as self-acting breaks, methods of turning the train off the rails into the ballast, &c. These were generally only applicable to colliery trams, and the like. He would say no more upon that, but come to the defects of rolling stock. Amongst those, he should go first of all to the question of wheel tires. Railway wheels in England were made of wood, wrought iron, or more rarely of cast iron. Occasionally they had wheels made of solid wrought iron discs, and those were very good wheels. They had a good many wooden ones; but they generally made them of iron, and put the tires on in the same way as they put the tires upon wooden wheels. He was not sure that the engineer was to be praised for continuing this mode of manufacture. The railway wheel had spokes which were laterally vertical, and which, therefore, resisted vigorously any radial pressure applied to them: the carriage wheels, on the other hand, as shown by the figures, had spokes which were inclined sideways, or dished, as it was called, so that, when the tire was shrunk on, the contraction increased the inclination, and in that way the size of the circle was diminished, to adapt itself to the contracted diameter of the tire; and, as such a tire, by the hammering action which occurred on roads, became elongated, the elastic wood spokes, reasserting their former position, preserved for a long time the tightness of the tire. In wrought iron wheels there was not any dishing of the spokes, nor would it be safe to employ such a construction. They had a material that did not admit of yielding, and there was a considerable difficulty in shrinking the tire on with certainty. If they did not have it small enough it would be liable to come off, and if too small, it would be in danger of bursting. To hit the point between the two was difficult, but it had been done. The ordinary way to make the tire was to roll out a straight bar of steel, and having rolled it out to bend it into a hoop, leaving the ends to be welded together. The welding first employed was not found to answer, and several more or less complicated methods were tried instead, but it was at last found that a simple butt weld was the best. The great object was to prevent the ends from getting dirty in the fire, as this prevented the contact of metal with metal. That was done in this way. The ends were cut clean and brought opposite one another, and one end was hammered so that its edges fitted over the other end; then, while the iron was in the fire, by means of a screw, forcing the ends together, the weld was made. But still the weld was a source of danger, and it was the common practice in wheel works that the workmen should put a mark upon each side, showing to any person who might get the tire into his hands the position of the weld, so that it might not be weakened by drilling holes through it. But where, if they wanted a hoop, was the necessity of making a bar, to begin with? It was just as easy to make a hoop at first. In 1864, Mr. Bramwell brought the matter before the British Association at Birmingham, and he then ventured to say that he did not think in ten years' time there would be a welded tire in England. Now, no new tires with welds were made, or if so, the cases were very rare. He would not be right in saying that no new welded tires were made. Nevertheless, do what we could, tires occasionally fractured, and such fractures had been attended with the most disastrous results. There had been a safety appliance to obviate that, which, if the tire burst, prevented the parts from flying away. The common plan was to have bolts, which were of use only to prevent it from slipping off sideways, if it got loose. But Mr. Mansell turned a groove, and put rings in it with a lip or hook, which entered into a pair of recesses turned in the tire. By means of those rings with the hooks, it would be seen that the tire was held all the way round. Instances had been known where the tire had broken but the wheel continued to run with absolute safety. That was one of the greatest safeguards for a tire that they had. Probably they might know that when a tire was made circular at once, the rolling mill in which they were made was so contrived that one of the rollers was within the tire and another outside, and turned the tire round and round. Now one of the greatest advantages from that mode of rolling was the saving of iron. In rolling a straight bar of iron, the "crop" or rough irregular end had to be cut off. In ordinary waggon tires of 9 feet long, about 2 feet at each end were useless. But when a tire was in a ring there was no crop end, and, therefore, a considerable saving in the manufacture. Moreover, when they were rolling a hoop between a pair of rollers, it ran by itself and did not require any handling. Again, with respect to certain defects in the rolling stock. On the wall he had two figures of a crank axle or double crank.

There might appear little difference between the right and the left hand ends of the figure, yet there was sufficient difference to cause one constructed in the manner shown to the left of the centre line, to fail inevitably and very speedily, while one constructed as shown to the right of the centre line, might be expected to run with safety. This was only because they were differently shaped. So surely as they put the crank to the left to work, would a minute crack begin at the junction of the crank pin. If the axle were taken out no crack would be visible, but if hammered, a minute line of grease would ooze and reveal the crack. But if they had curves at the crank, and did away with the superfluous metal, then the crack would have no spot to begin, and so it would not begin at all. All sorts of papers had been written on that, and he ventured to say, "Read my book." He had written a paper, read before the British Association, on the influence of form upon strength, and had endeavoured to explain where it was these extra strains took place. He came next to the subject of explosions in locomotive boilers. At the North-Western Works, at Crewe, they made steel boiler plates of great strength, and so well, that out of 500 sets of plates for boilers they had only turned out one bad one. Time would not allow him to say anything more as to preventing accidents from defects in rolling stock, and he would go on to the causes of accident from collision. Collisions were of three kinds; first, a train might overtake another when they are both in motion; secondly, a train might run into another when it was at rest; and thirdly, a train might meet another, as on a single line of railway, or when coming to a junction from a branch on to the main line. As regarded the single line, the railway safety appliance for preventing accident was so simple, that he was afraid they would say it was not an appliance at all. It was based upon the well known rule that an object could not be in two places at once. The contrivance was simply to use what was called a staff, a piece of wood, ornamentally formed and with a name upon it. It belonged to two stations, and unless the engine driver had the staff, he had no right to be upon the section of railway between them. This placed a great restriction upon freedom of traffic, for if the staff were taken from A to B, and it was not wanted to send a train back from B to A, they could not manage it except by sending an engine back with the staff. That would not do on the suburban lines, or on lines where at particular times the bulk of the traffic went one way. Then there was also the staff and ticket system, by which the station master at A holding the staff sent two or three trains on with tickets, and then a train with the staff. The station master at B, in like manner on receiving the staff became the controlling authority, the principle being that whoever had the staff was at liberty to issue tickets. With respect to accidents from two trains meeting one another on a single line, an accident was commented upon some two years ago. Two trains going at the rate of 35 miles an hour each met, and it was said that they met with a force of 70 miles an hour. That was a mistake, it being an error to suppose that two bodies running in opposite directions would meet with a force represented by the sum of the forces of each. As regarded contrivances applicable to all lines, semaphore signals were almost entirely used in England. [Mr. Bramwell then went through the various positions of the semaphore signal.] Formerly, he said, they wanted three positions, for they regulated traffic by time. The train went past the signalman, who put the signal to danger; it remained at that for a certain time, say five minutes, and was then put to caution; it remained at caution for a further time, say five minutes, and the signals were then put to safety. That mode had now been given up, and the block system, which did not depend on time but on distance, had been introduced. They had the home signals and distance signals at the space of about a hundred yards. Now if they took the figure on the wall, they had the elementary block system. They had sections A B, B C, and C D. The moment a train passed A, and got between A and B, the signal at A was put up, showing that a train was in the section. If B be signalled all right the train will pass B. But if there be a train between C and D, until the man at D signals that it has past him, the first train would not be allowed to pass B. There was no doubt that that system had contributed a large element of safety in the working of railways. It was not absolutely safe, for such a thing had happened as a train breaking in half. Then the signalman seeing part of the train passing him might signal "line clear," and the remainder would be run into. Then again the man at B might not telegraph to the man at A, or the latter might think that he had, and take his signal off. But contrivances were now made which, though they enabled one signalman to put up the danger signal, required the concurrence of two to take it off. There were other contrivances which had been invented for preventing one train from coming into collision with another, by means of electric signals, transmitted through a metallic brush attached to the passing engine. Then there was a contrivance for blowing a whistle, and there was the old fog signal. Before coming to the question of brakes, he would notice an invention of Mr. Ramsbottom, to enable engines to take in water while in motion. Mr. Bramwell then described, by aid of a diagram, how a pipe let down from the tender dipped into a trough in which was from four to five inches of water. The mouth of the pipe scooped up the water, and a velocity of 16 feet would send the water up the pipe, and would fill the tender. The difficulty as to the proper place for lowering and raising the pipe was met by giving the rails for a few yards before arriving at the trough a slight rise, the top of the hill being reached opposite to the end of the trough. That carried the pipe over the end of the trough, and the engine going down a corresponding hill immersed the orifice in the water. At the further end of the trough the hill was repeated in the rails, and the pipe was carried clear of the trough. An engine could thus take in 1,500 gallons of water without stopping. Concerning brakes, they acted usually by arresting the wheel and causing it to act as a sledge. There were continuous brakes and brakes only applied to the tender and to the brake van occupied by the guard. If they converted a wheel when it was revolving into a sledge, the resistance was equal to one-sixth part

of the weight; if the tender weighed 18 tons, and its four wheels were converted into four sledges, there was a resistance of three tons. As to the time and distance, take a train weighing 160 tons, and going at the rate of 30 miles an hour. In that case it would have the velocity due to a fall of 30 feet. But the train of 160 tons travelling at the rate of 30 miles an hour would have a stored up energy equal to 4,800 foot tons. If they pulled that weight through one foot it would represent the energy of that train. So, by increasing the resistance, they decreased the distance the train would travel. It was, therefore, plain that they could calculate the distance within which a train could be brought to rest. That distance would vary with the square of the velocity. In a train such as he had instanced, weighing 160 tons, the tender and two guard's vans would weigh 42 tons. When the wheels were converted into brakes they would act with a force of $\frac{1}{6}$ of that, or 7 tons. If the train, therefore, were going at thirty miles an hour, it would bring it to rest in 230 yards. In practice, brakes could not be put on the moment they are wanted, and required double the distance given by the calculation. It might have been thought that much could be done by the reversal of the engines. They would see that the brakes on the tender and the two guards' vans had a resistance of 7 tons, while the tractive force of the engine was $1\frac{1}{2}$ tons. By reversing the engine, they only converted 7 into $8\frac{1}{2}$ tons, and the reversal of the engine was by no means a judicious mode of aiding the brakes. The reversal of the engine was an excellent way of working a train down an incline, or when they wanted some brake power for doing the work at stations. M. Le Chatelier, who died some two years ago, was the inventor of the *contrevapeur* system. In it a small jet of water was injected into the cylinders, and was there converted into steam by the heat arising from the momentum of the train thus suddenly stopped. The heat was thus absorbed instead of being allowed to affect the cylinders injuriously. The ordinary way of working was by the two break vans, but there had recently been a great demand for the continuous self-acting brake, and some very careful experiments had been made. A late friend of his, a past president of the Institute of Civil Engineers, used to relate that inventors came to him and said they had a brake which would stop the train dead. "Then you have something to kill all the passengers" said he. But they might dismiss that risk from their minds. The best brake they had did not do much more than take $2\frac{1}{4}$ miles velocity out of a train in each second of time. See what velocity any person under the influence of gravity would obtain in each second of time. In a second of time a falling body would attain a speed equal to thirty mile san hour. They might fairly compare putting speed into the body and taking it out. A swing when in the middle of its course travelled at the rate of thirty miles an hour. Yet that was all taken out before it came up to the horizontal line, which would happen in $1\frac{3}{4}$ seconds. That thirty miles had been taken out at the rate of seventeen miles in a second of time. Recollecting what the best brakes they had would do, they need not fear being killed by the shock. At a colliery near Wigan there was 806 yards of winding from the bottom to the top. They must stop perfectly accurately, or the cages would go over the drum above. In the middle of its course the speed was 58 miles an hour. They did not check that until they were within 180 yards of the top, so that they stopped that 58 miles an hour in that space without injury to any one. But if continuous brakes did enable them to be brought to rest in a very short time, they would become universal. They were by no means an unqualified good, for when the wheels were converted into sledges flats were worn on them. That now only occurred, and of course caused jolting, in the brake vans, but if the brakes were made continuous, the same thing would happen all along the train as the wheels became subject to that kind of wear. Excessive brake power was not always useful in cases of accident. Sometimes it was productive of absolute harm. If a wheel of a carriage broke, and that carriage was coupled up tight with the carriage in front, so long as there was motion in the train and it was brought gradually to rest, no harm took place. But if continuous brake power were used, the train would be suddenly arrested, and the carriage no longer supported would cause an accident. Continuous brakes, in fact, would be an unalloyed good, if the engine driver had time to think of what was best to be done, or if he always knew what was best. That was not possible; but, on the balance of evils, Mr. Bramwell believed continuous brakes were a benefit. On some railways the express trains were provided with them, and he believed at the first station from London they stopped the train by means of them, to see that they were in order. But after that they used the ordinary brake, except in cases of accident or to avoid collision. He would mention a matter that caused him extreme surprise—the height which Capt. Shaw told him London firemen were in the habit of jumping. Any of his men, he said, could jump 20 feet, and some jumped 30. But it made a great difference upon what body the impact was made. If a man fell on the pavement he broke his arm, but on a carpet he did not do so. Yet the thickness of the carpet was very slight. In the same way at rinks one heard of broken limbs, but there were few such accidents on the ice, because in the latter there was a slight elasticity. He had now occupied them long enough, and should reserve his further remarks till their next meeting.

1870 TO 1873.—CAUSES OF RAILWAY ACCIDENTS.—PERCENTAGE, ONE TO EACH CAUSE.

1....	58·7	Collisions of various kinds.
2....	12·0	Trains turned into wrong lines or split.
3....	9·2	Leaving lines.
4....	9·2	Defects in rolling stock.
5....	4·6	On inclines.
6....	1·3	Entering stations at too high a speed.
7....	4·5	Miscellaneous.
	100·0	

Deaths of passengers from causes beyond their own control, per annum	35·5
Journeys, exclusive of season ticketholders, per annum	397,478,249
Journeys per death	11,000,000

MISCELLANEOUS.

THE RESOURCES AND PRODUCTIONS OF TUNIS.

In a report made by Consul-General Wood, is given a description of the Regency of Tunis, one of the Barbary States, which comprises the tract of country included in two ancient Roman provinces. It is situated in the central part of the northern coast of Africa, and is bounded on the north and east by the Mediterranean Sea, on the west by the Franco-Algerian province of Constantine, and on the south by the great desert of the Sahara and the Turkish Pashalik of Tripoli. It lies between latitude 37° 20′ north, and 31° south, and reckoning its average breadth from west to east to be 100 miles, it covers an area of about 42,000 square miles, including that portion of the Sahara, which is to the east of the Beled Djerid, extending towards Gadamés.

The Regency of Tunis pushes itself, as it were, far out into the Mediterranean, and its most northern extremity is only eighty miles distant from the coast of Sicily, Owing to the peculiar geographical position, it is considered one of the most important of the sea-bound provinces of Northern Africa. Its coast-line measures 400 miles, and is continually intersected with more or less commodious harbours. The northern portion of the country may be generally described as mountainous and hilly, particularly in the neighbourhood of the boundary line between Tunis and Algeria. The mountains between Tabarca, in the former, and La Calle, in the latter, are of considerable elevation, and take a southerly direction towards Keff. The districts to the north and east are nearly uniformly level, interspersed with a few inconsiderable ridges running in a diagonal line from the south-western boundary of Algiers, below Tebessa, to Cape Bon on the north-east. This elevated tract is considered to be a lower chain of the atlas range, but between the higher ridges of the mountain ranges there are considerable plains and valleys. The plain in which the metropolis is situated is fifty miles in length, and twenty in breadth. It is intersected by some unimportant ridges of rocks and hills, and its soil is extensively cultivated by the inhabitants. One of the most important districts is the Djerid; it forms, as it were, its southern boundary, and extends from latitude 34° north to the Sahara, and westward to a great salt lagoon, contiguous to the frontier line between Tunis and Algiers. It includes a district which contains numerous springs and watercourses, and these irrigate the fields and plantations of date trees, some of which cover several square miles. The inhabitants are wealthy, and live in villages or small towns, in well-constructed houses. They bestow extraordinary care on the cultivation of the numerous date trees which they possess, as well as on their extensive gardens and orchards of fig, apricot, peach, orange, pomegranate, and almond trees. They likewise raise a considerable quantity of cereals, vegetables, and melons.

In the absence of any census, it is difficult to estimate the present population of the country. We know that in the days of its greatest prosperity, vast quantities of grain were exported from its shores, and its own population (said to have been 17,000,000 to 18,000,000) fed from its abundant produce. The early Christian Church numbered many episcopal sees within its limits, and in the eighteenth century its population was estimated at 5,000,000. The great plagues of 1785 and 1829 carried off more than half the inhabitants, and the diminished population was again decimated by the famine and typhus in 1867. Calamities of this kind are felt with more than ordinary severity by the Bedouin Arabs, who are practical fatalists, and never adopt any precautions against famines or contagious disease. The present population is formed of Bedouin Arabs and Kabyles. The Arabs generally frequent the plains, and live under tents, which are pitched in circles. Although the Arabs are nomad in their habits, and wander from place to place in search of the most favourable spots for cultivation, and the most protected sites for their dwellings, the districts within which each tribe is at liberty to roam, are tolerably well defined. The Kabyles inhabit the mountains between the Pashalik of Tripoli and the Regency, to the south, as well as the ranges forming the western boundary which divides Tunis from Algiers. The former are docile and submissive, when compared with the Kabyles of the west, who barely recognise the authority of the Government. These latter are jealous, suspicious, and inhospitable. They allow no foreigner, not even an Arab, to visit their mountain fastnesses, which are protected by rugged ascents, and surrounded by the densest of forests. No approximate estimate can be possibly arrived at as to their numbers, but we know that they are able to bring 18,000 fighting men to the battle-field. Besides rearing cattle, these Kabyles offer for sale honey, wax, grain, pulse, and tobacco. Their extensive forests consist of the following trees, viz., elm, ash, poplar, yew, wild olive, oak, and cork. Tar and pitch are also obtained from them.

The capital is situated about ten miles south-east of the site of ancient Carthage, and is built on the western side of a lake, some twenty miles in circumference, which separates it from its port. The city walls measure about five miles, and the inhabitants who dwell within it are variously estimated from 100,000 to 120,000, comprising Moors, Arabs, the descendants of Turks, Negroes, Christians, and Jews. It contains about 8,614 houses, 4,644 shops, 2,973 magazines or stores, 204 coffee-houses and taverns, 3 hotels, 118 mills, 70 ovens, 193 caravanserais, 28 baths, 12 oil presses, and 27 granaries. It has, besides, 16 barracks, a Moorish and European hospital, five large, and many smaller mosques, and two public libraries. These contain about 12,000 Arabic manuscripts, the remnant of the 72,000 volumes said to have been destroyed in the Palace when it was sacked by the Spanish cavalry at the commencement of the sixteenth century. The chief manufactures of the city are linen and woollen cloths, embroidery, morocco leather, bournouses, horse accoutrements, silk shawls, silk interwoven with gold and silver, wearing apparel, jewellery, woollen rugs, haiks, or silk cloaks, and mats. The red woollen caps made in Tunis are famous throughout the Levant. In the Regency itself they are called sheshiya, and in Turkey fez. They excel all imitations in colours, fineness, and strength. A great number of people were formerly employed in their manufacture; but, owing to the cheap caps of similar make which are now sent to the East from France and Trieste, the exportation has greatly diminished. Nevertheless, the sheshiyas exported in 1873 were valued at £50,000. The manufacture of caps is in the hands of a number of Moors of superior class, and the trade is almost a monopoly. Tunis is also justly celebrated for its essences, such as attar of rose, jasmine, acacia, quince, narcissus, aloe, apple, orange, lemon, both acid and sweet, scented poplar, sambak, or double jasmine of Arabia. These ottars are held in great esteem, on account of the delicacy of their perfume; but, owing to their high price, a very small quantity is exported, and they only serve for local consumption. A very large quantity of rose-water, orange-flower water, and mint water is likewise distilled, with which the natives perfume their sherbets and sweetmeats.

The bazaars are inferior to those of Cairo and Damascus, but considerable trade is carried on in them in articles of native industry, and in Manchester goods and French silks. About 30,000 of its inhabitants belong to the Jewish community, which comprises some

wealthy merchants, brokers, and shopkeepers. There are about 10,000 Europeans of different nationalities, nearly half of them are Maltese. There are cattle, horse, sheep, wool, vegetable, fruit, fish, grain, and coal markets, which are plentifully supplied. The cattle, sheep, grain, and wool are brought by boats from the interior. The fishermen are Maltese and Sicilians. There are no public buildings of any magnificence, with the exception of the Bey's town palace, which is a modern building in the Saracenic style.

CORRESPONDENCE.

THE SEWAGE CONFERENCE.

Sir,—Owing to being so busily engaged in Parliamentary work, I was unable to give that attention to the Conference on the "Health and Sewage of Towns" I should have liked.

I observe, however, on page 6 of the printed reports, it is stated with reference to the town of Croydon that the mortality, in the year 1875, was 21·7, which was due to an epidemic of typhoid fever, consequent upon the intermittent character of the water supply. Now, as there is probably but one person in Croydon that believes the epidemic was produced by the intermittent character of the water supply, you will allow me to state, as a member of the Local Board, that such a statement ought not to go forth to the public as a fact. The epidemic of fever was present in Croydon previous to the water supply being intermittent for a few days in the March of that year. It is true that myself and others have stated, and believe, that the epidemic of fever was due to the water as supplied to the town, but that it was not due to the intermittent character of tho supply, as I can distinctly state, having designed a large portion of the water-works at Croydon; that in the newer districts of Croydon, which were visited alike with the older portions of the town by an epidemic of enteric fever, it is perfectly impossible for the intermittent character of the water supply to have affected the purity of the water. Moreover, in that portion of Croydon supplied by the Lambeth Water Company, in which the water is daily intermittent, fever has not been epidemic, but the epidemic outbreaks of last year and the previous years have been entirely confined to that district supplied with water from the Croydon wells, which are located in the centre of the old town of Croydon.—I am, &c.,

Baldwin Latham.

7, Westminster-chambers, Victoria-street, Westminster, S.W.
13th May, 1876.

THE COMMERCE OF GABOON.

Sir,—Not having had an opportunity of properly correcting the proof of my paper on "The Commerce of Gaboon*," before it was printed in the *Journal*, I find it necessary to point out a few errors which thus unavoidably appear in it, some of which are of considerable importance.

Page 585, for "Rapointyamba," read "Rapânlyâmbâ;" the â being sounded as "aw," or nearly as "a" in water.

Page 586, for "Townson," read "Towrson."

Ibid., *et passim*, for "Ba-Fant," read "Ba-Fanh."

Page 587. Will Glass died in 1856, not 1855.

Page 588, for "distinct tribes," read "distant tribes."

Ibid., for "as the invoice price," read "at the invoice price."

Page 589, *et passim*, for "Fernand Vas," read "Fernan Vaz."

Ibid., for "igolo-myi-mpunji," read "igolo-nyi-mpunji."

Page 592, for "augmented later *mercuriales*," read "augmented in later *mercuriales*."

Ibid., for "mpaya," read "mpâga."

Page 593, for "multiply the value," read "nullify the value."

Ibid., for "has never been abolished," read "has now been abolished."

Page 594, for "the South Atlantic. The admiral" read "the South Atlantic, the Admiral."

Ibid., for "Settlement," read "Settlements."

Ibid., for "non seulement à la perte de protection," read "non seulement au peu de protection." We cannot speak of the loss of what we never had, but we complain of the little protection vouchsafed to our persons, our liberty, our property, and our interests.

Page 595 for "Yousseref," read "Youssouf."

Ibid., for "being 25,000 billets," read "being under 25,000 billets."

Ibid., for "*B. ujavi*," read "*B. njavi*."

Page 596, for "resorts of shipping. Gaboon," read "resorts of shipping, Gaboon."

Ibid., for "and though," read "although," and strike out "even so."

Ibid., for "Mlenga," read "Inlenga."

Page 597, for "Tilunga," read "Tyilunga."

Ibid., for "Orugu," read "Orungu."

Ibid., for "this turbulent," read "that turbulent."

I do not mention minor errors, as in most cases readers will have no difficulty in recognising them, and as I shall probably correct and reprint the paper in a pamphlet form, with some few alterations and additions, those persons who may desire to peruse it in its amended form, will have an opportunity of so doing.

I may here remark, with regard to the healthiness of Gaboon, that three of the white residents have been there upwards of twenty-five years, viz., the Rev. A. Bushnell, Monseigneur Bersieux, Evéque de Collipolis, and the Rev. Père Le Berre; whilst Mrs. Bushnell and the Supérieure des Sœurs de l'Immaculée Conception have each resided there for twenty years or more; of course, in all these cases occasional visits have been made to Europe or the United States of America. The insalubrity of Western Africa is, as a rule, very much exaggerated, and Lieutenant Cameron has borne testimony to the healthiness of the interior. As regards the Gaboon, the health of Englishmen, Americans, Germans, &c., has always been better than that of the French; this we generally attribute to the different modes of living, and to the fact that the Government coal depôt is situated directly to windward of the quarters of the colonial officials and others, as it is generally believed that the exhalations from coal, especially in very humid and very hot climates, are excessively deleterious. It must, however, be remarked that Gaboon, although lying almost directly under the equator, is not by many degrees so hot as the Gambia, Sierra Leone, St. Paul de Loanda, and other places. The French have a much worse opinion of the climate of Gaboon than is held by individuals of other nations who have long been resident there. My own belief is that diet and other matters have much to do with this; whilst there is no doubt that in the majority of cases death is directly attributable to imprudence and other causes, within the control of persons themselves.

I could have named many other products of Gaboon than those specified in my paper, which are likely to prove of immense value, but I was deterred by considerations of space. I can refer those desirous of obtaining information on the subject to (among other publications) the "Catalogue des Produits des Colonies Françaises envoyés à l'Exposition Universelle de Londres de 1862," and to a catalogue of similar products sent to the Exhibition at Vienna in 1873.—I am, &c.,

R. B. N. Walker.

* It is only fair to say that a proof of the paper was corrected by Mr. Walker, and all his corrections duly made, although their tardy arrival last week occasioned an actual stoppage of the press.—Ed.

SCIENCE MADE EASY.

Sir,—With reference to my work "Science made Easy," recently reviewed in the *Journal*, I should like to be allowed to explain the method in which the illustrative diagrams are prepared.

My artist, Mr. Webb, prepares in water-colours an original drawing, of the size of the intended diagram, and of which every line is to be copied. Besides the lights which represent the colour of the paper to be used, there are only two colours, a medium tint and a dark brown or black, various degrees of light or shade being produced by employing in various proportions light lines on the medium tint, and tint lines on the black. For the two colours, two blocks or thick sheets of rather soft metal (probably a lead alloy) are used, supported on wooden frames. The London engraver cuts out of the first, or medium tint block, cavities or furrows where the paper is to be seen, and out of the second or black block he removes, in addition to these parts, all those where the medium tint is to be seen. The applying of the oil colour to the blocks, and the printing off by steam press, present no special features. Considerable nicety is of course required in making the blocks register accurately, but in this and other matters of detail Mr. Simpkins, of 70½, Strand, who prints these chromographs for me, has had considerable experience.

For the tablet of temperatures and the diagram of now crystals, single blocks are used. For botanical diagrams I may possibly require three or more blocks, unless I can realise, as I hope, the principle of stencilling or the preliminary underlaying of local patches of colour.

I am preparing a tablet six feet long, comparing the three thermometric scales, and a full sized skeleton in two colours.—I am, &c.,

T. Twining.

Penryn-house, Twickenham,
April 22, 1876.

GENERAL NOTES.

Edison's Electric Pen.—This invention, which was exhibited at a recent meeting of the Society, consists of a small electric engine on the top of a holder, which is used as a pen. This works a needle that pierces the paper, making 5,000 to 6,000 holes per minute, so that in writing such is the rapidity of the motion of the needle, that the point does not drag or tear the paper. The pierced paper or "stencil" is placed in a frame, and an inked roller is passed over it, which fills the fine perforations with ink; a sheet of paper is then placed below the written paper or "stencil," and the roller is again passed over it once or twice, when a perfect facsimile of the writing is obtained. It is stated that these facsimiles can be produced at the rate of four to five per minute, and one writing or "stencil" will suffice to print 1,000 copies.

NOTICES.

SUBSCRIPTIONS.

The Lady-day subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday evenings at 8 o'clock. The following arrangements have been made:—

May 24.—"Railway Safety Appliances," by F. J. Bramwell, Esq., C.E., F.R.S. (*Continued.*)

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

May 30.—"The Development of Central Africa," by Edward Hutchinson, Esq., Lay-Secretary of the Church Missionary Society.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

May 26.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood. Andrew Cassels, Esq., will preside.

Mr. Tayler's Paper on "The Wonders of Trees in India," is unavoidably postponed.

MEETINGS FOR THE ENSUING WEEK.

Mon....Loan Exhibition of Scientific Apparatus, South Kensington. Conference. "Mechanics."

Tues. ...Loan Exhibition of Scientific Apparatus South Kensington. Conference. "Chemistry."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. G. Adams, "Wheatstone's Discoveries and Inventions." (Lecture I.)
Medical and Chirurgical, 53, Berners-street, Oxford-street, W., 8½ p.m.
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on "Economy in Dead Weight of Railway Wagon Stock." 2. Mr. R. Price Williams, "The Permanent way of Railways."
Anthropological Institute, 4, St. Martin's-place, W.C.
Royal Colonial, 15, Strand, W.C., 8 p.m. The Hon. William Fox, "New Zealand."

Wed. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. F. J. Bramwell, "Railway Safety Appliances." (Continued.)
Loan Collection of Scientific Apparatus, South Kensington. Conference. "Physics, including Astronomy."
Geological, Burlington-house, W., 8 p.m. 1. Prof. R. Owen, "Evidences of Theriodonts in Permian Deposits elsewhere than in South Africa." 2. Mr. H. G. Seeley, "The British Fossil Cretaceous Beds." 3. M. le Prof. Alphonse Favre, "Sur les Anciens Glaciers au revers nord des Alpes Suisses."
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Thurs...Linnean, Burlington-house, W., 3 p.m. Annual Meeting
Civil and Mechanical Engineers, 7, Westminster-chambers, S.W., 7 p.m. Mr. E. Perrett, "Steam Tram Cars."
Inventors' Institute, 4, St. Martin's-place, W., 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Professor Tyndall, "Voltaic Electricity." (Lecture V.)
Loan Collection of Scientific Apparatus, South Kensington. Conference. "Mechanics."

Fri.......SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Indian Section.) Dr. George Birdwood, "Competition and its Effects on Education, with especial reference to the Indian Services."
Royal United Service Institution, Whitehall-yard, 3 p.m. Major-General Sir Frederick J. Goldsmid, "Military Training as a means of Administrative Power and of Political Usefulness."
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m. Mr. J. F. Moulton, "Verification of Modern Scientific Theories."
Loan Collection of Scientific Apparatus, South Kensington. Conference. "Biology."
Quekett Club, University College, W.C., 8 p.m.
Clinical, 53, Berners-street, W., 8½ p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W. 4 p.m. Professor Bentley, "Organs of Nutrition in Plants." (Lecture III.)

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Prof. Henry Morley, "King Arthur's place in English Literature." (Lecture I.)
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Physical Science Schools, South Kensington, S.W. 3 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,227. Vol. XXIV.

FRIDAY, MAY 26, 1876.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

ANNUAL EDUCATIONAL CONFERENCE.

The twenty-fifth annual Conference will take place on Friday, the 23rd June, at 12 o'clock. The chair will be taken by Sir Henry Cole, K.C.B.

With the view of giving special interest to the Conference this year, the Council have decided that the subject of Adult Education, especially in reference to Technical Instruction and its promotion by the action of the Government Education Code, shall form the principal subject for discussion, and all persons interested therein will be invited to attend.

REVOLUTION INDICATOR.

The Council, acting on the recommendation of the Committee appointed for the purpose, have awarded to Mr. T. A. Hearson, for his Strophometer, the Gold Medal, or Prize of £20, offered by the Society for the best Revolution Indicator for ships' use.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The competition for the ten Scholarships founded by the Corporation of the City of London was brought to a termination at the Mansion-house on Saturday, the 20th inst. The Scholarships were awarded to Misses Cole, Crevins, Goss, Jessop, Roberts, Shirley, and Storey, and Messrs. Boyle, Parfitt, and Tozer. There were upwards of 180 candidates.

The competition for the Halifax Scholarships terminated in the election of Miss Chappel and Mr. Francis Sharp.

Competitions are pending at Bradford, Bristol, Dover, Hastings, Sandwich, Leeds, Staffordshire Potteries, and North Wales.

Several persons having undertaken to subscribe various sums towards the establishment of a £40 a-year Scholarship, for five years, the Secretary of the Society of Arts has obtained the consent of these persons to put these sums together, and, as soon as the annual £40 scholarship is completed, to nominate to it one of the candidates already selected by the Society's examiners as qualified. Upwards of three-fourths of the annual £40 has already been subscribed, and the Secretary seeks the aid of the members to enable him to complete it, and solicits from them annual subscriptions of one, two, three, or more pounds per annum for this purpose.

Members willing to assist in this matter are requested to communicate with the Secretary of the Society of Arts without delay, as the School has already commenced its work.

HONORARY LIFE MEMBERS.

In accordance with Bye-law 66, the Council have nominated the following to Honorary Life Memberships:—

Cyrus Field, Esq.—For his valuable services in connection with the promotion of electric communication between England and America.

Lieut. V. Lovett Cameron, C.B.—For his energy in exploring and laying open to commerce districts of Equatorial Africa hitherto absolutely unknown.

NEWSPAPER POST.

The following correspondence on this subject has taken place between the Postmaster-General and the Secretary of the Society:—

Society for the Encouragement of Arts, Manufactures, and Commerce, John-street, Adelphi, London, W.C.,
May 9th, 1876.

My Lord,—I am directed by the Council of this Society respectfully to draw your Lordship's attention to the anomaly which exists with reference to the conveyance of printed matter by the post, owing to the distinction which the Post-office makes between the book post and the newspaper post.

If the printed matter be a newspaper, it has, as your Lordship is aware, the privilege of being carried for one halfpenny, practically without any limit as to weight. The *Times*, for instance, whatever its size, is carried for one halfpenny. If, however, the printed matter be what by the Post-office definition is a book packet, then two ounces is the limit permitted to be carried per one halfpenny; beyond which weight there is a progressive charge.

The Council wish to point out that one of the conditions laid down by the Post-office as defining a newspaper seems of a purely arbitrary and unessential character, viz., the condition which forbids a newspaper to be stitched under penalty of losing the newspaper privilege. A periodical in all other respects coming within the definition of a newspaper, is at once reduced to the two-ounce book-post limit, if a small thread for holding the covers together is inserted for the convenience of the reader. It thus becomes immediately liable to the progressive rate of extra charge. The Council of this Society desire to urge upon your Lordship that this regulation, which as it appears to them is of a purely arbitrary character, and unnecessary, acts with great harshness and injustice on a Society like the Society of Arts, which publishes a weekly journal of its proceedings for distribution gratis amongst its members as means of communicating with them and placing before them and the public that information at their command, which they deem valuable as promoting the welfare of the Arts, Manufactures, and Commerce of the country. The *Journal* is not of a commercial character, and comes strictly within the definition of a newspaper in all respects except the one which prohibits the stitching. If stitched it becomes a book packet

and is chargeable to book-post if exceeding in weight the two-ounce limit. As the *Journal* frequently exceeds this weight, it has been found necessary, in order to retain the privileges of newspaper post, to omit the stitching, to the inconvenience of the readers, and to the serious detriment of the usefulness of the publication. The leaves being loose become scattered and lost. It will thus be seen that while the Post-office is in no way relieved from the burden of carrying the increased weight for the lower charge, the public is injured and the influence of the Society for good is weakened. Under these circumstances the Council venture to suggest for your Lordship's consideration whether the condition against stitching cannot be withdrawn.—I have the honour to be your Lordship's obedient servant,

P. LE NEVE FOSTER, Secretary.

To the Right Hon. Lord John Manners, M.P., Postmaster-General.

General Post-office, London, 17th May, 1876.

SIR,—The Postmaster-General having had before him your letter of the 9th inst., I am directed to state that it was clearly intended by the Legislature, when the Act of Parliament upon the subject was passed, that publications registered as newspapers should be unstitched when passing through the post; and his Lordship does not consider that this is a condition which affords ground for reasonable complaint.

It seems to be a characteristic of a newspaper, that it should consist of a loose sheet or loose sheets—a publication which is stitched together having on the other hand the character of a book.

In regard to the *Journal of the Society of Arts*, it seems that that publication is frequently under two ounces in weight, and in this case might be sent through the post, either unstitched as a newspaper or stitched as a book, for a postage of a halfpenny.

When the *Journal* exceeds the weight of two ounces, and it is necessary that the sheets should be stitched together, his Lordship thinks it only fair that book-postage should be paid for it according to its weight.

Under these circumstances he regrets his inability to accede to your application.—I am, Sir,

Your obedient Servant,

JOHN TILLEY.

P. Le Neve Foster, Esq., M.A.

PATENT LAW AMENDMENT.

The following petition was presented to the House of Commons by the Right Hon. W. E. Forster, M.P., on Thursday, the 18th inst.:—

To the Honourable the Commons of the United Kingdom of Great Britain and Ireland, in Parliament assembled.

The humble petition of the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce, sheweth—

That your petitioners have had under their consideration a Bill now before your Honourable House, intituled:—"An Act for Consolidating, with Amendments, the Acts relating to Letters Patent for Inventions."

That your petitioners desire respectfully to submit for the consideration of your Honourable House:—

1. That paid Commissioners (not being political officers of the Crown), specially charged with the administrative work of the office, are, according to the principle of the Charity Commission, the Civil Service Commission, and other Government Commissions, absolutely necessary for the proper carrying out of the Bill, and that the said Bill cannot be carried into satisfactory practical operation unless such paid Commissioners are appointed.

2. That one of such Commissioners, other than either of the law officers of the Crown, who have not the necessary leisure for attending to the duties connected with the granting of letters patent, be in Parliament.

3. That an examination into the utility of any invention, or the frivolity thereof, is not capable of being carried out satisfactorily, and therefore the provision for such an examination ought not to form part of the Bill.

4. That no adverse report of an examiner, even with a right to appeal, ought to preclude an applicant from obtaining his letters patent, at his own cost and risk, since any tribunal of the above character assuming infallibility in commercial and scientific questions would be repugnant to the feelings of the country, and fraught with much danger to the progress of Arts, Manufactures, and Commerce.

5. That it would be of advantage if the prolongation of letters patent could be obtained on application to, and satisfying the Commissioners of Patents on the expediency thereof, and on payment of a high fee.

6. That looking at the large amount of work contemplated by and necessary to be performed under this Bill, the staff proposed by the said Bill is wholly inadequate to its due performance.

That your petitioners submit for the consideration of your Honourable House the importance of enlarging what is commonly termed the Patent Museum, now under the charge of the Commissioners of Patents, into a general Museum of Science applied to Industry, as proposed in the report of the Commissioners on Scientific Instruction, and that such enlarged museum be placed under a Minister of the Crown, responsible to Parliament, who can devote attention to it, and that any surplus fees derived from the granting of letters patent be applied to the maintenance of such a museum.

Your petitioners humbly pray your Honourable House to take the premises into your favourable consideration, and take such steps for amending the said Bill and procuring the extension of the said Patent Museum, as to your Honourable House may seem meet and right.

And your petitioners will ever pray.

Signed on behalf of the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce, this 14th day of May, 1876.

ALFRED S. CHURCHILL, Chairman.

HEALTH AND SEWAGE OF TOWNS.

The following are the papers brought before the Conference which deal with the dry, foreign, and other systems of treating sewage *:—

ON "OBSTACLES TO SANITATION."

By Richard Brewer, F.R. His. Soc.

The obstacles to sanitation is a most serious and perplexing subject, more espcially near London, and other cities and towns, all lands in their vicinity having either an active or dormant building value beyond their present value for agricultural purposes. Taking a radius of 12 miles round London, this additional value ranges from £100 to £1,500 per acre, hence the great difficulty of

* A report of the discussion will be issued in subsequent numbers of the *Journal*. For the convenience of those wishing to have the account of the proceedings in a more compact form, the same will also be published as a pamphlet, which can be had (as soon as ready) on application at the Society's House. Price 2s. 6d.

obtaining land for sewage purposes in those localities. Not only have the sanitary authorities to deal with this important matter of value in seeking for sewage grounds, but with another more serious still. No sooner does it become known that negotiations are pending for acquiring land for sewage purposes, whether the process is to be by irrigation, filtration, or other methods, than all the owners of other lands in the vicinity are at once alarmed, and opposition is threatened from all quarters; and this is not to be wondered at.

Whether such works can be carried on without creating a nuisance, is a debatable point; but that their existence would destroy the building value of the land near is undeniable.

The difficulties I have referred to will be sufficiently illustrated by reference to the proceedings of the Select Vestry of Richmond, acting as the sanitary authority for that town. And as your committee have (I think wisely) asked for a collection of facts rather than of theories, I cannot do better than proceed to narrate what has been done or attempted by the Richmond Vestry, and that they have been most active and earnest in their endeavours to surmount these difficulties, will be sufficiently proved by the narration. Richmond has an area of 1,209 acres; of this about 420 acres are Crown lands, namely, the Old Deer-park and the well-known Richmond-park. The Queen is Lady of the manor, and much of the house and other property belongs to the Crown. The population, according to the census of 1871, was 15,110, and is rapidly increasing; the number of houses is somewhat over 3,000, and the rateable value about £110,000.

In the year 1848 the Metropolitan Commissioners of Sewers' Act was passed, and by an Order in Council made thereunder Richmond was made part of the Commissioners' district. In July, 1850, upon a report made to the Commissioners by Mr. Donaldson, one of their surveyors, they constructed the system of sewage now in existence at Richmond, the cost being about £20,000. The Vestry at that time was most anxious that the sewage should not be taken to the river, the purity of the river being considered by them to be of the utmost importance to the inhabitants. This desire on their part was made known to the Commissioners, and Mr. Donaldson in his original design provided for the disposal of the sewage by irrigating the Old Deer-park, but the Commissioners of Woods refused their sanction to the scheme, and the Commissioners, much to the regret of the inhabitants, decided upon taking the whole of the sewage into the River Thames. In 1865 (a year before the Thames Conservancy Act was passed, and two years before the Act was extended to Richmond), the Vestry, finding the river had, as they anticipated, become much polluted, appointed a committee to consider and report what steps ought to be taken with reference to the condition of the river and the disposal of the sewage, and the committee reported to the Vestry on the 26th of September in the same year; their report was adopted, and a memorial from the Vestry was transmitted to the Secretary of State, asking for an inquiry by the Government officials into the matter.

The Conservancy Act of 1866 having by an Act passed in 1867 been extended to Richmond and the adjacent parishes, notwithstanding the protest of those places and the special report of Lord Henley's Committee in the House of Lords on the exceptional position of those localities. If time permitted, I should like to quote the whole of that report; I must, however, be content with giving the following extract therefrom:—

"In the cases of Richmond, Kingston, and the smaller towns in their neighbourhood, the difficulty of obtaining land for the necessary works would be very great; the whole of the country surrounding these towns is suitable for suburban building purposes, and the value of land is consequently very high. The property which adjoins the town of Richmond upon two sides belongs almost wholly to the Crown, and the evidence before the committee shows that very great difficulty exists in obtaining any portion of it, or the right to enter upon it for sewage purposes."

In September, 1867, notice was served by the Thames Conservancy on the Vestry to discontinue within thirteen months the flow of sewage into the Thames. Upon receipt of the notice the Vestry Clerk wrote to the Conservators, informing them that a committee of the Vestry had been appointed to consider the subject of the Sewage Utilisation Act, 1867, and the Thames Conservancy Acts of 1866 and 1867, and asking to be informed what standard of purity the Conservators would require for the effluent water, but no standard for such effluent water was sent until September, 1870, nearly three years after the application was made.

In 1869 another notice was served on the Vestry by the Conservators to discontinue the flow of the sewage into the river within twelve months. In 1870, after having investigated numerous schemes which had been submitted to them, the Vestry applied to Parliament and obtained the "Richmond Sewage Act, 1871," on the passing of which, by an arrangement with the Conservators, they obtained two years' further extension of time. Having heard that some land at Maldon, which they considered fit for a sewage farm, was for sale, they dissolved the committee appointed in 1867 and appointed a committee under the Sewage Utilisation Act of 1867, and took steps to acquire the property, upon which a local government inquiry was held. The proposal to take the land was met by great opposition, and was attended with very considerable expenses to the parish, and terminated in a failure, the inspectors' report being against the scheme. In November, 1871, the Vestry advertised for schemes, offering a premium of one hundred guineas. Several were submitted, and one was thought to be satisfactory, the more especially as it promised that not only should the scheme repay the estimated outlay, but yield an annual profit of from £500 to £600, a calculation which, I believe, the authors subsequently admitted was delusive. The Vestry immediately set to work to find land suitable for the purpose, and endeavoured to obtain a site near Asgill-lane, part of the Old Deer-park, but met with a refusal from the Crown authorities. In October, 1872, they sought for powers to take some land belonging to the London and South-Western Railway Company at the eastern boundary of the parish, but in consequence of the opposition of the railway company, the scheme had to be abandoned.

The Vestry then decided upon seeking powers to take some land near the last named, and another local government inquiry was held, which was so far

successful that a Provisional Order was obtained; but opposition was threatened on the part of neighbouring owners which seemed likely to occupy the Court of Chancery for several terms, and the scheme was condemned at a public meeting of the inhabitants, and had to be adandoned by the Vestry.

In 1873 the Vestry issued fresh advertisements for plans. As usual, a sufficient number of plans were sent in to puzzle that body, even had they all been civil engineers, and while they were under consideration the two years' extension of time expired, and the Conservators threatened proceedings.

In November, 1873, they selected one of the plans submitted, which proposed the purchase of some land at Hanworth. As usual, the Vestry was threatened with all sorts of opposition to the scheme; the Vestry, however, referred the plan to Mr. Abernethy to advise upon. They apprised the Conservators of all this, but nevertheless the Conservators determined upon a prosecution, took out a summons against the Vestry, and obtained a conviction, the Vestry being adjudged to pay a penalty of £150. Upon the advice of counsel they appealed against the conviction, but the appeal was dismissed with costs. In March following, Mr. Abernethy made his report, but it left the Vestry where they were; it neither approved or condemned any of the plans, but submitted another, which seemed less practicable than any of those previously considered. Mr. Abernethy, however, suggested the making of an intercepting culvert along the towing-path by the river side, and the Vestry determined upon carrying out the idea.

A suggestion to try an experiment of filtration in this culvert through straw filters was considered. I think the Vestry came to the conclusion that the straw process was all chaff. Here again the Vestry was stopped by the Conservators refusing to allow manholes or storm overflows in the proposed culvert, aud this scheme like its predecessors had to be abandoned. At this period the Conservators served fresh notice on the Vestry to discontinue the flow of sewage into the river within twelve months, upon the receipt of which notice the Vestry determined to hold weekly meetings, and visited sewage works at various parts of the country, but found none satisfactory; they then sought the advice of Mr. Hawksley, and pending his report, sent a deputation to the Conservators to endeavour to make terms, but without avail.

In February, 1874, not having received Mr. Hawksley's report, and the twelve months' notice being about to expire, they asked of the Conservators a further extension of time, and being refused, applied to the Board of Trade, who referred the matter to Captain Douglas Galton. In the meantime, Mr. Hawksley made his report, recommending a sewage site at Ham Fields, and a deodorising scheme at a cost of £45,000 (nearly half the rateable value of the property in the parish), and this, after all, he said, must be considered a temporary expedient.

As Kingston (within which parish the proposed site was situated), by the decision of Mr. Rawlinson, who was appointed by the Local Government Board to inquire into and investigate the matter, had failed to secure a less objectionable part of the fields for the disposal of their sewage, it may be imagined what chance Richmond had of obtaining he land. In June and July following, the arbitration before Captain Douglas Galton came on, and he gave the Vestry an extension of two years.

About this time the conference of local authorities suggested by Colonel Ponsonby Cox took place, and shortly after the Vestry received a letter from the Local Government Board, announcing the intention to hold an inquiry, upon receipt of which the Vestry passed the following resolution:—

"Resolved unanimously, that the Clerk be instructed to acknowledge the receipt of the letter, and to thank the Local Government Board for the promise therein contained, and to state that they will render every assistance in their power to the proposed inquiry."

Thus, for a period extending over ten years have the Richmond authorities been almost constantly engaged in endeavouring to solve the sewage difficulty, and they are quite as anxious as the Conservators to take the sewage from the Thames. It is estimated that during that period the parish has expended about £3,000 in endeavouring to find a scheme for the disposal of their sewage, and the labour and personal expense which has devolved upon certain members of the Vestry has been incalculable. The result of these unceasing labours has made it manifest to the Vestry—as it must be to all unprejudiced observers—that any attempt at local works in or for Richmond, whether by irrigation or deodorisation, must fail, and that combination to a greater or less extent with other parishes is the conclusion that has forced itself upon the minds of all who have considered the matter. Why Richmond, with its exceptional local position, should have been selected by the Conservators for prosecution, or, rather, persecution, I cannot say; but this much is clear, that years ago they were compelled, against their own wishes, to take their sewage into the Thames, at a cost of about £20,000. Scarcely had the debt incurred in doing so been paid off, than they were called upon to take the sewage from the river. They have tried all means within their power, and at an expenditure of about £3,000, to comply with the requirements of the Conservators. To do so at present seems impossible, and I think the interposition of the Legislature to form some large and general scheme for all the parishes in the valley of the Thames is imperatively required.

I must apologise for this lengthened detail of dry facts in putting before you the difficulties of Richmond, but in so doing I doubt not that I am also relating the failures and disappointments of many other places similarly situated.

ON THE REMOVAL OF THE EXCRETA AND REFUSE OF ROCHDALE BY THE "ROCHDALE SYSTEM."

By Mr. Alderman Taylor.

In the year 1865 I wrote to the Night-soil Committee, detailing to it a method of dealing with the night soil and refuse of the town, by which the increasing cost of removal might be lessened, the objectionable privies and middens abolished, and the health of the town improved. The two following paragraphs are contained in that letter:—

"The present plan of removal is based on the prin-

ciple of emptying the ash-pits when they are full, thus compelling the work to be done in an unsystematic manner and with a consequent waste of time, and therefore increased cost. The improved method, which I would recommend, is that the ash-pits should be emptied not less frequently than fortnightly, and most of them weekly, and that the excreta should be received in a suitable vessel and deodorised. This would involve the alteration of most of the privies and the provision for each of two boxes, one for excreta, and one for ashes. I would also recommend that the excreta and ashes thus collected, should be made into a manure in the state of a dry powder, as guano, to which it would be similar, though not so powerful.

"There is also the sanitary view, which in a town is all important. The atmosphere is much polluted by the present state of the ash-pits. The adoption of the plan under consideration would entirely remedy this evil, and as a consequence the death-rate of the town would be diminished, and the general health of the population improved."

The letter was read, but the plan was not then taken into consideration.

There was also the fellow question of the disposal of the sewage proper raised about the same period, and in 1866 it was distinctly recommended by high engineering authorities to turn the whole of the sewage into the river, so that it might make its way to the sea. The scheme was strenuously resisted by the writer, and, after some lengthy discussion, the Council refused to adopt the wasteful scheme, and decided to further consider the whole question. To the writer it appeared of the first importance that the question of sewage proper, that is, the washing and cooking water of the household, should be kept distinct and treated separately by towns, and I therefore again urged the Council to consider the whole subject. Conjointly with this, the difficulty of disposing of the night soil, the inefficient manner in which the emptying of the cesspools was performed, and the increasing demands of the contractor compelled the Council to give more attention to the question, and in October, 1868, the recommendation of 1865 was considered, and in the following December the Council appointed Alderman Mansell (who was Mayor and Chairman of the Night-soil Committee), Alderman Taylor, and Councillors Scholfield and Booth, to be a committee to arrange for a trial of several methods proposed, by which the night soil should be removed. In June, 1869, this committee engaged Mr. J. Havercough, our present manager, to superintend the removal of the night-soil and its manufacture into a manure. The methods decided to be tried, were, the Goux system, the ash system, and the pail system. After a nine months full trial, the Council, on the recommendation of the committee, decided that the pail, now known as the "Rochdale System" was the best.

I have so far given the history of the introduction of the Rochdale system, and the value of this account will be found in that it will enable this audience to distinguish between the true pail system and those which by many are supposed to be the same, but yet differ in that the simplicity of the Rochdale system is not maintained.

What then is the Rochdale system?

The answer may be given in a few sentences.

1st. That the excreta and refuse of a household shall be removed within a week.

2nd. That the household shall have no care or trouble thrown upon it.

3rd. That the collection be made in pails, not unwieldly, yet of sufficient size to prevent inconvenience from their being too full, and so constructed that they may be thoroughly cleansed when emptied.

4th. That the whole of that which is collected shall be utilised.

These propositions, which seven years ago were looked upon as chimerical, are now carried out.

The number of closets at this date in Rochdale is 5,644, and the excreta contained in these, the refuse, including ashes, from the house, are systematically collected weekly, or oftener, without any notice being required from the householder, and the whole is utilised by being made into manure, mortar, cement, or fuel.

The manner of operation is as follows:—The town is divided into six divisions, named A B C D E and F. Each division has its corresponding books, the pages being ruled into 13 weeks. In the books every excreta pail and ash tub is entered in progressive number, and the street recorded in which it is placed. Vans and ash carts are appropriated for the collection, and the guard is furnished every morning with the names of the streets and number of closets in that street, written on a ruled blank list, which he has to collect. When the van or cart returns, it is weighed, and the list given to the weigh clerk, in the ruled squares of which the guard has entered the pail or ash-tub number which he has brought in. The van is then emptied, the washer of the pails taking an account of the total number brought in by each van. An inspector daily enters from these lists into the division book, the numbers of the pails brought in, and is thus able to say at the close of the week if every closet has been attended to, and if not, a van is specially sent for the pail omitted. It is found that, with this oversight, the number omitted collecting in regular order has not exceeded 13 per week.

The pails are thoroughly washed, and into each is put a portion of chloride of alumina, and sulphate of lime. The excreta is emptied from the pails into a trench formed of fine ash, which has been sifted from the refuse and cinders collected by the ash cart. A quantity of sulphuric acid, 30 lbs. to one ton of excreta, is poured into the trench, and the whole mixed. In three days the trench is turned over with a spade, and again in 21 days, by which time the whole will have become in a tolerably dry state, containing about 35 per cent. of water. Before the sale of the manure it is again turned over and screened. The quantity of excreta to ash used at present is 7 cwt. of ash to 1 ton of excreta.

The ash carts pour their contents into the hopper of a sifting machine, which separates the fine ash, fine cinder, rough cinder, vegetable matter, glass, pots, and rags. The disposal of this refuse is by using the fine ash for manure, the fine and rough cinder for fuel for the steam boilers, and for sale; the vegetable matter is burnt, and the ash from it ground and added to the manure, for the sake of the potash; the clinkers and pots are ground up for mortar and cement, and the rags, glass, and iron sold. Thus the whole of the refuse col-

lected is utilised, and the nuisance of a tip obviated.

The quantities collected weekly vary as the system is extended. Last week, ending April 12th, the quantities were 118 tons of excreta and 208 tons of refuse material, from an estimated population of 52,000, and the weekly cost £74, excluding interest and depreciation, or 4s. 7½d. per ton, or £30 per 1,000. The total excreta collected last year was 5,398 tons, and of refuse 8,652 tons. The work is done by 18 carters, 18 guards, 18 horses, 3 washers, 1 labourer, 4 inspectors, 1 horsekeepeer, and 1 bookkeeper.

The area from which the collection is made is 4,136 acres, and the distance to the manufactory is, in direct line, from the north, 1½ miles; from the south, 1½ miles; from the east, 1 mile; and from the west, 1¾ miles. When this site was fixed upon the boundary of the borough was regular, being an exact circle of ¾-mile radius. The borough was extended in August, 1872. The extension has very considerably disturbed our operations, and increased the costs of the whole work. Three convenient sites would much lessen the cost of carting, and the cost of manufacture would be but minutely increased.

On the manufacture there are employed 5 men to riddle and wheel away, 6 to form the trenches and turn over the manure, 2 to empty the vans, 2 labourers, 1 engineer, 1 foreman, 1 bookkeeper, the weekly cost being £24. The product of the manufacture and separation is 84 tons of manure, 120 tons cinders, and 8 tons vegetable and other matter; the value being £84 for manure, £2 for mortar, and £2 cinders, for sale.

To the whole cost of collection and manufacture, and sale, would have to be added interest and depreciation.

The machinery at present in use consists of two steam engines, of 8 and 4 horse-power respectively, a riddle for sifting the refuse, a mortar mill, a boiler for evaporation of urine, a small fan for ventilation and blowing, and a furnace for burning the refuse. The capital expended is for building and machinery, £200; and for horses, vans, &c., £1,975. The manufacture does not cause any nuisance outside the premises.

That the inhabitants approve of the system is apparent from the steady increase in the number of pails used. In the first year there were 527 pail-closets; in the second year, 1,070; in the third, 1,699; in the fourth, 2,509; in the fifth, 3,980; in the sixth, 4,741; and this year at this date, 5,644; and in no case has legal means been taken to oblige alterations. From the acknowledged advantages the Corporation will doubtless compel the whole of the remainder of the old privies—which are now 2,786 in number—to be altered to the pail system, if such compulsion be ever required; but, from the present aspect, in two or three years the whole will have been altered independently of the Corporation.

There is another mode of ascertaining the value of the pail system, if the subject be looked at from the stand-point of 7 years ago. At that time the whole of our Lancashire and Yorkshire towns were on what is called the Lancashire privy system, and a terrible nuisance that was found to be. What is the state now? Manchester, Oldham, Warrington, Wakefield, Huddersfield, Halifax, and other towns in the country have, more or less, adopted the Rochdale system of collection, that is, by the use of convenient pails. Certainly, some have added what were supposed to be improvements, such as the addition of ashes and lining the pails, but there needs no great foresight to see that they will be obliged to come to the pail—pure and simple. Indeed, there is not a method adopted, in any of the towns, that was not carefully experimented upon in Rochdale, and abandoned because of its unsuitableness to a town's requirements.

There was also another reason, very powerful to the thoughtful, that by the pail system only, as practised in Rochdale, is the power afforded to deal with the excreta, profitably to manufacture it into a manure—and this, to my mind, is all-important. Having the excreta and the refuse in a separate state, the power to manufacture in any manner and to any degree of strength is given, and this is of the utmost importance to towns and to the nation.

The manure made by the process detailed will be of an average theoretical value of 22s. to 25s. per ton. This value is increased to £3 or any intermediate price, by the addition of blood manure, and also by the evaporation of urine collected from the urinals of the town. This has not been done largely, but will soon become a great addition to the strength. The urine is mixed with sulphuric acid, and reduced until it gives by analysis 10 per cent. of ammonia.

That it will be advantageous to increase the strength of the manure needs no insisting upon, and the Corporation with this intention has erected a drying machine, the invention of Mr. Kidd. The trial will be, whether the manure can be more fully dried without injury. The machine is only completed this week, so I cannot profess to give a true account of its work. As a machine, it promises fairly. There is also the probability that an extensive trial of General Scott's process will be made. With the whole, or a part of these processes, there will be a still greater saving to the ratepayers. One word as to comparative cost. Taking the actual cost of the past years on the old and new system, the comparison would stand thus:—The whole of the Borough without manufacture would be at a cost of £7,500 to remove the excreta, whilst if the whole were manufactured the cost would be but £2,000, and this, when the manure is strengthened would be further reduced. But though it is now demonstrated that it is much less costly than the old system, the estimate of the value of the new system must be placed much higher than a money saving. The sanitary improvement is undoubted, as shown by the diminished death-rate. In the six years previous to the commencement of the system, that is from 1864 to 1869, the death-rate was at the average of 26·22. In the last six years, from 1870 to 1875, the death-rate has been reduced to 23·57. And further, there is a perceptible improvement in the cleanliness, and particularity of the dwellers in cottages, and it is pleasant to contemplate that the demoralisation, which always accompanies filth when it surrounds the dwellings, is removed.

The state and yearly progress of the system is seen in the following table:—

Year ending March 31st.	No. of Closets.	Collected. Excreta. Tons.	Collected. Ashes. Tons.	Manure. Made. Tons.	Manure. Sold. Tons.	Houses.	Mill and Work shops.	No. Persons using the Privies.	Gross Expenditure.	Manure Made.	Net Cost.
1870	527	398	611	377	217	1,048	12	5,797	694	537	157
1871	1,070	846	1,521	1,059	699	2,9 4	31	11,770	1,538	1,380	158
1872	1,690	1,431	2,405	1,556	1,019	3,174	39	19,283	2,392	2,167	225
1873	2,509	1,989	3,413	1,989	142	4,560	69	26,984	3,463	2,826	637
1874	3,980	3,516	5,196	3,479	1,543	7,287	106	43,500	5,284	4,449	835
1875	4,741	4,224	7,650	3,741	2,002	8,487	123	50,000	7,057	4,420	2,637
1876	5,566	5,398	8,652	755	2,140	9,436	146	52,000	..	..	..

THE UNIVERSAL CHARCOAL AND SEWAGE COMPANY.

By George Elcock.

The proeesses of the Universal Chareoal and Sewage Company have for their objeet the utilisation of the dry waste and refuse of our cities, eomprising the street, house, and market refuse, as well as all exerementitious matters, so that deeomposition, and eonsequent pollution of the atmosphere by infeetious gases, may not oeeur. Sueh refuse, on its reeeption at the town yard, or other eentral depôt, is immediately deodorised and rendered perfeetly innocuous to health. By means of this proeess the street sweepings and house refuse (omitting from the latter, for the present, all consideration of the human exereta) are transformed into ehareoal by the simple act of earbonisation. The result of many analyses shows that the pereentage of earbon present in the ehareoal thus obtained, while often highly in exeess, is never lower than that found in animal chareoal, the purifying properties of whieh are too well known to require one word here. Thus, by this one operation of earbonising, whatever may be the nature of the rubbish, it is at onee rendered perfeetly harmless and inodorous, and its further putrefaction is utterly impossible.

The material whieh has been eollected is, by this method, redueed from 50 to 60 per eent. in bulk, whieh is a point of most signal importanee, where carting to a eonsiderable distance has to be done, and in finally disposing of the refuse.

The operation of earbonising is free from all nuisanee. In proof of this, the eompany remark that their operations at the Town Yard, Salford (whieh is in the eentre of a large population, and in elose proximity to the publie abattoirs), have been earried on under a elause specially inserted at the suggestion of the company, in the agreement with the Corporation to the effeet that, should any eomplaint be made of nuisanee from the process, the eompany should instantly stop operations and remove its plant in one week, and although more than two years have elapsed sinee the eommencement of the proeess in the Town Yard, no complaint has yet been made.

The ehareoal thus obtained is purehased from the company by the Corporation of Salford, at 21s. per ton.

Reverting to the exereta. It will be evident, that where a dry eloset, or "pail system," is in operation, there exists a neeessity for an absolute perfeet deodorant and disinfeetant. The ehareoal before mentioned, as obtained from the street and house refuse, most effectually removes all offensive effluvia, and, being devoid of smell itself, it leaves none behind. It thus supplies a medium for deodorising every nuisanee whieh ean be found within the preeinets of a town, and at a lower cost than any other deodorant.

Where thus used in eonneetion with a pail system, nothing further is neeessary than the simple admixture of the night soil with the chareoal for its perfeet deodorisation and eonversion into a good, yet eheap, manure, whieh for two seasons has been sold by the eompany at 35s. per ton.

Last year, eareful experiments were made with this manure by Professor Wrightson, of the Agrieultural College, Cireneester, who reports favourably of its aetion as a eheap manure.

Thus by this system the town refuse is made to afford the means of purifying and deodorising itself, and the transformation from fermenting and poisonous matter to a purifying chareoal effeeted by the waste einders eolleeted from the dust-bins, thus rendering a "town yard" independent of any external souree for its deodoriser and the fuel for preparing it.

As a deodoriser, the aetion of the ehareoal is perfeet, the foulest matter being rendered absolutely inodorous.

It has been estimated that the whole eost of seavenging, eolleetion of refuse, and its eonversion into chareoal, when under the eontrol of the authorities, is less than ten shillings per ton of eharcoal obtained.

Extensive experiments have been made of late to test the effieieney of the filtering eharcoal that is also manufaetured by the eompany from the refuse already mentioned; with the filtration of dyers' waste from the dye becks, brewers' wash, and other foul liquids, good results were obtained; and the success attending its use in filtering the water for hatehing the ova of fish is spoken of in the most unqualified terms.

SANITARY AND ECONOMIC MANURE COMPANY'S DRY CLOSETS.

By G. Walter Pearse.

The einder-sifting ash-closet system is the original invention of Mr. Conyers Morrell, of Leyland, Lancashire; and his patents of 1867 and 1870 are being worked by the above company.

The leading characteristies of the system are the immediate deodorisation of the fæeal matter by a material already on the premises, in a eomplete and eertain manner, and by automatic apparatus.

The elosets, whieh need not oecupy more spaee than 6 by 2½ feet, are provided at the baek with

an inclined riddle or sieve, on which are thrown the cinders and ashes as taken from the fire-grates. By a simple lever arrangement, which cannot well be put out of order except by intention, a movement is given to the screener each time the closet is used, which has the effect of separating the fine ash-dust, and allowing the cinders to fall on to the floor, or into a receptacle to be again burnt in the fire. The ash-dust passes into a measurer, from whence it is ejected on each occasion that the closet is brought into requisition, not in a random stream, but so evenly distributed over the newly-deposited soil as to become intimately incorporated therewith, forming a compound perfectly inoffensive to sight and smell, and containing valuable properties as a manure.

The soil may be received either in a moveable pail, or in a truck on wheels—to be changed weekly by a special service of scavengers—or into a water-tight tank or vault, its length being the breadth of the closet, its width 1ft. 8in., or more if desired, and its depth one or two feet. Practical experience has shown that in the latter case, so inoffensive is the product, the receptacle need not be emptied more frequently than once in three months; indeed, the limit of time depends more upon the capacity of the tank than upon the state of the excrementitious mass, which in a very short time is completely deprived by the ash-dust of its usual offensive character.

The closet may be arranged so that entrance is gained from inside the house, while cinders and ashes together are thrown in, cinders removed and pans changed, or tanks emptied, from the outside. Existing structures may readily be adapted to the use of the cinder-sifting closet by filling up the cess or ash-midden to the level of the surface, with the exception, in case the tank or vault arrangement be adopted, of the space it will occupy below the seat.

From the pan, or tank, the manure may be either used at once for agricultural purposes—and numerous experiments in the culture of vegetables, &c., testify to its great value thus used—or it may be conveyed to a central depôt, as will hereafter be stated in connection with a large application of the system.

Numerous and independent experiments have proved that, as a rule, sufficient ashes are made in every family for effecting the deodorisation of its own refuse; but, in the event of the closet being required in public buildings for those who do not reside on the premises, house sweepings, dried earth, or any other dry material, may be thrown into the hopper with the ashes, as the screener rejects all the portions unsuitable for use in the closet. A separate box is usually provided for garbage. If there be no pig-trough on the premises to receive the vegetable refuse, no difficulty will be experienced in towns in securing its regular collection for the sake of its value as manure or otherwise, and at worst it may be burnt in the kitchen fire at night. Neither this, however, nor broken pots, should be allowed to enter the soil-receptacle; surely the latter may be collected with less trouble than when in combination with decomposing animal refuse. Where a system of sewers exists, the house slops may be consigned to them with safety; in country districts they may be filtered through cinders before being passed into a water-course, or may be actually turned to good account by a simple method of sub-irrigation.

As to the value of coal-ash as a manure, the following passage may be cited from Dr. Stockhardt's *Chemistry of Agriculture*, addressed to farmers :—

"Coal-ash.—Notwithstanding that this ash is frequently so little valued as to be thrown away, it deserves to be made use of in agriculture; in the first place because it contains, besides small quantities of alkalies, lime and sulphuric acid (gypsum), consequently direct sustenance for plants; in the second place, because from the same circumstance, as also from the clay it contains, it has the power to deprive putrefying substances of their odour, and to fix their ammonia, so that it cannot evaporate. In districts where coal is the common fuel, this ash is consequently the cheapest material for disinfecting cesspools. The following constituents have been found in the ash of Saxon coal :—

Alkaline salts	$\frac{1}{4}$ to $\frac{1}{2}$ per cent.
Lime and magnesia....	3 ,, 4 ,,
Sulphuric acid........	2 ,, 3 ,,
Alumina and peroxide of iron	40 ,, 80 ,,
Phosphoric acid	very small quantities."

This system has been practically carried out in the Pendleton district, under the Salford Corporation; and its adoption is made compulsory in the case of all new premises, and all reconstructions in the district. The plan pursued is for builders of property to purchase the working closet from the Sanitary and Economic Manure Company, Limited, and fit the same to the necessary brickwork, in accordance with an authorised plan. The total cost, when every item has been taken into consideration, is found to be something less than that of the primitive and objectionable ash-midden system.

More than one thousand of the closets are actually in use in the district; but the following statement of the result achieved by the system is based on the working of 1,000 closets. Each pail receptacle contains $1\frac{1}{2}$ cwt., and, with an ordinary family, requires to be changed every week. Thus, 1,000 closets produce 75 tons of manure per week, or say 3,900 tons of crude manure per annum.

The full pails are conveyed in covered vans to manure works, especially constructed by the Corporation at Windsor-bridge, and alongside the canal. The works embrace an open receiving yard, a shed containing a mixing mill and a mortar mill, driven by a steam-engine, a space for storing the manure and mortar made, a weighing machine, and a small office. The receiving yard is on a higher level than the floor on which the produce of the works is stored.

The excrementitious mass from the pails, after passing through the iron mixing trough, together with a small quantity—one quarter hundredweight per ton—of sulphate of lime, comes out a consolidated manure of uniform consistency, which obtains a ready sale at 12s. 6d. per ton.

Garbage and other rough material found on the premises, including cinders not re-burnt by the occupants of the houses, are also conveyed to the manure works by the same van which collects the pails. The garbage is separated and sold direct at the rate of 3s. a ton, while the remaining rough material is ground and, by the addition of three

cwt. of lime to the ton, is converted into mortar, and sold at 5s. a ton.

The labour required per 1,000 closets is only that of $2\frac{1}{2}$ horses and 12 men, including the collection and the process at the works. The financial result is as follows:—

	Tons.		£ s. d.
Manure from pails	3,900		
Sulphate of lime added ..	50		
	3,950	at Per Ton. 12s. 6d.	2,468 15 0
Garbage	456	„ 4s.	91 4 0
Mortar made	130	„ 5s.	32 10 0
			2,592 9 0

Less expenditure as follows:—

	£ s. d.	
$2\frac{1}{2}$ horses and 12 men per annum	821 12 0	
Sulphate of lime, 50 tons at $8\frac{1}{2}$d. per cwt....................	35 8 4	
Lime for mortar, 20 tons at $8\frac{1}{2}$d. per cwt....................	14 3 4	
Interest and depreciation on amount expended on works, viz., £1,000 at 10 per cent. ..	100 0 0	
Fuel and engineer's wages	146 2 4	
		1,117 6 0
Total nett profit to Corporation		1,475 3 0
Thus, on the collection and disposal of the refuse of 1,000 closets, representing a population of about 5,000, the system produces an annual profit of..............		1,475 3 0
Which for a town with a population of 100,000 means a nett annual gain of....		29,503 0 0

And to this nett gain to the town must be added the saving of the fuel in the form of sifted cinders to the occupants of the houses.

The sanitary efficiency of the system is pronounced to be perfectly satisfactory by Dr. Tatham, the Medical Officer of Health for Salford; and as to its working generally, the following extract from a report published by a deputation from a neighbouring town, after a visit of inspection, offers impartial evidence:—

"On Thursday, December 2nd, your committee visited Salford. At the Town-hall they were courteously received by the Mayor, the Chairman and Members of the Health and Scavenging Committees, the Town Clerk, Borough Engineer, and Medical Officer of Health (Dr. Tatham).

"Under the latter gentleman's directions your committee were conveyed in a private omnibus to various parts of the borough, and had ample opportunities of examining the various closets and ash-pits in use there.

"They were first shown the "Morrell" closets. These are really pail-closets, with the addition of a cinder sifter, so adapted that by mechanical contrivance a certain amount of fine ash is thrown into the pail every time the closet-seat is relieved from pressure. The fine ash absorbs the urine and gases in its pores, and becomes more or less intimately mixed with the solid excreta. By this adaptation, the contents of the pail are not in that slushy condition observed in all cases where the pail receives only the human solid and liquid discharges, and the first stage in the preparation of a good useful manure is thus done automatically.

"These closets were particularly free from smell, and were very neat and clean. Salford has tried the simple pail, but has now discarded its use in favour of Morrell's improvement of it.

"Every new house has its own separate closet, and old houses are compelled to have at least one closet to two dwellings. The pails are replaced at least once a week, and conveyed in a covered van in daytime to the depôt at Salford-bridge. Here, one by one, they are emptied into an iron mixing-trough, more fine ash is thrown in along with a small quantity of sulphate of lime, and in a few minutes is discharged from the trough a dry, portable manure, in the course of a few hours quite free from smell, and sold at 12s. 6d. per ton. The coarse ash and clinker are ground in a mortar-mill with sand and lime, and form an excellent mortar, readily saleable at 5s. 6d. per ton. The works were of a very unpretentious character, the machinery simple yet efficient, and the offensiveness as small as possible."

The self-acting cinder-sifting closets may be applied to all classes of premises, and the system is especially applicable to large towns, the cost of application either to new premises or the reconstruction of old, varying from £4 10s. to £6 10s. per closet, including apparatus.

To sum up, in conclusion, the points in favour of this method: it secures all the advantages of the dry-earth closet without the cost and trouble of providing dried earth; it saves all the unconsumed fuel, in the form of cinders, for re-burning by the occupants of the house; it produces a valuable manure by the exclusion of cinders, and owing to the fact of combining the fine ash dust only with the fæcal matter; it supersedes the ordinary pail system, which, when not supplied with a deodorant on each use of the closet is found to be a greater nuisance than the old cesspool; it is superior to the earth and carbon systems, as they require to be constantly supplied with deodorants, which have to be brought from a distance; and, lastly, it is the only self-acting system which secures all the above advantages.

Thus, of all the dry systems of excrement removal, it is not too much to claim for Morrell's self-acting cinder-sifting ash closet system, that it is the only practicable one which is perfect, from a sanitary, as well as from an economical point of view; inasmuch as it is the only apparatus which sifts the ashes which are already on the premises, scatters a dose of ash-dust over the soil, and (as shown by the above figures) utilises to the greatest extent all waste material made on the premises.

THE GOUX ABSORBENT SYSTEM.

By Thomas Mason.

The Goux absorbent system of conservancy is one that has economy, simplicity, and sanitary effect for its motto; and the results attained by its use fully bear out its claims.

I in no way intend to oppose or undervalue any of the numerous closet systems, as I believe that all have some special value in isolated cases, even if they are not generally applicable to the requirements of every locality; but in passing I must emphatically assert that in those systems in which ashes are proposed to be used as a deodorant and absorbent, there is a total failure of their pretensions, as they will do neither one nor the other. The only character they can maintain, is, that of a vehicle for the carriage of the fæcal matter to the land, and in that capacity they are worse than useless, because they are poisonous to some lands and valueless to others.

The Goux system of closet is one in which every advantage of the dry earth system is attained without the expense or disadvantage of machinery. In the Goux system, the very refuse of a place is made to act as a disinfectant of all its fæcal matter; and all this without the slightest chance of any irregularity or mishap, through the break-down of any machinery, or through neglect to prepare the dry earth, or other absorbent, or deodorant, as in other systems. Instead of the deodorising material (as in all other dry collections) being contained in a hopper or reservoir, apart from the receptacle for the fæces, in the Goux system the receptacle itself contains the deodorant absorbent and disinfectant, and so one service suffices, while in the other systems at least two are required; and in the Goux all necessity for drying ovens is absolutely removed.

Before describing the details of the Goux closet, attention must be drawn to certain arrangements which are requisite before any system of conservancy can be effectual. First, old middens must be reconstructed or new closets built. The Goux closet requires the least expense in alteration, and in new erections the cost of building is considerably less than for any other system. Second, in towns or villages, or congregated communities, scavenging should be always done by the authorities or some competent contractor. The former system is preferable, as every resident ratepayer would have an interest in the matter, and the workmen be less liable to waste their time. In the Goux system, this operation is required to be done once a week for a family of ten persons, once a fortnight for a family of five, and so on in proportion to the number in the family; the general effect of this practice would be that half the drinking supply of the country would be kept from contamination, and 75 per cent. of the filth now flowing into our rivers would be applied to more profitable use in our fields, pastures, and gardens.

The Goux system, as before stated, is entirely devoid of machinery or mechanical appliances of any kind, therefore the success does not in any way depend upon the persons who use the seats, but upon the man appointed to scavenge. The advantage of this particular feature is very great, as one man can scavenge for one thousand persons, so that if any failure arise, the cause would at once be known instead of having to search for it among the persons using the closets. The manipulation is very simple, and can be done by a boy as well as by a man.

A tapering tub or container is provided, say 16½ inches high, and 20 inches at its greatest diameter. Upon the bottom of the tub is placed three or four inches of refuse, such as new stable litter, loft sweepings, stack bottoms, ferns, shavings, sawdust, shoddy, flax dressings, speuttan, or hops, or the various waste materials to be found in town or country; this is mixed with a little soot, charcoal, gypsum, or other deodoriser, for the purpose of packing or lining the tub. A mould of the same shape as the tub, but six inches less than the internal diameter, is placed upon the four inches of absorbent material referred to, and the space between the mould and the tub is packed with the same kind of refuse. One boy can pack eighty tubs in an hour, and this is all the manipulation required, except placing and removing the tub at stated times. The absorbent material having been only moderately pressed down, the mould is withdrawn, and there remains a cavity into which the dejections fall, the liquid parts of which are taken up by the absorbents, and, retained by them, so as to check fermentation.

The only alteration to any existing middens will be to fill up the pit and put a small door in the back or side of the privy, or hinge the seat or riser, so that the container can be placed and removed when found requisite to do so.

That the Goux system is generally applicable, is proved by its having been five years in use in private houses, unions, hospitals, schools, factories, prisons, camps, villages, and large and small towns. It is in use at Aldershot Camp, Sheerness, Woolwich, and elsewhere for the War-office; and the company is in treaty with the Government for its introduction at other places. This system of collection is adopted by the sanitary authority of Halstead, in Essex, and worked by their own men, under the supervision of Mr. Matthews, the town surveyor, who asserts that it pays for the collection, reduces the cost of the water supply, and generally improves the health of the town.

The villages of Townley, Mickley, Stella, Prudhoe, Walbottle, and Seaton Delaval, have also the Goux system in use, and the agent to an estate in the latter place, after seeing the good effect it had upon the health of the residents, and the fertilising properties of the manure, ordered 350 sets, and the same number of new closets or privies; these were placed at only eight feet from the doors of the houses without causing any nuisauce.

In the year 1870 the Goux system was first introduced into the town of Halifax in Yorkshire, and although no pressure has been put on the property owners, more than 3,000 of these closets are now in use. The health of the town during the period from 1870 to 1875, is shown on the maps before you, which have been prepared by Dr. Haviland, the well-known author of "The Geography of Disease." The deepest red shows the maximum of health, and the deepest blue the greatest intensity of disease, and the various tints show the different gradations.

In this town, said to be the most difficult town in England for scavenging operations, this system was worked for five years by the Goux Company at the rate of 5s. per closet per annum for a period, and then 12s. per closet including the collection of the ashes, and costing the company 8s. 6d. per house per year.

When the Goux closets numbered 3,159, the company gave notice to terminate the contract, on the receipt of which deputations were sent to inspect various systems by the Corporation, who then offered an additional subsidy of 50 per cent., provided the company would continue the scavenging for five years; this being declined, the whole of the Goux plant, with permission to use the system for the whole borough, was purchased by them for the sum of £3,500, and the work is now being done by their own men and horses, under the superintendence of the sanitary inspector.

From the figures on the maps you will notice the remarkable manner in which the extension of the Goux system has coincided with the advancement of the health of the town. I need not weary you by reading the figures. If these do not give proof

positive of the value of the system, they at least use strong presumptive evidence that the "Goux" has exercised a beneficial influence on the health of the town of Halifax.

TREATING HUMAN EXCRETA OF TOWNS.

By Mr William White Fereday, C.E.

Late Borough Engineer, Wednesbury, Staffordshire, and Wakefield, Yorkshire, and late Constructive Engineer to the Town Manure Company.

For a very considerable period I have devoted much time to the subject of treating the human excreta of towns in such a manner that the valuable manurial properties, and the great fertilising power which they are known to possess, should be retained in a concentrated form as a pulverulent powder, or, in other words, a dry, portable manure, capable of easy application to the soil.

For a long time I had only the results of treacherous experiments to guide me in estimating the probable amount of success I could ensure in extended and practical workings. Becoming, however, at an opportune moment, professionally engaged, in connection with a large contract, to design and construct works, and to direct and superintend their workings on a large scale extending over a considerable period, I had the desired opportunity of cultivating my research, and satisfying myself as to the efficiency of modes of treatment and collection, and of the capability of processes and apparatus to reduce the collected solid and fluid excreta to a residuum or dry powder, having, in a concentrated form, within it all the fertilising power which the bulk had previous to its reduction.

I made careful observation as to the practicability of appropriating, and the cost of altering, existing closets, and adapting them to other systems of collection. I collected reliable data as to the quantity of solid and fluid separately due from populations, the cost of deodorising and collection, and the cost and general results of manufacture. I proved, too, the marketable value of the manufactured manure as a fertiliser, and had the satisfaction of witnessing its salutary effects upon various kinds of crops.

One very important fact demonstrates itself in a practical working, and it scarcely admits of dispute. It is, that if the human excreta are to be made to retain their organic and inorganic constituents in an unaltered and unimpaired condition for the purposes of reproduction, they must be in contact with an ammonia fixer, assimilable to their nature, immediately on their deposit, so that a conservative power can at once take effect, before atmospheric influences step in, assert their empire, and commence their allotted task of decomposition and destruction.

It further appears that no one system of collection can become universal, that is, to be as effectively applicable to one place and population as another. Where the collections have to be made merchandise of, to have a manurial and monetary value which will produce substantially more than the cost of getting them together, experience points very strongly to the "tub system" as the one admitting of an easy and inexpensive application to towns having from one to fifty thousand inhabitants.

In towns of this size, more especially in agricultural and mining districts, it will be found that the "privy and midden system" is the one in general use, and that at an average cost of about forty shillings, it can be altered, and readily converted to the "tub system," and where the alterations are properly done and well finished they are made to have the appearance of extreme neatness, and a great sanitary advantage over the old system at once presents itself.

I favour, myself, the introduction of a grey enamelled sheathing, fixed underneath the seat, having somewhat the appearance of a water-closet pan, but not so deep and constructed purposely to avoid dirt and discoloration; this greatly obscures anything which maybe considered unsightly, and leaves nothing open to objection, even by the most fastidious.

The collection and removal of the tubs and their contents may be generally undertaken by contractors at one shilling per head per annum of the population, and where sanitary boards elect to do the work themselves it can be done for less.

I beg now to submit what has been my actual experience in the manufacture, and what was realised during a twelvemonth's working of the Town Manure Company at Westbromwich, and will first mention that the mode of collection adopted there was in boxes lined with pitch, but the deodorising agent invariably decomposed the pitch, and the boxes became leaky and useless for the purpose, which is not the case with tubs, which are bound together with hoops as they cannot become leaky, nor do they require any lining. In all cases I recommend that the collection be made in air and water-tight vans, constructed for the purpose, as at Rochdale.

The process of manufacture which the company adopted, was evaporation by fire-heated surfaces, but as the temperatures were neither indicated or under control, the "make" was uncertain; sometimes the delicate chemical structure of the dried excreta was completely upset, and a great percentage of the ammonia dissipated. Another time, when the "make" was good, the organic elements would be undisturbed, and a very considerable percentage of the ammonia retained, enough to constitute a marketable value of about £8 per ton, at which price there was always a ready sale.

I here regret that I am unable to possess myself of a record I once had, giving several analyses; I can only put my hand upon one published by the company, showing seven per cent. of ammonia, but I know that I have had considerably more than that. This one year's working indubitably proved the possibility of reducing the excreta to a dry manure, usable in the ordinary way and not affected by change of temperature or moisture, having a ready market, and a fair and remunerative trade value. The principal defects were insufficient control over the temperatures, rendering the preservation of the organic elements a great uncertainty, and insufficient provision for the destruction of the gases given off, during manufacture. On account of the latter, the works were considered a nuisance, and further working was suspended for a time.

It is, then, these two great essentials that have of late been engaging my attention, and I am

pleased to be able to say, that I have put together processes and inventions which, upon a very substantial trial, have disposed of all difficulty, and given reliable results.

A brief explanation may suffice to give an idea of their efficiency. I divide my process of evaporation into two parts, disposing of the first 50 per cent of moisture by steam-heated surfaces at low working temperatures, and the remainder by fire-heated surfaces.

It is absolutely necessary that the quantity of ammonia fixer in the residuum should have a just proportion to its other constituents, as if I put as much in at first as is necessary to hold the ammonia at high working temperatures during the first half of the evaporation, the fixer being non-evaporative, I should have too much in the manufactured manure. I use steam, because its temperature can always be controlled even to a quarter of a degree, and when having first ascertained with a minimum of the fixer, at what temperature the ammonia begins to fly, I regulate and set my steam valve to a working three degrees below that point, the ammonia is then undisturbed, and the working can be continued for days and nights together without a mistake.

When the first part of the evaporation is effected, the contents of the apparatus are removed for further treatment, and finishing at higher temperatures in ovens constructed for the purpose, with proper thermometrical arrangements. The production thus guarded all through its manufacture has a very high manurial value.

To prevent the escape of noxious gases and to ensure their total destruction, the first provision is in the construction of the building, where the operations are carried on. It has no outlet through which gases can escape, and air is only admitted through valvular openings, to which action is given by an exhaust-fan working inside; the vapours as they are generated during manufacture are collected by the fan and driven through large quantities of liquid deodorant, in volume and sprays, where total condensation of the wet and absorption of the dry are effected. If, however, it is found that any of the gases pass through, they are conveyed to a furnace having such a temperature as insures their total destruction.

I may mention that this latter arrangement is applicable for the destruction of vapours given off from alkali and other works, and that I have secured it by Letters Patent.

THE PAN AND PAIL SYSTEM IN EDINBURGH.

By Adam Scott.

The following interesting statement is made by Dr. Henry Littlejohn, the Medical Officer of Health for Edinburgh. It appears in a report upon the Liernur system made to the Corporation of the City of London by their engineer, Lieut.-Col. Haywood:—

"Edinburgh consists of two distinct towns, an old and a new, but with very different populations. The new town is inhabited by the better classes, and is pre-eminently a water-closet town, whereas the old town consists for the most part of strongly-built tenements, which, in the process of years, have undergone repeated sub-divisions, until individual rooms, by means of partitions, are found to contain several families.

"It has been found impracticable to supply these tenants with ordinary water-closet accommodation, and to this day they have to make use of pails for the reception of the excreta of those confined to the house. These pails are brought to the street daily, and emptied into carts provided by the authorities.

"The authorities have also provided numerous public privies, which are daily cleaned by scavengers, and the contents of these pails and pans add largely to the value of the refuse of the city of Edinburgh. From a return made to the corporation in 1874, I find that 41,613 houses were examined. Of these 27,294 had water-closets, and 14,319 [population about 70,000] none. The latter mainly constitute the worst part of the old town of Edinburgh. Some notion may be formed of the nature of the house accommodation when it is stated that of these 14,319 houses, no less than 13,506 were rented under £12.

"From this state of things—the low morality of the population, the bad ventilation, the crowding together, and the retention of the filth in the living-rooms for the greater part of the day, it might naturally have been imagined that typhoid and diphtheria were endemic in the old town. This is not the case, however, for, despite the surrounding circumstances, these diseases may practically be said to be unknown.

"In the new and water-closeted town, however, the case is quite different; typhoid and diphtheria are never entirely absent, are frequently epidemic, and it has been noticed that the ravages of these diseases have been the greatest in the best houses."

I may add to this that the water supply in both towns is the same, that the corporation have, as opportunity offered, introduced water-closets into various houses as improvements upon the old arrangements. Dr. Littlejohn states that whenever this has been done typhoid fever or diphtheria has invariably broken out within six or nine months, and Dr. Murchison, in the second edition of his book on "Fever," page 444, states, that typhoid fever was unknown in Edinburgh until its sanitary arrangements were altered.

The lesson which this teaches is, that any system of removal cannot be sanitary unless, by it, in the words of Mr. Simon, all the excremental produce of a population is so promptly and so thoroughly removed that the the inhabited place, in its air and soil, shall be absolutely without fæcal impurities.

EDINBURGH AND GLASGOW WATER-FLUSHING SYSTEMS.

By Adam Scott.

Dr. Fergus, the President of the Health Section of the Glasgow Philosophical Society, was, I believe, the first to point out the startling fact that, according to the returns of the Registrar-General, the death-rate in this country from cholera, diarrhœa, and dysentery, which are recognised as diseases all more or less arising from excremental pollution of air, soil, or water, was nearly four times what it was thirty-five years ago. The figures are as follows:—

		Deaths per million per annum.
Mean of five years,	1838–42	298
„	1867–71	1,161

During these years there was no epidemic to disturb the normal rate, and typhoid fever—which sickens 150,000 each year, and which is recognised to be solely an excremental disease—is not included in the above figures, as until lately the deaths from this cause were not separated from those arising from other fevers.

While the accuracy of these figures as compiled from the returns has never been challenged, the deduction made by Dr. Fergus that the increase in these diseases has been caused by the fact that now we throw excrement into common sewers, thus polluting air, soil, and water, coupled with the fact of the greater crowding of the population in towns, has been strenuously denied by the advocates of the flushing system. They allege that the apparent increase is caused by the improper regis-

tration of these diseases under other names. To this it has been objected that the peculiar features of the diseases are such that it is impossible for them to have been mistaken.

Up to the present time neither the Government nor any scientific association has ever instituted an inquiry into this subject. Of its importance, no one can have the least doubt, as the question involved is whether the great so-called sanitary movement of the last thirty years, which is every day extending, is really a sanitary movement, or the reverse, and my object in writing this paper is to induce the Society of Arts to undertake an open and comprehensive inquiry into the matter.

The figures obtained from the Registrar-General's return furnish in themselves a *primâ facie* case that justifies such an inquiry, but as facts regarding individual towns, which facts are not generally known, can be brought forward in support of the argument founded on such figures, it is important that this should be done.

With regard to Glasgow, I may state the fact that in the period 1838-1842, typhoid fever was simply unknown in that town. My authority for the statement is Dr. A. P. Stewart, the eminent physician, of Grosvenor-street, who at the time was engaged in the Glasgow Hospital. Dr. Stewart is an authority upon typhoid fever, for it may be remembered that he was one of the first to point out the difference between it and typhus, at a time when these diseases were supposed to be identical. Dr. Stewart, to whom I am permitted to refer, states that typhoid cases did appear in the hospital, but in every case they came in for treatment from Campsie, a place ten miles off. In Glasgow itself the disease was unknown, nor did it appear until the sanitary arrangements of the town began to be altered. Since then that fearful disease has never left the town. The following statements, made by the late medical officer of Glasgow at two different periods, are instructive :—

"It was accurately stated that the evils inseparable from the water-closet system were likely to be less felt in Glasgow than in many other places, owing to the considerable fall of the greater number of sewers, and the almost unlimited supply of water by which the matter is diluted."

"It has been conclusively shown that houses presumed to be beyond suspicion of any possible danger to health from this cause—houses in which the most skilful engineers and architects had, as they believed, exhausted the resources of modern sanitary science—have, nevertheless, been exposed in a high degree to the diseases from air in contact with the products of decomposition in sewers, and this for a very obvious reason. Such houses are usually built on high levels, when the drains have a very rapid fall."

Dr. Stewart also mentions that in Edinburgh typhoid fever was unknown, and this is confirmed by the writings of the late Professor Reid, of St. Andrew's, who remarks that, like as in Glasgow, the only cases were those, not originating in the town, but which were brought in for treatment in the infirmary from the county of Fife. I find this is also confirmed by Dr. Murchison in the second edition of his book upon "Fever," pages 443-4, in which he states that typhoid fever did not exist in Edinburgh until the alteration in its sanitary arrangements took place. As to its prevalence now the following statement made this year by the Medical Officer of Health tells its own tale :—

"In the new and water-closeted town of Edinburgh typhoid and diphtheria are never entirely absent, and are frequently epidemic, and it has been noticed that the ravages of these diseases have been the greatest in the best houses."

Can anything be more striking than the fact which he also states (see pan and pail system in Edinburgh, on another page), that in certain districts, containing 14,319 houses (or at five persons a house, 70,000 people), where the sanitary arrangements were never changed, typhoid and diphtheria are to this day unknown.

The water supply in Edinburgh for the districts afflicted and not afflicted with the typhoid, is derived from the same sources. The sewage is partly disposed of in irrigation fields, partly carried out to sea, and partly discharged into a small burn. The fall of the sewers is great, the whole town being built on high ground. In Glasgow, the sewers are of very rapid fall, are nowhere of any great extent, but run direct into the river that passes through the town; and they are flushed by the enormous quantity of 53 gallons of water per head per day. The water, which comes from Loch Katrine, is above suspicion.

The sewers in both towns, as in the case of every town in the kingdom, allow percolation of sewage into the subsoil and the formation of sewage gas, and the house drains, like the house drains of all other towns in the kingdom, are frequently imperfect, and also allow free access of the sewage to the soil. It may be that if the sewers were made impervious, and the house drains also made perfect, and of impervious material—it may be that then, but not till then, excremental matter might be safely flushed into them. This simply means that every sewer in the kingdom should be rebuilt and every drain examined, and in most cases re-laid. As a system of perfect sewers and drains, however, comes under the head of "systems not yet tried," I suppose it must not be discussed. Meanwhile we may well assert that the great principle which the sanitarian should advocate, in regard to water-flushing towns, is that the filth, which is the cause of disease, should be utterly excluded from those imperfect sewers and drains which allow of pollution of air, soil, and water, and should be removed in such a manner that none of these three elements should be tainted with excremental refuse. In this alone lies the first great principle of safety.

THE MUNICH SEWERS,

AS ILLUSTRATING HOW THE SUBSOIL AND SUBSOIL WATER OF TOWNS ARE POLLUTED BY SEWAGE.

By Captain Liernur.

The fluid mass in sewers does not flow away without infecting the soil in which they are built, simply because no masonry can contain it. The chemical action of water upon mortar has been repeatedly ignored or denied by eminent sewer builders (they can be no engineers). They ascribe the percolation of sewage to bad materials, bad sectional profiles, insufficient gradients, or to crevices caused by subsidence, &c. They say, "build really good sewers of the best material, keep up a constant flow in them, and there will be no fear of percolation."

But as it always happens, when scientific truth has been temporarily silenced through the noisy violence of ignorance or interest (too often taken as a test of the correctness of judgment of so-called "practical" men), experience has also corroborated its dicta. She has shown that the very best kind of sewers, constructed by the very ablest of that class of engineers, with all the care and skill they could muster, become in a short time as leaky as a basket, and impart to the soil a great deal of the putrid fluid passing through them.

The best proof of this is to be found in the report of the Commission appointed by the City of Munich (Bavaria) to examine the new network of sewers constructed in a part of that town. The choice in regard to the Commission was in all respects a fortunate one, falling as it did on Professors Feichtinger, Ranke, Frank, and Pettenkoffer, the last-named being charged with reporting the results. The city engineer, M. Zenetti, a most worthy and skilful member of the profession, and the builder of the sewers in question, was placed at the disposal of the Commission.

To give a general idea of these sewers, I can do no better than give a condensed translation of the report itself.

"There are three classes of sewers, viz. :—

Intercepting sewers,	7ft. high in the clear,	4ft.	wide.
Main ,,	6 ,,	3ft. 5in.	
Branch ,,	5 ,,	2ft. 8in.	

The width refers to the spans of the upper arches, which are larger than those of the 'inverts,' giving the section the profile of an egg. The gradients are very steep; for instance, the intercepting sewers average 1 in 800, increased lower down even to 1 in 140. All sewers are throughout built of the best burned brick, laid in hydraulic cement, and have their inner faces cast flush, and plastered with the best cement mortar."

It is evident from this that any percolation of sewage cannot, in this case, be ascribed to bad construction, for the gradients are steep, the sections advantageous, and the masonry of the best kind. Everything, also, is arranged to exclude all privy matter. Let us note the effect of passing such comparatively harmless sewage through these conduits. I translate further.

"The Commission picked out for investigating the amount of impregnation by percolation, three streets. Pits were dug along the sewers until a little below the foundations, large enough for examining at ease the entire outward face of the structure.

"In Karl-street, where the sewer is throughout of hard brick and cement, the face of the masonry was throughout wet, and in many places water squirted through in little jets. Professor Feichtinger collected, in 14 minutes, ¾ of a litre in a bottle from one of these jets. When the sewage was reduced to its lowest level, the jets diminished in force, but not entirely.

"In Dachauer-street, the sewer is built of hydraulic cement beton; no jets were visible, but a shovel-full of sand, taken from under the sewer, was very wet, and stunk slightly.

"In Schelling-street, the intercepting sewer was examined, having walls two feet thick of brick in cement. No jets were visible, but there was a strong sweating, and the soil under the sewer was very wet, and stunk.

"As the first and third sewer had been built by contract, it was resolved to examine one in Mitlerer-street, which had been constructed under the management of the town officials. Here also a strong leakage was found.

"The result," says Professor Pettenkoffer, "will not surprise anybody who has once before instituted similar tests. Waterproof sewers exist only in the imagination of those theorists who consider hydraulic mortar and waterproof to mean the same thing.

"Professor Feichtinger analysed the soil dug from under the foundations. The fine sand washed from the gravelly sand imparted but little organic matter to either cold or boiling water, neither did it stink; but on drying it exhaled the loathsome scent of putrid glue. When this brown-looking dry sand was superheated in a porcelain cup, in order to drive out the organic matter, it became black, and threw off strong empyreumatic ammonia vapours—a sign that this matter was really composed of nitrogenous substances. In one cubic foot was found organic matter :—Dachauer-street, 122 grammes; Schelling-street, 98 grammes; Mitlerer-street, 247 grammes. In other words, the greatest quantity was found in the street where the sewers were the more porous.

"Professor Feichtinger was then requested to submit to analysis soil taken from places not in contact with sewers. This was accordingly done with material taken from three different gravel-pits in the suburbs, and also with the grit taken out an unsewered street. The gravel-pits gave respectively 28, 8, and 4 grammes organic matter, and that from the unsewered street 14 grammes per cubic foot.

"A comparative analysis of the nitrogen retained in one cubic foot gave the following results:—

	Gram.
The three sewered streets gave respectively ..	6·220
	5·010
	13·350
The unsewered street	0·623
The three graveled pits	1·787
	0·897
	0·257

So far the report of Professor Pettenkoffer. It settles at once and for ever the question whether the best kind of sewers, constructed upon the best plan, are porous or not. We see that, in all the cases, the quantity of nitrogenous matter unmistakably due to percolation from the sewers, was a very large one, even in the short time (five years) that they have existed. What will it not be in 50 years? It would be greater than ten times as much; for by that time a great deal of the lime of the mortar will be decomposed, and thus the porosity increased.

Now in Munich, no privy matter was permitted to be put into the sewers, but this rule had been violated in several instances by stealth. If, as in many English towns, the whole of the excremental matter went into the sewers, the impregnation of the soil with nitrogenous matter would be far more intense.

The Munich Commissioners proved this by comparing their sewage liquid with that of Rugby, according to Messrs. Lawes and Gilbert's analysis. It was then shown that one litre contained:—

	In Munich. Gram.	In Rugby. Gram.
Mineral matter in solution	0·361	0·643
,, ,, suspension	0·040	1·351
	0·401	1·994
Organic matter in solution	0·189	0·151
,, ,, suspension	0·080	0·670
	0·269	0·821

The Rugby sewage thus contained four times as much organic substance, and it follows that the soil of the town receives every year at least four times as much putrid ingredients.

What occurs in London must be something enormous. I learn from the report of the Registrar-General, that of the water pumped into London, no less than the enormous quantity of 20,000 tons daily (or 7,300,000 tons per annum) is lost by evaporation or by percolation into the soil, with all the excremental and other impurities it contains.

THE LIERNUR SYSTEM AT DORDRECHT.

By T. A. Van der Kloes,

Director of Public Works of that town (translated from the *Opmerker* of 7th October, 1875.)

During the last ten months I have been asked from so many sides for information about the Liernur system in this town, and more especially about the arrangements for making poudrette, that I resolved to make use of your Journal to answer them all at once.

It shows that the interest which people are taking in the ingenious invention of Captain Liernur is very general, and this is not without cause, as the great question of the cleansing of towns is becoming of more importance every day, and the conviction of the great difficulty to find a solution satisfactory in every respect is very prevalent.

The practicability of the system having been proved in the most satisfactory manner in some parts of Leyden and Amsterdam, the introduction of the same in Dordrecht cannot be considered as a trial, though in the first-mentioned places the way of getting rid of the manure and in consequence the financial proceeds, are not satisfactorily settled, a circumstance which has much to do with making towns hesitate to adopt this system.

Messrs. Liernur and de Bruynkops, fully convinced of the difficulty of the ready sale of the large quantities of this manure in its natural and liquid st te, have directed

their attention to the problem of reducing it into a state in which it should be easily transported, and be marketable at all times, without losing any of the manurial ingredients.

They try to carry this design out by the drying up of the fæcal matter in vacuo into poudrette (human guano) by means of the exhaust steam of the air-pump engines, and though the possibility of this scheme has been doubted by many scientific men of good name and reputation, there is now no doubt any more but that their efforts will meet with complete success.

The town of Dordrecht claims the honour to be the first to have given to these gentlemen the opportunity of realising their conception in this direction on a large scale.

The Council of this town resolved on the 7th October, 1873, to adopt this pneumatic system, and to execute it at once on two small canals, which were in fact nothing more than open sewers, without any flow of water through them. At the same time they resolved upon the erection of a central station, with central exhausting machinery, capable of working the greatest part of the town.

The pneumatic network in those two canals (which were first filled up and transformed into streets) came into operation in the autumn of 1874, and their connection with the central exhausting machinery followed in the course of 1875. The result thereof answers fully the expectations which people entertained after the experience on this head in Leyden and Amsterdam. But, as was expected, the sale of the manure could not cover the working expenses, the less so as in this instance the working plant was designed for a network of at least ten times the extent of that actually in use. At the same time, the apparatus for the making of the poudrette was erected, but it would have been a wonder if it had given satisfactory results from the very beginning. With the lack of all experience, it was almost impossible to foresee the different influences which would disturb the regular working.

That is why I did not want to publish my opinion about the working of the poudrette scheme till it should be in regular operation. But I had to give up that intention; firstly, because several months will pass before that will be the case, and I attach too much importance to this matter not to satisfy the demands of my many correspondents for information; secondly, because in some respects the results were too satisfactory not to mention them, the more so as I know that the success of the poudrette-making will be of great influence on the adoption of this system in other towns in this and in foreign countries.

The idea of reducing fæcal matter to poudrette is in itself not new. It can be done by evaporation on an open fire. This is done, as I am told, at Berlin, where, according to the information of Mr. Albert Putsch, civil engineer, the poudrette got in that way is readily sold for 6s. the hundredweight. The consumption of coals hereby is 70lbs. per 300lbs. of fæcal matter, the cost of which, added to that of the other expenses, as hand labour, &c., almost outweighs the value of the poudrette, so that this method in a financial way is only possible in places where the collecting of the raw material would cost nothing at all, or even is paid for by the inhabitants, as is the case with Berlin.*

Notwithstanding its great cost, this method is of great importance, as it shows the practicability of poudrette-making by simple evaporation. Neither can this be doubted, nor the value of the product as manure; but the great question is if it will be possible to evaporate the great quantity of water contained in the closet matter by means of the heat of the exhaust steam of the air-pump engines necessary for the working of the pneumatic network. And it must be said that Messrs. Liernur and de Bruynkops have succeeded in showing this to be possible. It has been proved that on an average a quantity of 800 kilogrammes of water were evaporated in vacuo from the fæcal matter by the exhaust steam, without burning any more coal in the boiler than necessary for the driving of the exhausting engine; and that if the system were extended over a portion of the town proportionate to the capacity of the poudrette machinery, the collected matter, with very little expense, will be reduced to a dry state, which will enable the town corporation to find a ready sale for the manure, which is not the case with the same in a liquid condition.

These gentlemen have, however, not as yet found the best form for the apparatus for producing the manure in a practicable dry state. They find from experience that several changes will be necessary, a very comprehensible consequence of the utter lack of experience in this respect and also of the phenomena during the trials, which could not have been foreseen, but by which they learned the way how to come to a good result. One of these is the heavy priming during the boiling in vacuo, which did not show itself during the trials on a laboratory scale.

A few months will be necessary for the changes in the apparatus, and Messrs. Liernur and de Bruynkops are fully convinced of the ultimate success of their inventions.

In the meantime the collecting of the matter by the central exhausting machinery is in full operation, and leaves nothing to be desired, though at present nothing can be said of the pecuniary results of the scheme. Nevertheless, even regardless of the making of poudrette. I consider the adoption of the pneumatic system a great benefit for towns such as Dordrecht. It is true that the outlay of capital and the difficulties of laying down the pipes in an old town are great; but the network once in operation, the collecting of the privy matter goes regularly as clock-work. Here in Dordrecht we are very much satisfied in this respect; a few times the closet funnels were choked up, but never the pipes themselves. Those obstructions were always caused by throwing, after the old fashion, all kind of things into the funnels to get rid of them; but gradually this happens less; people get accustomed to a better use of the closets, and also throw in less slopwater, since they learn by experience the disadvantages thereof.

Before closing, I cannot fail to utter the wish, that the adoption of the Liernur system may soon become very general even without the reduction to poudrette. But if this last operation should succeed as effectually as Messrs. Liernur and de Bruynkops represent, then I consider that the Liernur system will meet with a splendid future. [See postscript to succeeding article.]

* In Berlin, the inhabitants pay for the collecting and changing of the pails, about £4 10s. per house per annum.

THE LIERNUR SEWERAGE SYSTEM AT DORDRECHT (HOLLAND).

By Adam Scott.

I am asked to give a description of the Liernur system in Holland. I have already done so, not only at the last Sewage Conference in December, 1874, but more elaborately in a paper read before the Society on the 7th of April, 1875. I should, therefore, be to a certain degree repeating myself, so I prefer quoting part of an account which appeared in the London *Standard* on 25th December last, of a visit made to Holland for the purpose of inspecting this system. This is a very fair and impartial statement, and deals specially with Dordrecht. The circumstances connected with Amsterdam and Leyden, as being different, I treat in separate papers:—

(From the *Standard*.)

* * * * * *

"First and foremost, then, the Liernur system starts with the principle that, as prevention is better than

cure, all human fæcal matter, which is directly or indirectly the origin, according to Dr. Richardson, of no less than 15 of the most fatal diseases that scourge the human race, should be isolated, and removed every 24 hours, before it can do any harm. This is effected by the pneumatic system, without requiring intrusion into the houses, and without requiring any flushing apparatus, although this can be used where required. Sink sediment can also be separated and conveyed away by the pneumatic system.

"The second great principle of the Liernur system is that fluctuation of subsoil water, and the pollution of the subsoil itself, by percolation from porous sewers, should be put a stop to. This, of course, can only be effected in places not at present sewered, as it necessitates a separate set of agricultural drain pipes for the subsoil water, and impervious sewers for house and rain water, made after Captain Liernur's plans, and said to be only half as costly as our present system of sewers.

"Further, manufacturing refuse has to be purified separately; street detritus has to be prevented by filtering street gullies from entering sewers, and is to be removed by scavengers; and, where required, the house and rain water of the ordinary sewer is to be purified by filtration through coke, which is afterwards utilised in the pneumatic furnaces.

"The above is a brief sketch of the Liernur system as a whole. The only sub-division in actual operation is the pneumatic system; the other parts are, however, adopted for Winterthur and St. Petersburg.

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"We were shown over the pneumatic works at Amsterdam, Leyden, and Dordrecht, by the officials. At the two first-named places the system was served pretty much by the same temporary means as when it was merely on trial for experimental purposes. At Dordrecht, however, it had been adopted on the strength of the success at the two other places. Hence the works, which are intended to serve for the whole town, are of a permanent character, and a description of them will give the best idea of the system.

"All the refuse of the town of Dordrecht (better known perhaps by its ancient name of Dort) is thrown into the numerous canals, and in one district, embracing about half the population, is swept away by the tide. In the remainder of the town the canals are below the level of, and shut off from, the tidal channels. The stench is consequently at times overwhelming, and the mortality great. In some streets it rises to 100 in the 1,000, and the average of the unfortunate district, which contains 16,000 people, is between 50 and 60. The average for the whole town is between 30 and 40. It is not to be wondered at that the sanitary benefits of the Liernur system attracted the attention of the Dort Town Council; but, bearing in mind how slow such bodies are to move, it is somewhat wonderful that in so short a time they adopted it for the whole city, and pushed forward the works in that part of the city which most needed sanitary improvement. Dort is not a prosperous town. It is living on its past reputation, whilst its trade and population are fast slipping away to its more energetic neighbour, Rotterdam; and yet, with that spirit of indomitable enterprise which has converted the sea into a kingdom of dry land, this poor little old Dutch town has set itself the task of trying to solve the problem which is puzzling the world, by a system as novel in its principles and action as railways and telegraphs were in their time to the old style of locomotion and communication.

"After inspecting the working plans at the office of the Director of Public Works, we proceeded to the central station of the system, from which, in course of time, the whole town is to be served. Only part of the machinery that will be hereafter required is yet erected; the remainder will be put *in sitû* as extensions necessitate. At present there is only one air-pump steam engine of 30 horse-power, some poudrette machinery, and two iron tanks, one below and the other above ground, having a capacity together for about 22 tons of fæcal matter. In the lower tank, at the time of our visit, the indicator showed there were five tons of material, the transference of which to the upper tank was the first operation performed in our presence. In two minutes this was effected by air pressure, and without our either seeing or smelling anything offensive. Indeed, the entire absence of odour of any kind, in a place where large quantities of such loathsome matter were dealt with, was most remarkable, but easily enough understood when it was explained that all the receptacles are air-tight, and that all the air and gases pumped out of them are discharged into the furnace of the boiler and there burnt. If, therefore, such gases contain germs of infection these would be destroyed.

"The lower tank, having been thus emptied, was now ready for the reception of the day's fæcal matter from the houses joined to the system, and it is into this and similar tanks that, when in complete operation, all the excremental matter from the whole town will be collected. This will be effected entirely by under-ground pipes, which, like water-pipes, will enter each house, but be connected with the closets. While, however, water-pipes force water by pressure into houses, the pneumatic pipes draw or suck fæcal matter from the houses. From many parts of Dort such matter will thus have to travel underground a distance of between two and three miles, a journey which will only occupy a few minutes. As yet, however, the longest journey it has to travel is half a mile, the furthest houses at present served being at that distance.

"After leaving the central station we went to the farthest point, to witness the emptying process, the operations for which take place entirely in the street. Under the pavement was an air-tight iron tank, connected with the streets and houses round it by street mains and branches. One such street main served for 100 houses, and several mains are connected with one street tank, which is, in its turn, connected by a separate central or vacuum pipe with the central station. Such a central pipe calls at a number of street tanks on its way. All the pipes are shut off from the street tank by cocks like those in water mains, with which we are all familiar, and turned in the same manner. After he had shown us that the tank was empty, by opening a lid and inserting a rod, the principal operator, by turning one cock, put the tank for one moment in connection with the vacuum pipe, from which the engine at the central station is always pumping out the air, so as to keep up a vacuum. In that moment the air was sucked out of the tank, and the vacuum thus made was then isolated by shutting it off. The other operator then opened the cock in one of the street mains, the matter in which was thus drawn towards the tank. Twice was the vacuum renewed, and twice its power again let loose upon the same street main, by which time all the material to be removed had arrived in the tank. This meant that in two minutes the whole 100 houses on that one pipe had been cleared. A similar operation was gone through with each of the other street mains, and the district connected with that particular tank was finished for the day. There was now, as we saw by inserting the gauging rod, a large quantity of matter in the tank, which had to be dispatched to the central station before the men proceeded to serve the next street tank. This was effected by opening a second connection with the vacuum pipe. This second connection dips to the bottom of the tank, and through it all the matter therein was instantly drawn and carried literally on the wings of the wind to the central station—the tank on our next examining it being quite empty. The extent of the vacuum created from time to time was shown by a small vacuum guage, and the arrival of the material drawn in was indicated by the fall of the needle, showing that the vacuum was destroyed.

"The most remarkable feature of the pneumatic system is that, with the exception of the simple cocks we have referred to, and which can be lifted by hand at any time, there is nothing movable, or that can get out of order in the whole system of pipes, from and including the closets to the central building; and yet the difficulties to be overcome were great. Not only was there the difference in distance of the houses from the tanks, but the fact that closet pipes received unequal quantities of matter, and some none at all. The beautiful application in the pipes of the principle of equal barometrical columns, by which these difficulties are obviated, is of deep scientific interest, but I have not time to enter upon it here. I must proceed to record the impressions derived from our inspection of the closets in the houses.

"Although the Liernur system provides for the introduction of water-closets of a water-saving character, this is simply to prevent the want of these conveniences being a stumbling-block to those who consider they cannot be done without. One of the objects of the system is to collect the manure in its most valuable form—viz., fresh and undiluted. Hence the introduction of water-closets is a matter of expediency only. In Holland the people are quite satisfied with the pneumatic closet, without water. It is simple, and not liable to get out of order, having nothing movable in its construction, requires no water, and is perfectly inoffensive. These are all qualities for which the conveniences generally in use in this country cannot be praised, and about which strangers to the system are generally sceptical. The pneumatic closet, as designed by Captain Liernur, is inoffensive to sight and smell, and of such closets we saw many. There were, however, other closets in use in which we could see that some of the provisions laid down by Captain Liernur were omitted. In these there was decidedly an offence to sight, and in other closets we found, as might be expected with the more careless of the poorer classes, slight staining of the funnels, but in not one of the many we saw in the three towns—and we saw them in the poorest quarters, in almshouses, and in the dwellings of the wealthier classes—was there the faintest trace of odour of any kind. The position of many of the closets was such that they would be unbearable if there was the possibility of any smell. We saw them by the kitchen fire, where cooking was going on, and in some cases without any partition between, we saw them in cupboards without any opening to the external air, and yet everywhere they were perfectly inoffensive. In this respect they are infinitely superior to the ordinary English water-closet.

"Our next inquiry was as to the destination of the manure. At Dort it is dealt with under the general contract for scavenging the town, and made into compost manure; at Amsterdam it is applied to land belonging to the corporation; and at Leyden it is sold to a farmer. In Bohemia it is used largely in beet cultivation. The Liernur system provides for the manure being converted into a dry substance like guano, but this part of the system has not yet been tested on a scale large enough to give trustworthy results. At first towns wanted to see if the method of collection was technically a success before they went to further expense, and unfortunately, perhaps, the pecuniary results of the sale of the fluid manure were such that they did not see the necessity of listening to Captain Liernur's warning that no lasting financial benefit could be got until they were independent of the very few farmers to be found near their towns, by manufacturing a product that could be stored and sent to any of the manure markets of the world, like guano. The enterprise of Dort has in this case again shown itself. The municipality have erected the requisite machinery, and it was in operation a few days before our visit. We were informed that the trials proved the practicability of the evaporating process being effected by the economic use of the heat contained in the waste steam of the air-pump engine, without requiring any additional fuel. But, as might be expected in the first trials of an entirely new application of scientific principles, various changes were found to be necessary in the forms of the machinery, some rendered necessary by the violence of the evaporation being greater than was either anticipated or provided for. Hence, it will be still some time before the poudrette is manufactured on a commercial scale. I look forward to the result with great interest, as upon it, it seems to me, will depend whether the system is to become 'the one of the future for all large towns,' as the Leyden Commission for Public Works calls it, or is to take its place among the many systems which merely keep up a struggle for existence.

"Everything connected with the system at Dort is an undoubted success, if we except the poudrette manufacture not yet on trial; and the same may be said of Leyden. Here central stations were all that could be desired, and we were informed by the secretary of the city that the Financial Commission, the Public Works Commission, and the mayor and alderman had each, in separate reports, recommended the extension of the system to the whole town, and further that the principal inhabitants, including all the 19 professors of the celebrated university, had petitioned for this to be done. The council were, however, waiting the results of the poudrette manufacture at Dort before deciding.

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"In conclusion I would say a few words upon the system in its technical, sanitary, and financial aspects.

"*Technically* it seems to be a great success wherever Captain Liernur's plans have been followed. At Leyden, the corporation minutes, a copy of which we were favoured with, state, as a reason for extension, that the operation of the system had been daily witnessed for three years, and that there were no failures to report. At Dort we were told the same, but the time of operation was only a year. And at Amsterdam the last minute of the corporation testified to its good working, and decreed its compulsory extension. It was when these extensions were being carried out that the inimical alderman came into power, and complaints of all kinds arose. Under the new alderman, however, a better management exists, and it is right to remark that, in an official statement, dated 31st July last, that gentleman, without, however, implicating his predecessor, acquits the system of any blame for the failures that took place, and he is extending the system, notably in districts where he, as a large householder, will have to bear a considerable proportion of the cost. I may add, too, that the extensive pneumatic works at Prague, Brunn, and Olmutz have now been working successfully for five years, and that the operation of the system at the Vienna Exhibition drew forth an eulogistic report from the International Medical Congress, and resulted in the knighting of Captain Liernur by the Emperor, after making a minute personal inspection of the works himself. It seems to me, therefore, that technically the system must be admitted to be a success.

"*Sanitarily*, it appears that the system ought to be perfect, as, from the moment the closets are emptied until arrival at the central station, for conveyance to the country for utilisation or conversion into poudrette, the excreta are absolutely deprived of all power of doing harm, being confined from first to last in air tight pipes and vessels. The gaseous products, including all air that in the pipes and vessels has been in contact with the matter, are passed through the furnace and burned. No matter, therefore, how infectious they may have been, their power to work evil is stopped for ever. The air, soil, and wells of towns are freed from the possibility of excremental pollution and from the diseases, such as typhoid, which owe their origin to that source alone. Both in Amsterdam and Leyden the minutes of the corporation speak in general terms of the "immense

beneficial advantage" the system has on the public health. It seems to me, however, that this statement is grounded rather on what they feel certain must be the consequence than from actual observation, for nowhere have I been able to find any statistics upon the subject. These would have been much more satisfactory than a mere general assertion.

"*Financially*, it is impossible at present to judge of the system. At Leyden only, in Holland, has the revenue from the sale of the fluid manure exceeded the working expenses. At Prague, Brunn, and Olmutz, where that manure was sold for as high a price as 8s. per head per annum, until the users bought up the works altogether, the financial results were very brilliant; but as the surrounding circumstances were quite of an exceptional character, this is no criterion. I am, therefore, led to the conclusion, that unless the fluid manure can be economically converted into a concentrated dry product, the financial results of the system must be poor. A bulky fluid that must be got rid of, is expensive in transport, and must be used at once whether crops want it or not, must always be disadvantageous and unremunerative, but the dry product will, no doubt, be valuable. Captain Liernur is sanguine that he can so manufacture it that the revenue will be sufficient to pay not only working expenses, but interest on the capital expended; in other words, that the pneumatic system will cost the town nothing. Whatever one's own private opinion may be, one would be wanting in respect to the eminent engineer, who, in the pneumatic system, has conquered difficulties everyone looked upon as insuperable, to doubt his word. It may be, therefore, that the poudrette manufacture may be a further triumph of his genius. A few months will tell, but until then the Liernur system will make but little progress in this country. If the manufacture succeeds, however, only so far as to produce a revenue that will cover the working expenses, the pneumatic system will have done more than any other sewage system in the world, and will undoubtedly have a great future before it."

I may add to this account that, as the Liernur system has been adopted in principle for the whole town, the new houses in isolated districts and on the outskirts are compelled to be provided with Captain Liernur's adaptation for single houses. The pipes from the houses rise outside to the surface of the street, and are covered by a cap. They are capable of holding a fortnight's collection, but once every week a hand air-pump and tank is sent round, and the contents of the pipes emptied. This separate system gives great satisfaction, and in future, when the districts become sufficiently populated to lay down central pipes, main pipes, and street tanks, these houses will be connected with the central station house in the usual manner.

The cost at Dordrecht cannot be ascertained, as the central station and pipes are intended to be used for a much larger population than is at present served by the system, and a good deal of other work, such as filling up old canals, had been effected at the same time, and cannot be properly apportioned.

P.S.—With reference to the Poudrette Works, information has just come to hand that they commenced permanent work at Dordrecht on 13th May, and have proved a complete success, in that the whole evaporation is practically effected by the economical use of the heat contained in the exhaust steam of the pneumatic engines, and that all the manurial ingredients are preserved in the poudrette.

THE LIERNUR SYSTEM AT LEYDEN (HOLLAND).

By Adam Scott.

The pneumatic system for collecting excrement is the only subdivision of the Liernur system in operation in this famous old university town. The following figures are taken from the report made to the Corporation of the City of London, by their engineer, Lieut.-Col. Haywood, upon the visit he made by desire of the Corporation, to investigate into the Liernur system. He gives them upon the authority of the Mayor and the Secretary of the City:—

The district served by the system numbers 1,197 inhabitants, and, as this is the only place where the work, both inside and outside the houses, and including engineers' and patentee's charges, has been paid for by the municipalty, the cost is a matter to be borne in mind; it was £2,137, or £1 15s. 8d. per head. The work was completed in April, 1872, and, as all the pipes are of 5-inch cast iron, it is important to remember that at that time iron was nearly double its present price.

The pneumatic system at Leyden is worked from a small central station, and by an engine of 8-horse power, which works only three or four hours daily, and, therefore, could easily serve for several other districts. The engine is a locomotive, converted into a stationary one, and when the system is largely extended, will be replaced by engines specially built for the purpose.

In July, 1873, the following passage occurs in the message of the Mayor and Alderman to the City Council, alluding to the system:—

"Where it is applied, thus far in this town it has given the most satisfactory results. Since it has been put in operation the good and regular working has been daily witnessed, and there were no failures to report. The immense beneficial influence it has on the public health, resulting from the advantage that the excrements are daily removed without polluting the soil, stream, and atmosphere in any way whatsoever, or being a nuisance to any one, is for itself already reason enough to adopt it for further extension; but also the fact of its requiring a greater outlay is without any importance in this case."

The manure at Leyden is not converted into the poudrette, as it should be if the system were carried out in its entirety. There were strong doubts at first as to whether the pneumatic action would be effective, and then when this was proved there were doubts whether it would stand the test of time. Naturally, therefore, the authorities hesitated to go to the further expense of the poudrette works until the above points were settled. Dordrecht, however, having adopted the system, from seeing its success in both Leyden and Amsterdam, went in for it complete, poudrette manufacture and all. Leyden waits to see the results. [See postscript to article on Dordrecht.] It must also be borne in mind that Holland is principally a pastoral country, and needs but little manure beyond what the animals produce. The price at first paid by the farmer was 8d. per hectolitre, or over 2s. per head per annum; but, in 1874, he readily paid 1s. per hectolitre, or 2s. 9d. per head per annum, the farmer paying besides all expenses of removal.

The figures for 1874 as given by Lieut.-Col. Haywood, under the signature of the town clerk, are as follows:—

Received for manure	£166
Expended for men, fuel, repairs, &c.	140
Profit	£26

Such a profit must not be relied upon as a criterion in any way, and this is shown by the fact that the price sunk in 1875 to 2d. per hectolitre. For 1876 the price has advanced 25 per cent.

As regards the working of the system, Lieut.-Col. Haywood states that he was assured it was a complete success; that two obstructions had occurred at the commencement of the working, and had been caused by malice, but there had been none since—up to the time of his visit. Writing to me on 4th January of this year, in answer to an inquiry, the secretary of the city states that "there are never any obstructions nor any difficulties in working the system."

I may add to this that the Commission for Public

Works have reported in favour of extending the system to the whole town of 40,000 people. In that report they designate it as "the system of the future for all large towns." The Financial Commission have reported in similar terms, as have also the Mayor and Aldermen, but the Council have not come to any decision on the subject, and are not likely to do so until the result of the poudrette works at Dordrecht is known. In addition to this, the principal inhabitants, including all the nineteen professors of the celebrated university, have petitioned for the extension of the system to the whole town.

It is right to mention here that it was announced that a Commission from the English Government, consisting of Messrs. Rawlinson, Smith, and Sewell-Read, were commissioned to visit Holland to inquire into the Liernur system. Their report, if written, is a secret document, but what they have communicated to a municipal deputation that waited on them is no secret, as some members of the deputation published in the local newspaper, under ten different heads, the conclusions arrived at, as communicated to them. As these have thus, in an irregular way, become public, it is right I should, to prevent persons being misled, record the fact that most of the so-called conclusions are misleading, and some of them, in dealing with matters of fact are simply untrue, as I can show by official letters in my possession. For instance, one of the statements made is, that the system is not to be further extended at Amsterdam and Leyden. I have spoken above as to Leyden. As to Amsterdam the best answer is, that a very short time after the Commission visited that town, the Council decreed an extension by 29 votes to 6. Further, I may say that the authorities at Leyden and Dordrecht state that they are not aware of the Commission ever having visited their towns. The Commission must, therefore, have remained incognito during their visit; why they did so, when they made themselves known at Amsterdam, I cannot tell.

Sanitary Results.—The secretary of the city of Leyden states that the district where the system is in operation was formerly noted for the prevalence of typhoid fever and diphtheria, but that these diseases have entirely disappeared since the system was put in operation. No statistics, however, appear to be collected as to this, but as in Holland both the householder and the medical attendant are by law bound, under penalty, to report to the Mayor all cases of infectious disease, there is no doubt the secretary of the city has the best authority for the assertion.

THE LIERNUR SYSTEM AT AMSTERDAM.

By Adam Scott.

The Pneumatic System was first put in operation in 1871, in two districts, numbering respectively 1,570 and 360 inhabitants.

On 10th April, 1873, the following decree was issued by the Common Council:—

Mayor, Aldermen, and the Common Council of Amsterdam declare herewith, on the subject of Captain Charles T. Liernur's System of Sewage.

"That the results thereof, in a technical point of view, agree in every respect with the assurances of the inventor, namely, that the excreta are removed by atmospheric pressure from the houses near to the reservoir, and those at the greatest distance therefrom simultaneously, and that the decanting of the material collected in barrels takes place with ease, speed, certainty, and without any offence.

"That the localities appointed for the trial were two streets, the first one having mainly very irregularly-built houses, schools, and manufactories, offering a great many technical difficulties, due to the intricate nature of the places to be reached, and to the uncertain character of the soil as to solidity, which, however, all have been conquered with good success, so that the practicability of the system may be considered proven even in case of such obstacles.

"That the results obtained in a sanitary point of view in general, but particularly for Amsterdam, are of the utmost importance, while it has been demonstrated that the system is capable of removing human excreta from the houses without offending sight or smell, before any noxious gases can be developed and escape.

"That seeing that in consideration of above results the extension of the system cannot be but beneficial, we have resolved to make its application compulsory in the following places:—(Here seven different districts are named).

"And it deserves observation that, for the localities mentioned sub 2, 4, and 7, the proprietors themselves have demanded it.

"Mayor and Aldermen aforesaid,
(Signed) DEN TEX, Mayor,
DE NEUFVILLE, Secretary.

So far, then, as these first experiments were concerned, the system proved an entire success, and therefore these large extensions were ordered. But now arose an opposition, more unscrupulous, if possible, than any which has so often resisted the inception of great and beneficial works. In giving an account of this opposition, as it is my duty to do, so as to prevent the public being misled, I prefer doing so as much as possible in the words of independent Dutch officials. The first extract I shall make is from the account of the Liernur system by Dr. L. J. Egeling, of the Hague, the senior Government Medical Inspector of Holland, a gentleman who occupies a position similar to that of the Medical Officer of the Privy Council and the Local Government Board. This account will be found in *Public Health* of 2nd November, 1874:—

"In Amsterdam things did not go quite so smoothly.

"During the execution of the extensive works resolved upon by the Common Council, the alderman who until then had been chief of the Board of Public Works, resigned. His place was filled up by a gentleman named Tindall (a late naval officer), who soon declared himself an adherent to the old plan of washing the excreta by means of the common sewers to sea, or to the nearest stream. He objected to Liernur's system. One of his first official acts was to bring in a motion for ceasing its further extension. This motion, however, was rejected by the Council, and Captain Liernur's proposal for going on more vigorously was carried instead. Of course, this did not make the alderman referred to a friend of the plan, and since that time all that has been done for the further extension of the system has had more the effect of giving to the system, in the eyes of superficial judges, the appearance of a failure than of proving its good working and of securing its benefits.

"No notice was taken of the first requirement of the system, namely, that on every story of a house adequate means should be provided for throwing away wash-water, &c., in order to prevent the closets being used for this purpose, thus diluting the manure and diminishing its value.

"Further, the new and powerful machinery voted by the Council to carry out the system was so long *in statu nascenti*, that, as I am informed, during a year and a half the emptying process took place, instead of daily, only twice, or sometimes once a week, for each of the blocks of houses.

* * * * *

"More such examples could be given, but these will suffice to prove that the management in Amsterdam is not, or at least was not till recently, what it ought to be. A comparison with the working at Leyden, however, shows clearly that the shortcomings to be observed in Amsterdam are not to be imputed to the system."

Aldermen in Dutch towns have different powers to those in our Corporation. The office, while a highly honourable one, has a small stipend attached to it, and each alderman is placed at the head of a department, over which he has practically supreme and arbitrary control, subject only to the directions of the Council. It is gratifying, therefore, to find that at least one of the permanent officials under Mr. Tindall, the Alderman of Public Works, whose conduct is above alluded to, had the noble independence, at the risk of much personal obloquy, and even of dismissal, to denounce in unmeasured terms the acts of his superior, and to continue doing so in spite of all the pressure and intimidation

that was brought to bear upon him. This gentleman, whose name is to be remembered with honour, is Mr. A. Bergsma, an engineer, who occupies the important position of Chief Clerk of the Public Works at Amsterdam. In August, 1874, he wrote me a letter, which has been published, in which the following passage occurs, which confirms the statements of Dr. Egeling, although omitting the name of the alderman.

"Like all other great reformations, this system has had to conquer much opposition, chiefly from the above-mentioned old water-flushing plan, which has already caused, in your country as well as in ours, so much embarrassment. Its adherents maintain that human excreta have no agricultural value, and, therefore, considering the pneumatic tubes which Captain Liernur employs for the separate removal and utilisation thereof an, unnecessary and expensive complication, executed his plans imperfectly, and subjected the works, after being established, to a very indifferent treatment, probably in the hope thus to defeat its general introduction. For this purpose arbitrary changes were made in the designs proposed by him, without consulting the mechanical principles involved thereby, and without his knowledge, resulting then in a defective working, without his knowing the reason; machinery for the exhausting process was kept in service totally inadequate for the extent to which the pneumatic tubes were laid, causing thus privies to often overflow, and creating a horrible nuisance. The arrangements prescribed for the system to prevent waste and kitchen water being thrown in the privies were completely ignored and neglected, causing a dilution of the manure, greatly deteriorating its value and transportability, and instead of vigorous steps being taken to derive an income through its advantageous sale, it was given away for a mere song to the first applicant."

I may add to this, that these matters are no secret in Amsterdam. They are the subject of numerous official reports, and have been the subject of numerous articles in the press, and have never been denied by the alderman implicated, Mr. Tindall, simply because he could not do so. A few examples of the administrative misdeeds may be instanced. Captain Liernur holds a letter from the city engineer, with plans attached, showing no less than nineteen arbitrary alterations he made in the plans under Mr. Tindall's directions. Among these are such things as actually placing a closet below the level of the pipe which is intended to drain it. Now, so perfect is the pneumatic process, that even this departure from Captain Liernur's plans would not have mattered if the daily working of the system had been performed. But, as stated above, Mr. Tindall, while he obeyed the order of the Council in extending the system in seven other districts, did not choose that the provision of the engine power, also ordered by the Council to work such extension, should be supplied as required. Indeed, he delayed such provision for a year and a half, in which time the emptying process in the whole nine districts had to be performed by the machinery that had been originally provided to work the two experimental districts only. Hence the emptying took place only once or twice a week instead of daily. As the houses are built in flats, each flat containing a family, and having closets the one over the other, the nuisance from the collection of matter that flooded the lower closet, which was below the level of the pipe supposed to drain it, may easily be imagined.

When the small steamer, with air-pump apparatus, which was ordered by the Council for the purpose of navigating the canals and visiting the numerous and widely-spread districts, did make its appearance, it was found that Captain Liernur's designs were again departed from. This steamer was only intended for temporary purposes, until the extension of the system in the various quarters justified the erection of central stations, from which they would be worked by fixed machinery. Captain Liernur designed the vessel, so that when it has served its temporary purpose, it could be used as a fire-engine. Mr. Tindall has produced a boat that will not answer that purpose, that takes an hour to do the work that should be done in a few minutes, and the general comicality of whose arrangements is best indicated by the fact referred to by the *Standard* correspondent, its funnel strikes forward when passing under bridges!

I mentioned that Mr. Bergsma rendered himself especially obnoxious to Mr. Tindall by his fearless exposure of that gentleman's acts. When visitors come to inspect the system, Mr. Bergsma would point out all the imperfections, and then produce the plans of Captain Liernur kept in the office of Public Works, and show conclusively that in each case these had been departed from. More than this, a favourable account of the system, written by Mr. Bergsma, had appeared in an English technical journal.

The Mayor and Aldermen (departmental letters being signed in their name), thereupon wrote to the editor of that journal, saying that the account given was incorrect, and requested him to publish their letter in his next issue. To this the editor replied that he could not publish it in that shape, but if the Mayor and Aldermen would only say in what respects the statements of Mr. Bergsma were incorrect, he would be happy to publish such a letter. As the Mayor and Aldermen wrote and declined to enter into particulars, the editor answered declining to insert their former letter, as he could not publish any general assertions tending to injure the character of any official when they were not prepared to state the facts upon which these assertions were founded.

Foiled in this, Mr. Tindall made a last and desperate attempt to dispose of Mr. Bergsma. That gentleman had, in a technical journal, and in his private capacity as an engineer, severely criticised the report of the Director of Public Works, one of Mr. Tindall's subordinate officers, also the engineering scheme propounded by him. Thereupon Mr. Tindall brought the matter before the Town Council, demanding the dismissal of Mr. Bergsma, and offering as the alternative his own resignation. His accusation was, that by such conduct Mr. Bergsma abused his official position. The Council, however, did not agree with Mr. Tindall, and unanimously maintained that Mr. Bergsma had a perfect right to do as he had done. Mr. Tindall, in support of his charge, referred to the before-mentioned favourable account by Mr. Bergsma of the Liernur system, as an instance of his abusing his official position to disseminate false statements. Upon this, very strong expression was given in the Council to the effect that the account given by Mr. Bergsma was quite correct, and it was insisted on that Mr. Tindall should specify the statements he alleged to be untrue. Mr. Tindall, thus forced into a corner, replied that there were two false statements. The first was that Mr. Bergsma had said that the manure was sold to one man, who retailed it to the farmers. This formerly was true, but now this man used it all himself. This was one of Mr. Bergsma's false statements. This revelation was received by the Council with such a shout of scorn and derision, that the second so-called false statement was not revealed, and as the Council declined to accede to his demand for Mr. Bergsma's dismissal, Mr. Tindall resigned. His resignation was unanimously accepted; a vote moved by one member, that as a matter of courtesy they should accompany the acceptance by an expression of regret, falling to the ground for want of a seconder.

The importance that these statements should go forth to the public, to put them in possession of the truth respecting Amsterdam, will be evident, when I mention instances of what Mr. Tindall has done with respect to this country. He came over here, and had interviews with many of our principal engineers, and condemned the Liernur system to them. He also wrote a long account to the Southampton Town Council, full of misleading statements. That may be seen in the collection of reports upon the system, collected and published by the Winchester Corporation, many of the misstatements he makes being pointed out by that cor-

poration by reference to numerous other official documents. I take but one instance from his letter. He states the expenses at Leyden to be 6s. 8d. per head per annum, for the same period that it will be seen Lieut. Col. Haywood shows he has it in writing from the authorities that these were only 2s. 4d. Mr. Tindall also, since he has been put out of the office, has amused himself by waylaying English gentlemen who visited Amsterdam, and himself serving as guide to show them the system. A notable instance of this is the case of Mr. Busch, of Liverpool. Mr. Tindall even took this gentleman to Leyden, but carefully prevented his seeing any of the authorities there. The consequence was, that Mr. Busch produced a report, repeating the misstatements that were in Mr. Tindall's Southampton letter (as is also remarked by the Winchester Committee). This report was published in numerous papers throughout the country. This elicited official contradiction by a letter from the Secretary of Leyden, which appeared in the *Engineer* and the *Local Government Chronicle*, and briefly remarked that "every statement made by Mr. Busch, as to the working of the system at Leyden, was entirely untrue." The new Alderman of Public Works at Amsterdam also wrote that none of the statements of Mr. Busch were founded on any information given by him.

Even in regard to the sale of the manure, as stated by Mr. Bergsma, Mr. Tindall interfered. He imposed conditions that but few farmers would accept, and actually, on one occasion, he gave the contract to a personal friend, at half the price for which an offer was in his possession, from the farmer who bought the Leyden manure. Remember these facts are in official reports, and are uncontradicted.

Even now, Mr. Tindall, though deprived of office, is still in the Council, and, like all resolute men who are born to rule autocratically, exercises considerable influence. That has been shown by his prevailing on the authorities to issue an order that Mr. Bergsma should no longer show any strangers over the system, but should hand them over to the very men who carried out the instructions of Mr. Tindall, and who, under him, were responsible for the imperfections of the work performed.

I may add that, during Mr. Tindall's reign, I wrote to the Mayor and Alderman, asking, in consequence of the many statements of the imperfections of the system that had appeared in England on Mr. Tindall's authority, if there were any that could be shown were in places where Captain Liernur's plans had been carried out. My letter was published in the *Handelsblad* of Amsterdam (the *Times* of Holland), and I am told my request was supported by the whole of the Dutch press, but Mr. Tindall remained silent, for an obvious reason. The plans are in existence to confront any statement he might have made.

Here I may refer, by permission, to the editor of the *Handelsblad* for the truth of the statement as to Mr. Bergsma, Mr. Tindall, and the Town Council, and as to my letters, the action of the Dutch press, and Mr. Tindall's silence, all these being public matters.

It will be obvious from the above, that the sale of the manure gives no criterion from which to judge. The official trials of the provincial government of North Holland had set its value above guano for three crops, on which they tried it, and equal to guano in other three crops; and of course, as it is not reduced to poudrette, and is much diluted, from the neglect of other provisions to dispose of house water, its marketable value is merely nominal. Up to September, 1874, one man took it all at 5½d. for 200 lbs. of liquid manure, but the town had to provide transport. Since then it has been sold for even lower prices, or used in the lands of the Corporation. The last news from Amsterdam is, that the demand is becoming more brisk, and the price rising. At Amsterdam, as at Leyden, however, they are looking forward to the completion of the poudrette works at Dordrecht.

I understand that Sir John Hawkshaw has reported unfavourably as to the Liernur system for Glasgow. It is right, therefore, to say that Sir John, when at Amsterdam on other business, took simply a passing glance at the system, under the guidance of those gentlemen, who, as I remark, are not favourable to the system. He neither examined thoroughly into it, nor did he visit Leyden and Dordrecht.

"In spite of the antipathy of some men in power," says the Commission from Winterthur (which has now adopted the system), "in spite of irregular and defective management, the system steadily gains ground in Amsterdam." One of the new Aldermen, a large householder, had it put into all his houses, and, as an answer to Mr. Tindall's statement, published a declaration by himself and his tenants that it worked well, and that they desired nothing better. Many petitions and applications for its adoption in various new localities were sent in, but refused consideration by Mr. Tindall. Even builders, who at first opposed the system, now propose it themselves, their houses becoming more valuable on account of the sanitary benefits thus conferred on the occupants being now recognised.

Since the removal of Mr. Tindall, the Council have decreed extension; and Lieut.-Col. Haywood remarks, in his report to the Corporation of the City of London, that it is considered it will be applied to the whole of the new part of the town (population about 100,000). New houses in isolated districts have the separate house adaptation of the Liernur system applied, so that when the place becomes more populous, street mains and central pipes can be laid down to connect the houses with one or other of the central stations. In this separate house system the pipes are emptied once a week, by a hand air pump and tank, which is found to work satisfactorily.

The new Alderman who succeeded Mr. Tindall, has written an account of the system (signed by him in the name of the Mayor), which completely exonerates Captain Liernur from all blame for the imperfections that exist in Amsterdam. "The results," he says, "cannot be considered otherwise than satisfactory. What many deemed impracticable has proved to be quite practicable. What seemed complicated is now to most men plain and easy. This does not take away that there are many opponents, and that the manner in which it has been executed here has given rise to complaints which explain that opposition too well." He further states that the dilution of the manure is caused by the non-provision of means of throwing away house water, and the use of the closet for that purpose; also that the cost of that system at Amsterdam is no criterion for other towns, iron having been double its present price, and the town being built upon piles, all the pipes having to be supported. With regard to the manure, he mentions that by its being leased to one farmer, the others were prevented from trying it. Now, several have provided themselves with it, and the results, so far as shown, are favourable, even with the diluted manure. Speaking of the sanitary results, he says, "No infection with disease in houses connected with the system has taken place."

In conclusion, let me quote an extract from a letter received last month from the Senior Government Medical Inspector of Holland:—"Amsterdam has done much evil here as well as in England. There is one consolation, the system is good, and so it must find its way, and it will find it, though slowly. People who wish to see the system in working should go to Leyden and to Dordrecht, and leave Amsterdam alone."

THE LIERNUR SYSTEM IN PRAGUE, BRUNN, AND OLMUTZ.

By Adam Scott.

Prague was the first place in which the Pneumatic System was first in operation. The military authorities gave permission for its application (in 1868) to a barrack,

on condition that the Imperial Engineers' Department were to attend and report daily on its working for a month.

The engineer in charge concluded his report by saying: —"Considering the great advantage offered by the system, I take the liberty of strongly recommending its introduction into all the barracks of Prague, as well as into hospitals and larger military buildings."

This extension, Captain Liernur, by War-office rescript of 18th September, 1868, was ordered to carry out. A small syndicate of capitalists offered to provide the money, their only remuneration being the manure for a period of 15 years, after which everything was to revert to the Government. So successful in a financial sense was the speculation, that they extended their operations to Brunn and Olmutz with the same results.

Many thousand people are thus sewered by the system in these three towns, but solely in barracks, hospitals, and factories.

The demand for the manure by the best cultivators was so great, that the contracts made for the sale of the manure, were at the rate of 8s. per head per annum, and for several years. The conditions were, on the one side that the materials were fresh and undiluted, and on the other that the farmers provided the barrels, brought them daily to be filled, and carried them away at their own expense.

The original company or syndicate sold all their works at a large profit to the "Earth Culture Company at Vienna," which became bankrupt at the time of the great Vienna crisis. The farmers who used the manure then stepped in, and bought up the works, so that no financial results are now accessible.

THE LIERNUR SYSTEM AT VIENNA.

By Adam Scott.

Captain Liernur's Pneumatic System was in operation in a part of the International Exhibition of 1873. The following is an extract from the certificate of the Director-General of the Exhibition:—

"27th November, 1873.

"To Captain Liernur.

"Honoured Sir,—In regard to the Pneumatic Sewage Works, constructed by you on behalf of the Austrian Joint Stock Company 'for Earth Culture,' for collecting and utilising human excreta without loss of organic matter or the use of water, I have the honour to state that these works have earned our full satisfaction and approbation, in testimony of which I affirm:—

"That the closets and urinals were entirely inodorous, both during use and during the emptying process.

"That the exhausting of the network of sewage-pipes, and the decanting of the matter into barrels for the transport of the manure took place in the engine-room, always sure, quick, and without any nuisance whatever.

* * * * *

"That as long as the Exhibition lasted, no interruption whatever in the working of the system took place, that no trouble nor nuisance was experienced, and that the whole gave satisfaction in every respect."

The International Medical Congress met at the Liernur Engine-building on 5th September, 1873, and the report of their visit, written by the vice-president, Dr. Wilhelm von Hamm, Chief Councillor to the Minister of Agriculture in Austria, was published in the *Exhibition Journal*. Their verdict is summed-up in two sentences.

"The trials made in the presence of the many members of the Congress convinced them that the entire system is capable of doing its task completely. . . . All the various motions occupy such an infinitesimal small space of time, operate so smoothly, and without attracting notice, that the invention called forth the utmost admiration, and every one present, among whom were professional men of he highest class, could not do otherwise than acknowledge his in unmeasured terms."

The report of the Chief Councillor of the Minister of Agriculture caused his Majesty the Emperor to inspect the Pneumatic Works of the Exhibition on the 17th of September. His Majesty ordered the whole manipulation to take place in his presence, and expressed loudly his satisfaction with the rapidity, certainty, and absence of all offence with which the emptying of so many closets and the transferring their contents into barrels for transport to the country took place.—*International Exhibition Journal.*

To this, I may add, that the Emperor afterwards bestowed upon Captain Liernur the honour of knighthood, in recognition of the sanitary merits of the invention, and that towards the end of the Exhibition, when fewer closets were required, the water-closets were closed, and the Liernur Pneumatic System kept open.

TWENTY-FOURTH ORDINARY MEETING.

Wednesday, May 24th, Lord Alfred S. Churchill, Chairman of the Council, in the chair.

The following candidates were proposed for election as members of the Society:—

Fitzgerald, John F. Vesey, 131, St. George's-road, S.W.
Kennedy, Lady Gilbert, 76, Eaton-square, S.W.
Merino, Lorenzo, Wool Exchange-buildings, Coleman-street, E.C.
Nixon, Brinsley De Courcey, Athenæum Club, S.W.
Pullar, Robert, Perth.
Randolph, Charles, 14, Park-terrace, Glasgow.
Wright, James Baird, 3, Great St. Helen's, E.C., and 23, Camden-square, N.W.
Wright, William, 3, Great St. Helen's, E.C., and 434, Camden-road, N.W.

The following candidates were balloted for and duly elected members of the Society:—

Honeyman, John, 140, Bath-street, Glasgow.
Hopkins, J. Satchell, J.P., M.R.His. Soc., Jesmond, Edgbaston, Birmingham.
Howorth, James, Farnworth, near Manchester.
Hoyle, William Claremont, Bury, Lancashire.
Whitney, James A., 212, Broadway, New York.

The second lecture was delivered on—

RAILWAY SAFETY APPLIANCES.

By F. J. Bramwell, F.R.S.

Mr. Bramwell began by explaining a large working diagram, on which was shown a portion of a railway line where a junction occurs between a main and a branch line. Model trains, fitted to slide on lines representing the lines of railway, showed the arrangements for turning the trains on to the particular lines required, and there were also signals representing the proper home and distance signals. By means of this apparatus Mr. Bramwell showed how by giving wrong signals trains were brought on to the same lines, and collisions of course produced. To follow the description given without the aid of the models would be impossible. With regard to the working of trains one important point was to be considered, that there were peculiarities in the locomotive which, so far as he was aware, did not obtain in any machine except a balloon. It was that the person in charge had no control over the direction he took—he could stop or reverse his engine, but he could not guide it, and was absolutely at the mercy of others as to direction. That being

so, it was most important that the signals should be absolutely correct, because the engine-driver had no guide but what the signals afforded him. It was not only necessary that the signals should be right among themselves, but that they should be right with the points, for after all it was the points that directed the course of the engine, although the signals invited the man to approach. It was probably well known to them that there were two kinds of points, facing points and trailing points. Facing and trailing points were the same in themselves, and the difference depended upon the direction in which a train approached them. The effect of facing points was to make the traffic diverge, and of trailing points to cause it to converge. Trailing points were not a source of danger, but when they used facing points they might be a source of danger, if so set as to permit a train intended for one branch to go down another. It was most desirable not only that signals should agree among themselves, but also should agree with the position of the points. In former days the levers and the signals were close to the points themselves. The effect of collecting the levers of the points into one house while it simplified the work was in itself a cause of danger. When the signalman went to the points he must have known to what point the lever belonged, but when he had before him a number of levers referring to points at a distance, as one lever was very like another, there was great liability to mistake. They could see also how the addition of a few more lines of rails added to the number of points, and rendered it almost impossible for even the best trained signalman always to be right. At the Cannon-street station of the South Eastern Railway, there were over 300,000 possible combinations of signals, and of these, only about three hundred were safe, so that the chances were actually a thousand to one against safety. It became desirable, in that state of things, to prevent the occurrence of accident by devising a safety appliance to put it out of the power of the man to make a mistake. Mr. Bramwell then explained, by means of models and diagrams, the action of the ordinary locking signal apparatus. He showed how the lever working the points could only be put over after the signal lever had been moved and the proper signal given, and how the movement of the signal lever locked all the point levers, except the one setting the points in the position corresponding with the signal given. Any number of levers might thus be coupled together, so that when any single signal was given, all the points corresponding were right. By a modification of this arrangement the locking was effected by the action, not of the lever itself, but of the spring catch, so that the first movement of the pointman's hand locked all the levers but those requiring to be moved. A similar arrangement could be applied to the protection of level crossings, and Mr. Bramwell showed a model, lent by Messrs. Saxby and Farmer, illustrating such an arrangement. The four gates across the railway were opened and closed simultaneously by a hand-wheel operating suitable appliances. When either opened or closed they were held in position by stops worked by a lever similar to a point lever. This was connected in the usual way to the signal levers, and the effect was, that until the proper signals had been given the gates could not be moved. Such were some of the appliances for preventing errors in signalling; and so complete were they, that he might say that even if an absolute stranger were to get into the signal-house, or a drunken man or a madman were there, he could not succeed in doing anything beyond blocking traffic. By that means the public were relieved not only from carelessness and inattention, but from all sorts of difficulties which arose from fatigue. And in passing he would say a word for the signalman. If a man shot at a mark a hundred times and failed once, nothing was thought of it, but if a signalman once made a mistake, a great deal was thought of it. Amongst the sources of accident given on the table* they would find that the second cause of accident, to which 12 per cent. was due, was from trains either being put on to wrong lines or split. As to the latter cause, if, while a train were passing over points, they were moved before it had entirely got through them, the very worst kind of accident would arise. [By means of his model Mr. Bramwell showed the manner in which accidents arose from this cause.] They might ask how such things happened: he would tell them. If they were working a train on the down main line, and it was to be followed by another train on the down main line, by the block system the signalman would not be justified in letting the second train go by until the first was out of the section. But when the train on the down main line was to be succeeded by another on the down branch line, he knew he had only to let the first train get clear before he could let the next pass. On suburban lines and others where the traffic was very great, there were trains running at three-minute intervals, and the signalman was tempted to lose as little time as possible in "making his road." Sometimes the operator was 80 or 100 yards from the points, and if he could see the train he probably could not tell whether the last carriages had passed over or not. He might think they had, and after giving the proper signal he might move the points. The result was that some of the carriages which were past the points ran on the main line, and the others were turned into the branch. They became stretched across the track and overturned, while some ran into others. To meet this danger the engineer again came forward with a safety appliance, and he might say that where the appliance was used an accident could never occur. To prevent accident there was put parallel with one of the rails, either inside or outside, a bar of iron so long that there must always be one wheel of the train upon it, after the first wheel had passed over it. From the moment, therefore, that the train came upon it to the moment it left it, one or other of the wheels was upon the bar. One of the wheels being upon it would form an impediment to its rising. The points were so arranged that until this bar could be raised, they could not be used. The signalman could not, therefore, shift the points while the train was passing over them, without lifting the train, which was of course impossible. He would now draw their attention to a large diagram, figure 18, which showed a small portion of the Great Northern time-table for April, 1874, under

* See p. 649, *Journal*, May 19, 876.

the form of a diagram. It represented a section of the line from King's-cross to Peterborough, and showed the time from 9 in the morning till 2 p.m. The vertical lines represented hours, while the horizontal lines were stations. By the diagonal lines was represented the course of a train. By means of this diagram the course of each train could be traced, with the places where the faster trains passed the slower trains, and the condition of the whole traffic at any particular time could be seen at a glance. Taking into account the magnitude of the traffic, what was the chance of obtaining safety by relying upon the exactness of a man or upon the time being actually kept? When Mr. Bramwell began he informed them that the traffic was now regulated by time not by distance. When they worked by time, it was impossible that a traffic such as they had there could be safe. It was a paradox, but nevertheless a fact, that the quicker the trains and the greater the traffic, the less was the use of punctuality. If they had a railway like the one in Egypt, where three or four trains ran in a day, and there was always several hours between them, nothing much then could go wrong, unless the signalman was greatly at fault. But in this country it was impossible to have safety by merely keeping time. On the French railways, leaving out of account the express trains, a sufficient amount of time was allowed to give ample margin, and so they knew they would get in to the minute, but at every roadside station they waited, and made up time for one or two minutes. Now, if a company divided their trains into two classes, one an express train, punctuality guaranteed, London to Birmingham $4\frac{1}{2}$ hours, and the other London to Birmingham, punctuality not guaranteed, time 3 hours, how many people would travel by the train with guaranteed time? Then again, the doctrine of averages did not give any help to the engine driver. Trains could never start before their time, and if the driver gained a little time in one section of the line, when he reached the next station he would not be able to go on until the time was quite up. It was in fact impossible to have a punctuality such as to ensure safety, and at the same time admit of speed. A traveller might go to Glasgow once with perfect accuracy of time, but another time he might be delayed 20 minutes, as had actually happened by a strong gale of wind. If trains went by time, because they were delayed twenty minutes about 20 days in the year, during the other 340 they would have to submit to the same extension of time. The best way to get speed was to keep the train going at a high speed, which in England they liked, and as a rule they got, and to preserve their safety by means of the block system. Perhaps they might think he was addressing them as if there were no complaints, no accidents. He was not there to defend the railway company, but the engineer. But if he were there to defend the railway company, he would say it was not a bad result, when they had the enormous traffic of this country conducted with a high speed, there were only $35\frac{1}{2}$ deaths per annum of passengers from causes beyond their own control. He could not find what accidents there were in the old coaching days, but they could find something that would enable them to form a comparison. The deaths in London from accidents averaged 216 per annum. There were thus six times as many persons killed in the streets of London from being run over by cabs and knocked down by runaway horses as were killed by railways all over the country. He was there to bring before their notice safety appliances, and to ask them to give their applause to those who had devised them. Perhaps they thought that they could do better than that, yet it must be acknowledged that at present they did not do badly. One item in that 12 per cent. arising from the splitting of trains, was, he would undertake to say, wherever the apparatus he had showed them was employed, done away with once for all. There was one other safety appliance he would show them. It was necessary to have at intervals switches to connect the up and down lines together, and with sidings. The points of these switches were formerly locked by a padlock. This was obviously inconvenient; but by the model before them, an apparatus was shown in which the locking of the lever working the points was effected by a key, which remained in a lock, locking the signal, and unless the signal was locked at danger, the key could not be removed to unlock the points. In conclusion, Mr. Bramwell thanked the meeting for the attention with which they had listened to him, both that night and last Wednesday.

DISCUSSION.

The Chairman said they had had a most interesting discourse upon the causes of railway accidents. The ingenuity of the contrivances was something wonderful, and he had no doubt in future years they would experience an increasing immunity from railway accidents. One point occurred to him—Ought not the signals always to be set at "danger?" On some railways he believed they set them at "danger," and on others at "all right." At the Abbott's Ripton accident the snow blocked the signal in some way, and there was some hitch which prevented the signal being put to danger. He had heard it suggested that the right way was to have the signal at danger, and have it only put down from danger when the train was going to pass. Was not that Mr. Bramwell's opinion?

Mr. Bramwell said it was not, but before giving his reason he would, with his Lordship's permission, mention a matter he had forgotten. To make the facing points safe was not only of use to make the line safe, but was also of use as a means of increasing the powers of carrying extra traffic. Before facing points were perfectly safe, they were used as little as possible. A train to enter a siding without their use had to go through a tedious process of backing and shunting. But supposing they made the facing points absolutely safe, the train could without stopping and backing enter the siding. Instead, then, of wasting the time waiting in a siding, sidings were made now about half a mile in length, with an entrance at the end by facing points and a way out on to the line at the further end by trailing points. So that when a slow train got out of the way of a faster, it could jog along in the siding while the quick train passed along the line. It was now possible, by putting these on a railway, materially to increase the traffic. He would now give the reason why he disapproved of signals being kept habitually at danger. They no longer worked by time, but by distance. If the signal were constantly kept at danger, the engine-driver would never know whether it meant safety or danger. It would never do for him to have to shut off his steam and wait for the signal, for an express train might be following him. In that way expresses would have to be pulled up every two miles, for the driver would not

know whether the train were in real danger or sham danger. But in the block system, if a train were not out of the section in front, the signal was at danger; but if it were at safety it invited a train to approach. That was his reason for thinking that, with the block system, to have the signals set at danger was inexpedient.

Mr. Hale did not think the feeling of the public was against the engineer. In his opinion there was obstruction in the attitude of the railway companies as to adopting improvements.

Mr. William Smith, C.E., observed that the difficulties raised by officers of railway companies in the adoption of improvements arose from many circumstances. Some arose from the fact that many of the officers were themselves inventors, and a man who was in a position to work a railway naturally had the ear of his employers. The improvement which Mr. Bramwell had touched upon, the interlocking apparatus, was devised by Colonel Yolland and other officers of the Board of Trade. Another of the ingenious contrivances exhibited by Saxby and Farmer, was invented by Mr. Bannister, resident engineer of the Brighton Railway. There were a great many other instances going far to remove the stigma attached to officers of railway companies. There were other contrivances, such as Harper's block signal instruments, which time had not permitted Mr. Bramwell to describe. They were very useful on single lines. Instead of using the ticket and staff, by the use of the instrument a single line was made absolutely safe, if the engine-driver attended to the signals.

Mr. Bramwell asked Mr. Smith to explain the apparatus for recording the movements of railway points and signals, and the time in relation to such movements.

Mr. Smith said in all these matters it was a great thing to have uniformity of proceeding. It was a great point for the manager to know that the traffic was carried out according to the table he laid down. It had occurred to him that by having each signal-box at a given distance, especially at junctions, and by recording within each box the time the trains passed, when the signals were given and received, and by sending the record each 24 hours to the traffic manager, he would be able to see the course of things over the whole course of his railway, as if he were present the whole time. The apparatus by which this was effected was worked by magnetism. The passing of a train set an apparatus in motion during the period the train was passing. No movement could take place by putting the signals over, or by returning them, without a record of it being kept against the signalman. The manager had an opportunity of seeing, by putting these side by side, what had occurred on the passage of a train during its whole journey.

Mr. Christopher Cook had heard the chairman of the South Western Railway object very strongly to single lines. In America he found the trains travelling in perfect safety because they kept good time. In his opinion the cause of accidents was that trains do not keep correct time.

The Chairman would like to ask Mr. Bramwell whether the apparatus he had shown were generally adopted, and whether there were any regulations of the Board of Trade as to their adoption.

Mr. Bramwell stated that he believed no new line would be allowed to be opened without being provided with apparatus of the kind.

The Chairman thought that by means of the security obtained by the apparatus a great deal more heavy traffic would be able to pass over lines. A suggestion had been made to him that instead of duplicating the whole line, duplicate stations should be provided, through which the fast trains should not pass. The slow trains would go into the country stations over facing points, and the facing points would then be put right for the main line fast train, which would pass by while the slow train was loading and unloading its passengers. By that means a great deal of the necessity for duplicating lines would be obviated. He begged to move a vote of thanks to Mr. Bramwell for his interesting paper.

Mr. Bramwell briefly thanked the meeting for their indulgence.

After the conclusion of the discussion, Dennis's patent pneumatic fire extinguisher was exhibited. The machine consists of a hollow cylinder enclosed at both ends, with a metal tube through the centre from top to bottom, forming a stay. This tube is pierced at the lower end in order to admit air and water, and at the upper end (which is passed through the top of the cylinder) a steam gauge is fixed for showing the amount of pressure when the machine is charged. The charging of the machine is effected by means of a force pump attached to the cylinder, which is worked until the guage registers a pressure of 20lbs. of air to the square inch, after which the suction hose is laid in water and the pnmp used until a pressure of 100lbs. to 120lbs. is obtained, when the machine is fully charged for use.

MISCELLANEOUS.

THE PATENT BILL.

The following resolutions were passed at a meeting of the Institution of Mechanical Engineers, held 16th May, 1876:—

That inasmuch as the Patents for Inventions Bill, 1876, now before Parliament, does not meet the views of the special meeting of the institution held on the 28th June, 1875, resolved, that a petition be forthwith presented to the House of Commons, embodying such views in so far as they are applicable to the present Bill, and that the President be authorised to sign the petition on behalf of the Institution of Mechanical Engineers.

That the views of the members of the institution be expressed in the following terms.

That the petitioners are of opinion that many of the provisions in the Patents for Inventions Bill, 1876, proposed by the Lord Chancellor, are contrary to public policy, and an interference with the admitted rights of inventors and others connected with property in inventions.

That the said Bill would be much worse in its operation than the Act of 1852, for the following reasons (amongst others), viz.:

It would give unlimited power to the Lord Chancellor to stop patents, as well as control the terms on which they should be used, to a large extent.

It would not appoint paid Commissioners to manage the office.

It would abolish provisional specifications; and

It would appoint irresponsible examiners, who would have the power of reporting against the applications for patents on grounds of which they frequently could not possibly judge.

That any preliminary examination of applications for Letters Patent which may be hereafter instituted should not extend beyond the questions whether the specifications are clear, and whether the invention is open to objection on the ground of want of novelty, regard being had to prior publications in the Patent-office.

That an adverse report should not disentitle an applicant to a patent.

That in lieu of the proposed publication of reports (which would in many instances operate unjustly) the applicant should merely be required to insert in his specification a clear and definite reference to, and an

acknowledgment of the existence of, the prior matter found and pointed out by the Patent-office officials, with a clear statement of what he claims notwithstanding.

That inasmuch as the changes in the law proposed by the Bill now before Parliament differ materially from the recommendations of the Royal Commission of 1865, and of the Select Committee of 1872, it is expedient that no legislation on the basis of the Bill now before Parliament should take place without special reference to a Select Committee.

CARBON FROM SHALE.

Among the sanitary agents and appliances exhibited last week in connection with the Sewage Conference was a material called "sanitary carbon," which was first introduced to public notice at the Social Science Congress at Brighton in October last, and is now offered as a marketable commodity, applicable to a variety of deodorising, decolorising, purifying, and sanitary purposes. A few days ago a public exhibition of the qualities of this product took place at Campbell's Model Sewage Works, Wandsworth-road Station. The carbon is the residual product of the destructive distillation of "black-stone," one of the bituminous shales which in very considerable quantities intersect the Kimmeridge clay deposit on the Dorsetshire coast.

From experiments recently made, it appears that a ton of black-stone produces 9,000 cubic feet of gas, of the illuminating value of 21·55 candles, leaving a residue of 11·6 cwt. This residue product is the "sanitary carbon" in question, as coke is the residual product of the distillation of coal, and animal charcoal of bones. By repeated experiments it has been found that the carbon is about equal to the carbon of animal charcoal, or bone-black, and that the material has for almost all purposes to which animal charcoal is applied the same properties and effect as this substance, and that as a deodorising and decolorising and purifying agent it is a perfect substitute for the same That the residual product of the distillation of bituminous shale is a substitute for animal charcoal is not a new discovery, as may be seen from Muspratt's Chemistry (under Bone-black, p. 342, &c.); but it is added that "the rare occurrence of this substance places it beyond the reach of most manufacturers." It is, however, a recent discovery that the black-stone of the Kimmeridge clay deposit yields this substitute, and further, that the deposit of this black-stone in the Kimmeridge clay is practically inexhaustible.

Among the experiments exhibited at Wandsworth on the occasion alluded to, was one made and several times repeated on raw sewage, pumped up on the premises from the South Metropolitan main sewer, which runs beneath them. The liquid, almost as dark as ink, thick with suspended matter, and emitting a most abominable odour, was poured from pails into a filter, and passed through the carbon. It came out as transparent as the clearest spring water, without the least unpleasant smell, or even taste. Another series of experiments, to show the deodorising properties of the carbon, consisted in passing through filters mixtures of dyes, dye refuse, printers' ink, mines and chemical refuse, and a variety of other highly coloured fluids, either singly or in combination, and the result in all cases was a perfectly clear effluent.

Among other applications, it is stated that the carbon will remove, like animal charcoal, the nitrogenous and albuminous substances suspended in syrup, and is therefore applicable to sugar refining. It will absorb and deodorise the refuse from slaughter-houses, tan-yards, and distilleries. It will purify foul air from sewers, and destroy all ammoniacal odours. In fact, as before stated, it will do all that animal charcoal will do, and hence it is applicable to the manufacture of artificial manures, and especially that known as super-phosphate of lime. Its chief practical application may be expected to be in the direction of the purification of drinking water, the prevention of the pollution of rivers by the purification of the refuse of mines and chemical works, and, above all, of the effluent water from sewage after the more solid matter has been subjected to some process of precipitation.

SELF-REGISTERING WEIGHING MACHINE.

This appliance, invented by M. Chameroy, the improvement in which consists in its printing the weight on a ticket by the very operation of weighing, was lately brought before the Paris Society of Civil Engineers by M. Armengaud, junior, who first called attention to the great importance of obtaining accurately, as well as readily, the weight of various articles, as weight alone determines the Customs' dues, and is also the basis of railway and canal tariffs. While the superseding of the balance with its accumulation of direct weights by instruments of the steelyard character has greatly simplified the operation of ascertaining the weight of an article, it has at the same time given ground for the multiplication of errors and for fraud. As soon as the goods weighed are removed from the machine, there are no longer the means, as in the old system, of again reckoning up the weights which together counterbalanced the load, so as to check the weight read off; in a word, there is no sure trace or record as a guarantee of the operation. It is to supply this want that M. Chameroy has designed his check machine, which prints the weight in ordinary figures, on small special tickets, by the very action of weighing. This, too, is accomplished, without any change in the form of the machine, or alteration in the present method of weighing, and especially without adding thereto any distinct appendage, the beam and the slider being made to imprint the weight of the article weighed.

To accomplish this, the lever or beam carries on its lower edge a series of steel punches, representing figures in relief, and arranged at suitable distances from one another, determined by the dimensions of the beam and its slider. These figures represent hundreds in the case of a machine for weighing up to a little over 1,000 kilogrammes. In the interior of the slider is arranged a moveable piece below the beam, and capable of being brought in contact with it by means of a lever or an eccentric. An aperture in the side of the slider permits of the introduction of the ticket between the moveable piece and the edge of the beam. In this way the hundreds are printed, but it is also necessary to ascertain the subdivisions and print them. This is effected by a simple arrangement which avoids the complication of supplementary sliders, whether above or at the end of the main beam. Within the slider works a rule like the bolt of a door, and furnished on its lower edge with figures in relief representing the tens, each accompanied by a small horizontal line. Lastly, the units are expressed by equidistant spaces previously printed to one uniform size on the ticket, each space being sub-divided by a dot. The weighing-machine thus constructed permits of the automatic impression of the weight as ascertained. To effect this the slider is brought under the hundreds figure which is nearest to the weight, and the equilibrium is exactly adjusted by moving the bolt from left to right in the slider. The ticket is then introduced into the aperture, and a smart blow is given to the lever. By this action the figures of the hundreds and the tens are punched on the card, the position of the horizontal line following the tens figure with respect to the interval of the dot and line already printed on the ticket, permitting of a weight being determined and registered correct to within a quarter of a kilogramme. In this manner the

ticket bears upon the face of it the exact weight as determined by the machine—in fact it is the machine itself which registers its own operation, and the tickets may accompany the invoices and bills of lading in confirmation of the weights stated.

The advantages of the new system were thus summed up by M. Armengaud:—1. A complete check on the operation of weighing by the substitution of a ticket printed by the machine itself for the usual reading on the scale beam. 2. A greater facility in reading the weight printed on the ticket than upon the beam, which becomes fatiguing to the sight and requires a man of some intelligence, while, by the new method, the operation may be performed by a labourer, who has only to adjust the slider so as to obtain an equilibrium. 3. Easy inspection to the operator, who has only to ascertain the position of the points at the moment of impression. M. Chameroy has even designed an arrangement which renders this impression impossible unless there be equilibrium. 4. Preservation of the weight, as determined, upon one or several tickets, and the absolute certainty that any false entry of the weight is the result either of a voluntary error or fraud. To these advantages must be added that which the new system presents of enabling different weighing machines under which certain goods have passed, to be checked, one against another, so that those of faulty construction or needing repairs may be at once attended to. In certain cases it would be possible to substitute for the tickets endless bands of paper, on which the results of successive weighings might be printed.

CORRESPONDENCE.

HEALTH AND SEWAGE OF TOWNS.

SIR,—It is stated in a paper read by Dr. Alfred Carpenter, of Croydon, at the Conference on the "Health and Sewage of Towns," and published in the *Journal of the Society of Arts*, that the engineer of the Croydon Local Board, at the expiration of the lease of the sewage farm at Croydon, advised the Local Board to have no dealings with Mr. Marriage, with reference to the sewage farm.

Will you allow me to state that I was the engineer of the Local Board at that time, and that the statement in question is entirely without foundation?

The assertion that the Croydon Irrigation and Farming Company commenced their works with a real capital of £1,500 (nominal capital being £10,000), and that they borrowed money from their bankers, is equally incorrect. Upwards of 800 £10 shares were subscribed for in the company, the whole of which were, from time to time, fully paid up. Dr. Carpenter also states that "the lease had been so drawn," that "while they (the company) paid no valuation on going into the land," beyond fixtures, and a few small matters left in the ground by Mr. Marriage, "when it ended they were to receive a valuation according to the custom of the country, and under that clause the arbitrators and umpire again saddled the Croydon ratepayers with an enormous sum as valuation; and in the payments for 1874 figures the sum of £5,238 paid to the receivers of the Farming Company." I should state that every farthing of the valuation which was paid by the Local Board to Mr. Marriage, and other tenants, when they left the farm, was repaid by the Farming Company, and the Farming Company did not go out under the terms of the lease, but under a special agreement entered into between the Local Board and the Company. The latter, instead of going out under the terms of the lease, were to be paid for the growing crops and live and dead farming stock, and were mulcted in a fine of £500 on surrendering the lease. (This fine, by the way, figures as a profit on sewage farming in Dr. Carpenter's return.) The £5,238 represented very much more than an ordinary farm valuation. In fact, it represented, at that time, the whole of the capital necessary to stock the farm.

In conclusion, I would add that, instead of receiving back a large proportion of the capital, every shareholder in the Farm Company lost £8 out of every £10 share, and during the three years the Company held the Sewage Farm at Croydon, they lost upwards of £6,000. The state of the sewage farm when given up by the Company, was not in that "ruinous condition" described by Dr. Carpenter, if this expression applies to the absolute condition of the farm; if, however, it applies to the process of culture carried on, it would be a correct statement; but I cannot readily believe the latter, as Dr. Carpenter, acting as chairman of the present committee of management of the Sewage Farm, has insisted on continuing the same ruinous policy of culture to within a few months of the present time. It is no longer necessary to make out a case as to the advisability of the application of sewage to land, as this mode of dealing with sewage is now generally admitted to be the only satisfactory mode of getting an effluent of a high standard of purity, and therefore it is not necessary to put forth exaggerated statements as to profit or loss, incurred in performing what is the absolute duty of the authorities of all towns who have to deal with sewage, that needs to be thoroughly purified before being turned into the pure, fresh watercourses of the country.—I am, &c.,

BALDWIN LATHAM, C.E., M. Inst. C.E., &c.

7, Westminster-chambers, Westminster,
S.W., 24th May, 1876.

GENERAL NOTES.

Japanese Hemp.—Japan produces hemp of the finest quality, and probably, when machinery has been brought to bear on the industry, it will compete favourably with Manila hemp. The plant is perennial, and attains a height of six feet and upwards; the stem is covered with a short hairy substance; the leaves are heart-shaped, with a sharp point, their surface being of a bluish colour, and the back white; both sides are furry and rough to the touch. In the summer small sprouts of about two or three inches in height appear at the point where the leaves join the stem, and throw out blossoms, which develop into small white flowers. Mr. Consul Robertson gives the following account of the manner in which the fibre is obtained:—When the summer has set in, the plantation is fired, after which the ground is well prepared with manure, and left till the close of the summer, when the shoots will have attained their full height. They are then cut and soaked in running water for about four hours. After immersion the stalks are broken in about three places, by which means the rind is separated from the pith. In the interstice thus made the thumb of the left hand is inserted, and the stalks shredded. The shredded parts are placed in layers, and are next laid on a board which has a foot piece at one end, so as to make an inclined plane. A small edged tool is then grasped in the right hand, the shreds being firmly held down with the left, and the inner white coating is scraped off. The shreds are now hung upon a frame, after which they are again placed on the board, and this time the outer green pith is scraped off. The fibre is then tied together in bundles and dried. This dried fibre is woven into cloth and all kinds of piece goods. The outer green bark or peel is also dried, macerated, and made into paper pulp, being used for the manufacture of the coarsest kinds of papers. It is sometimes used in its dried state by the poorer classes as a stuffing for mattresses. The best of the outer or surface fibre is also made up into a material very strong in texture and of a mouse colour. The pith, or what is left after obtaining the fibre, is utilised in finishing off the thatch of houses.—*All the Year Round.*

Competition for Oakum Combing. — The *Société Industrielle du Nord de la France* has inaugurated a competition for the combing of oakum. A prize of 5,000 francs (£200), and a gold medal worth 500 francs (£20), will be accorded to the inventor of a machine for combing oakum, which shall fulfil the following conditions:—1. The quantity produced must be greater than that of other machines now in use; 2. The cost and the production shall be such that a kilogramme (2·2 lb.) of raw oakum shall be converted into tow, at a rate not exceeding 10 centimes (2d.) per kilogramme, labour, general expenses, and interest on capital included. It is understood that this machine must be worked under the above conditions, and at an establishment in the neighbourhood, for at least three months.

Innocuous Glaze for Earthenware.—Apropos of Dr. Richardson's remarks in his recent lecture, it may be interesting to note that M. Constantin, a chemist and druggist at Brest, is stated to have succeeded in making a harmless glaze for common earthenware, destined to replace the lead glazes which have hitherto been employed, and which possesses the great drawback of inducing more or less rapid poisoning. By the year 1872, M. Constantin had produced glazes which were not, so to say, dangerous, inasmuch as but a very small portion of lead entered into their composition. His mixture consists of a silicate of soda, with the addition of powdered silex and a very small quantity of minium. Subsequently to the year 1872, the glazes tried and approved of in the Lanilis Pottery, near Brest, have contained no trace of lead. One of the two recipes adopted is as follows:—

100 parts of silicate of soda,
15 „ powdered quartz,
15 „ Meudon chalk;

and the second is the same, but with the addition of 10 parts of borax. The latter substance renders the glaze more fusible, as well as more brilliant, so that it requires a less strong fire than that according to the former recipe. The articles can be coloured by copper for green, and manganese for brown.

Use of Sulphate of Alumina for the Precipitation of Sewage.—The question of the utilisation of sewage has again come before the French Academy of Science, this time in connection with the discovery of a large bed of kaolin in the department of Mayenne. It is well known that sulphate of alumina has often been proposed as an agent for precipitating the organic matter contained in sewage, and that experiments on a large scale have been made. M. Cagnant, the discoverer of the bed of china-clay, is of opinion that the possibility of manufacturing this salt at a much lower price than heretofore will permit of extending the experiments, and of arriving at more satisfactory results than have hitherto been obtained. M. Belgrand, however, observed that the high price of the re-agent was not the only reason why its use as a precipitant had been rejected. The construction of basins sufficiently large for the treatment of the enormous quantity of water used daily by the capital would lead to an expense out of all proportion to the value of the products that must be obtained; the removal of the deposits formed in the basins would involve a considerable amount of labour; and this practice would be as deleterious to health as leaving the sewage in the river. M. Belgrand was convinced that, regard being had to the volume of water to be got rid of, the best method after all, was to utilise the sewage itself, as a vehicle for the fertilising matters it may contain, and that irrigation is the only method really practicable, provided, however, that it be practised over a sufficiently large area.

NOTICES.

SUBSCRIPTIONS.

The Lady-day subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

PROCEEDINGS OF THE SOCIETY.

African Section.

Tuesday evenings at 8 o'clock. The following arrangements have been made:—

May 30.—"The Development of Central Africa," by Edward Hutchinson, Esq., Lay-Secretary of the Church Missionary Society.

Indian Section.

Friday evenings, at 8 o'clock. The following arrangements have been made:—

May 26.—"Competition and its Effects on Education, with especial reference to the Indian Services," by Dr. George Birdwood. Andrew Cassels, Esq., will preside.

Mr. Tayler's Paper on "The Wonders of Trees in India," is unavoidably postponed.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...Loan Exhibition of Scientific Apparatus, South Kensington. Conference. "Biology."
Royal United Service Institution, Whitehall-yard, 8½ p.m. Surgeon Sandford Moore, "Assistance to the Wounded in time of War."
British Architects, 9, Conduit-street, W., 8 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m. Annual Meeting.
Victoria Institute (at the House of the Society of Arts), 8 p.m. Annual Meeting.

Tues. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (African Section.) Mr. Hutchinson, "The Development of Central Africa."
Loan Exhibition of Scientific Apparatus, South Kensington. Conference. "Physical Geography and Geology."
Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. G. Adams, "Some of Wheatstone's Discoveries and Inventions." (Lecture II.)
Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. 1. Discussion on "The Permanent Way of Railways."

Thurs. Linnean, Burlington-house, W., 8 p.m. 1. Rev. G. Henslow, "Floral Aestivation." 2. J. G. Baker, "Madegascar Ferns." 3. Mr. F. Darwin, "Glandular Bodies in *Acacia* and *Cecropia*, serving as Food for Ants." 4. Dr. J. Anderson, "Structure of the Spoon-billed Sandpiper, *Eurynorhynchus*."
Chemical, Burlington House, W., 8 p.m. 1. Dr. Thudichum and Mr. Kingzett, "Hematine and Phosphorised Compounds contained in Blood Corpuscles." 2. Mr. W. N. Hartley, "Liquid Carbon Di-oxide from Different Sources." 3. Dr. Thudichum and Mr. Kingzett, "Note on the General Applicability of the Frankland and Armstrong Combustion Method, for the Estimation of Carbon and Nitrogen in Organic Substances." 4. Mr. Thos. Fairley (I.) "Peroxides." (II.) "The Estimation of Nitrogen." (III.) "Chromic and Perchromic Acids." 5. Prof. Mallet, "Aluminium Nitride." 6. Prof. Dewar, "Chemical Studies." 7. Prof. Tuson and Mr. E. Neison, "The Volumetric Estimation of Mercury."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. W. Cave Thomas, "Proportion in Reference to the Fine Arts."
Loan Exhibition of Scientific Apparatus, South Kensington. Conference. "Physical Geography and Geology."
Royal Institution, Albemarle-street, W., 3 p.m. Professor Tyndall, "Voltaic Electricity." (Lecture VI.)
Civil Engineers, 25, Great George-street, Westminster, 9 p.m. President's Conversazione, at the South Kensington Museum.

Fri. ......Loan Exhibition of Scientific Apparatus, South Kensington. Conference. "Physical Geography and Geology."
Royal United Service Institution, Whitehall-yard, 3 p.m. Rev. Edmond Warre, "Ancient Naval Tactics." (Part II.)
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m. Professor Roscoe, "Recent Discoveries about Vanadium."
Royal Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Professor Bentley, "Organs of Nutrition in Plants." (Lecture IV.)

Sat. ......Royal Institution, Albemarle-street, W., 3 p.m. Prof. Morley, "King Arthur's place in English Literature." (Lecture II.)
Foremen Engineers (at the House of the Society of Arts), 7 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, JUNE 2, 1876.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

ANNUAL EDUCATIONAL CONFERENCE.

The twenty-fifth annual Conference will take place on Friday, the 23rd June, at 12 o'clock. The chair will be taken by Sir Henry Cole, K.C.B.

With the view of giving special interest to the Conference this year, the Council have decided that the subject of Adult Education, especially in reference to Technical Instruction and its promotion by the action of the Government Education Code, shall form the principal subject for discussion, and all persons interested therein will be invited to attend.

CONVERSAZIONE.

The Society's Conversazione will be held on Friday, June 23rd, at South Kensington Museum, by permission of the Lords of the Council on Education. Cards will be issued in due course.

HONORARY LIFE MEMBERS.

In accordance with Bye-law 66, the Council have nominated the following to Honorary Life Memberships:—

Dr. C. H. D. Buys Ballot.—For his meteorological researches.

Professor Joseph Henry.—For his discoveries in light, heat, electricity, and magnetism, applied to the telegraph and lighthouses.

General Morin.—For his researches in the principles in warming and ventilation.

NATIONAL TRAINING SCHOOL FOR MUSIC.

Several persons having undertaken to subscribe various sums towards the establishment of a £40 a-year Scholarship, for five years, the Secretary of the Society of Arts has obtained the consent of these persons to put these sums together, and, as soon as the annual £40 scholarship is completed, to nominate to it one of the candidates already selected by the Society's examiners as qualified.

The following are the subscriptions already promised for this Scholarship:—

	Annual for 5 years. £	s.	d.
Warren De la Rue, F.R.S.	20	0	0
Major Carpenter	8	0	0
Wm. Hawes, F.G.S.	2	2	0
Thos. Twining	2	0	0
John Ball	1	0	0

INDIAN SECTION.

A meeting of this Section was held on Friday, May 26th, Andrew Cassels (Member of the Council for India), in the chair. The paper read was—

COMPETITION AND ITS EFFECTS ON EDUCATION, WITH ESPECIAL REFERENCE TO THE INDIAN CIVIL SERVICE.

By Dr. George Birdwood.

It was with some reluctance that I accepted the suggestion to read a second paper here on "Competition and the Indian Civil Service." The arguments for and against competitive examinations have been exhausted; and I knew that the system of competition for the Indian Civil Service was under revision by the Government of India and the Secretary of State in Council for India. In fact, my present paper is necessarily but a general comment on the blue-book just published, on "The Selection and Training of Candidates for the Indian Civil Service;" and, as I most cordially approve of the despatch of February 24, 1876, so far as it goes, at least, as it appears a sincere attempt, and in the right direction, to maintain and improve the efficiency and high character of the Indian Civil Service, I fear that this paper will be almost oppressively dull. But, after all, the India-office despatch, of which so much is hoped, and which, on its first publication was received with so much rejoicing, as giving the death blow to "cram," in reality, I fear, will but serve to confirm and aggravate, and rapidly extend the very worst evil of the old system of competition for the Indian Civil Service, namely, the degeneration of secondary education throughout England. Under this despatch, the successful candidates at the competitive examination will have to spend two years at Oxford or Cambridge before going to India. This, as far as the Indian Civil Service is concerned, is a clear gain. Something of a University education will be secured for, practically, every Indian civilian. Something of the old Haileybury *esprit de corps* will be revived in the service—inspired, too, by a wider culture. Something also of the personal tie which united the old Company's servants with the Court of Directors, will now probably grow up between the Civil Service in India and the India-office here; at least the opportunity for its growth will be offered, and will, I hope, be encouraged by the institution of India-office levees, at which the young probationers at Oxford and Cambridge will be periodically presented to the Secretary of State for India and the Members of the Council. It would have a most salutary effect. It would practically restore the responsibility of the Secretary of State for India as the ministerial chief of a great service; and he would be himself able to judge at a glance how competition was working for the good of the State. He would know his men, and this would enable him to understand also many things done in India, which must be a mystery to a minister who advertises for callow civilians through the penny newspapers, and sends them to India through the penny post, without any personal knowledge of them as men, or any knowledge of them at all except that afforded by the examiners' yearly lists of the successful competitors.

In the mutiny of 1857, the Court of Directors knew exactly how every Englishman throughout India would behave, and every man in India knew how the men who were together with him at Haileybury or Addiscombe would behave, and this knowledge was the power which really broke down the mutiny before a single regiment arrived from England. But had competition then prevailed, all that the Secretary of State would have known of his men, and they of each other, would have been their numbers on the examiners' list for the different years A.D. "Who is at Dustypore?" "No. 23 of 1855." Who at Budgepore?" "1 of 1856." "At Gupgaum?" "7 of 1857." A partizan of competition might, perhaps, insist that you would know them by their answers—by their numbers. Do we know Colonel Montgomerie's or Colonel Walker's numeral pundits a whit by their admirable topographical work? We know exactly the sort of man Purungir Gosain was, who rode hilarious races with Bogle on their march into Tibet; but who knows Colonel Montgomerie's famous pundit No. 9? The necessarily defective sympathy of a Secretary of State with a merely numeral Civil Service, made up of squads of numerals, connected only, squad with squad, by the sequence of years, and numeral with numeral, by their haphazard succession in an examination list, must lead at last to encroachments on the appointments, and pay, and rank of the service, and then its *personnel* must deteriorate, however much you may strive to otherwise improve the system of obtaining candidates for it.

But the despatch of February 24th last, in place of insisting that a University education shall be given before the competitive examination, provides simply that "an allowance of £150 will be given, during each of the two years of their probation, to all candidates selected in July, 1878 (or thereafter), who pass their probation at some University (to be approved beforehand by the Secretary of State), at which moral responsibility for the conduct of the students is undertaken, and rules of discipline are enforced." At the same time, the maximum of age for competition is wisely reduced from 21 to 19; and it is impossible to appreciate too highly the statesmanlike motive which has in fact dictated this reduction, as set forth in paragraph 13 of the despatch—"A lower limit of age is recommended by another consideration of importance. Out of the number who present themselves for competition, it is certain that four-fifths must fail, because the candidates are usually more than five times as many as the vacancies; and no prudent parent, in selecting a profession for his son, will leave this certainly out of consideration. Some professions are absolutely closed, others are almost impossible to a man who thinks for the first time of entering them at the age of 22. A man, therefore, who competes for the Indian Civil Service at that age, undoubtedly strives for a valuable prize, but does it at a formidable risk. He stakes, in a measure, his chance of self-support upon the result of a competition, in which it is certain that four-fifths must fail. It is more than probable that such a risk must weigh strongly with parents, and diminish the field of competition, especially among the professional class. But no such apprehension will be possible if the limit of age be fixed at 19." This paragraph also seems to evince a consideration for the failed which is the first glimmering symptom of it I have ever detected in the whole history of competitive examinations. Had it only been made compulsory on all successful candidates to spend the two years of their probation at Oxford or Cambridge, and that no candidate should present himself for examination who had not been a year in residence at Oxford or Cambridge—or two years at any college affiliated to these Universities—everything would have been done that could be demanded by those who desire to maintain the Indian Civil Service in the highest moral efficiency, and to preserve in their integrity the national secondary schools of England. The maximum age of competition might in that case have been reduced only to 20, although it is more expedient to fix it at 19, as the earlier the young civilian is introduced to Indian work, after receiving a University education, the better for himself and the Government. It must be remembered also that it is only as one of the indirect effects of competition that the University examinations at Oxford and Cambridge have at last become so difficult that men will not go into residence now until 19 or 20, instead of at 17 and 18, as their fathers did before them. The examinations now are practically competitive examinations, and not simple test or pass examinations.

It was thought at first that the India-office despatch would practically force every civilian to go through the full University course. Every one of the selected candidates, it was said, would be sure to spend the two years of probation at Oxford or Cambridge, and, in anticipation of their success at the competitive examination would have spent a year in residence beforehand, so as to make sure of their University degree before being sent out to India. And if a candidate failed he would receive no damage, but would, with his University training, always be good for something. Should Lord Salisbury's despatch work in this way, it will indeed effect all that is wanted, and by a stroke of the pen. It will restore ministerial responsibility for and interest in the *personnel* of the Indian Civil Service, thus ensuring the preservation of its status and privileges; it will insure the disciplinary (University) training of all candidates for the service, over and above the competitive test of mere intellectual capacity or quickness, a test which, however searching, of itself alone is an insufficient guarantee of a man's fitness for the Indian Civil Service; and, although it does not expressly recognise it as an obligation on the part of the State, it will virtually secure the rejected candidates against injury: and above all will arrest the degradation of English secondary education under the contaminating influences of unrestricted competition. In a word, it will smash the crammers and cramming in every shape and form. But there is another side to this picture of probably too bright anticipations, and I fear that the effect of the India-office despatch will, on the whole, simply be to enforce cramming from an earlier age, from 13, and 14, and 15, when boys have only just got over their second teething, and are entering on incipient adolescence, a period at which cramming would prove almost as dangerous as during second dentition itself.

All my argument is against cramming. I am

not opposed to competition, on the contrary, I accept it as a necessary evil. I only contend that it is no infallible panacea. The system, as launched into the world by its fabricators, was a very good one to start with, but practical experience of it has shown its defects, and its faults of excess. Its obvious evils, as at present, or, we will say, hitherto administered, are, that it destroys ministerial responsibility, that it yearly throws a large and increasing number of ill-educated and often wholly untrained and disappointed needy men upon the country, and that it is reducing the whole education of the country to a monotonous system of cramming for the public services. It also destroys the personal interest of the heads of Government in their servants, without which it is impossible to preserve the content, and zeal, and efficiency of the public services. The system has been too exclusively founded on encyclopædiac examinations, in fact. It was chiefly the fabrication of Lord Macaulay, and it really pre-supposes that all men are potential Macaulays, or, at least, are capable, under high-pressure instruction, of becoming mechanical fac-similes of Macaulay. Lord Macaulay took a real, paternal interest in the welfare of the Indian Civil Service, and his system for training its candidates reminds one of the schemes of universal education enthusiastic fathers are prone to draw up for promising sons, but which, as experience slowly teaches, have, year by year, to be gradually dwarfed down to the most commonplace and practical proportions. Had the working of the competitive system been watched from the first by the Government with any parental sense of responsibility for the education of the rising generation, or even an adequate interest in the welfare of the public services, its defects and excesses would long ago have been discovered and haply corrected. Even the despatch of February 24, although it may set everything right in working, seems to think first of conserving the competitive system as a sort of fetische it would be sacrilege to touch, and of the efficiency and well-being of the service next only, and not at all of the education of the nation of English children.

We must all, indeed, accept competition as an insurmountable fact; and I think no one will waver in accepting it frankly, even if grudgingly, who reads the overwhelming evidence of the present blue-book in favour of the principle of the system. It has worked fairly well for the Indian Civil Service, and there is no fear of its working ill so long as the pay and position of the service is kept up. Indian public opinion, and the opinion of the most distinguished officers of the Indian Civil Service, old Haileybury men, and new "competition wallahs," is strongly in favour of the system, with such restrictions as Lord Salisbury's despatch now enforces. The blue-book gives a complete history of the system and its working, and an exhaustive exposition of its uses and abuses, its advantages and disadvantages. I would particularly recommend to those who would form a clear conception of the whole controversy, to read the reports by Mr. H. H. Risley, Hazareebagh, p. 70; Mr. A. H. Haggard, Buxar, p. 57; Mr. H. C. Fanshawe, Ferozepore, p. 131; Mr. W. G. Pedder, Bombay, p. 277; and Mr. W. Lee Warner, Bombay, p. 287; and the minutes by Col. Yule, p. 313, and Sir Robert Montgomery, p. 323.

I have been charged with saying that the civilians under the competitive system were generally not gentlemen. I never said anything like it. I expressly said that, while the emoluments of the Indian Civil Service and its position were maintained as at present, it would always attract good men, and some of the best going. I only argued that, as soon as the Government ceased to feel a proper personal interest in the service, its appointments and emoluments would be cut down, and the relative rank of its members lowered, all of which is happening, and that this would gradually render it less and less attractive to superior men, until at last the Indian Civil Service would be reduced to the same condition as the Indian medical services. So far from saying that men who were not gentlemen in the conventional sense were getting into the service, I protested that the system of competition, by virtually giving a monopoly of the patronage of the service to the ring of London crammers, made it impossible for any but rich men's sons, who could pay the examiner's commission, to get into it. It absolutely excludes the poor, however capable naturally and well educated, but who, under a sound system of national education, would be able to rise step by step from the humblest primary schools to the public schools and universities, and to compete for the public service without let or hindrance, without money and without price, provided only they proved their fitness by a rational competitive test, the essential feature of which should be the proof of having gone through a systematic course, moral and disciplinary, as well as intellectual, of educational training. So far from objecting to men who might not be "gentlemen," I would desire to see the education of the country so regulated that every English boy might have a reasonable hope of rising to the highest positions in the Church and State, if only opportunity, as well as his natural capacity and acquired merits, favoured him. I never even once used the word "gentleman" in my paper. There is no better birth than wholesome birth, and no higher pedigree than your pedagogues. If a man could not claim both, he might well prefer to be a pupil of Arnold of Rugby, than the descendant of a Percy or a Howard. I did indeed urge that marks should be given for physical superiority also, and, all else being equal, that a boy should get marks for his father. All these things count in real life, and should in a real examination for the work of life. It is a special advantage in India to have an hereditary connection with the service, and, so far as the Civil Service is concerned, it has been fully maintained under competition hitherto. But competition has failed in securing the same uniformity of physical superiority in the Civil Service as was conspicuous under the old system of patronage. The assertions of the blue-book do not indeed support this fact. But let any one who knows the men personally run down the names of the Indian Civil Lists, and he will be able to mark very few of the old Haileybury men as under-sized, or who have bad eyesight, or cannot ride and shoot well; while the most of them are fine, well set up, handsome-looking men, the sort of fellows a dashing recruiting serjeant would select for the Guards or Horse Artillery. But a noticeable proportion—

noticeable in church and at levées, and in ballrooms—of the competition men are under-sized and *chétif*, and wear spectacles; and in proportion as they really are poor and puny, they are a real source of weakness to the Government of India.

But in providing a system for admission into the public service, no Government dare overlook its effects on national education. Every child in the country is as sacred a trust of the State as of its parents, and it is not the first concern of a Government to secure even the cleverest youths for its service, but the sound, and, according to their natural capacity, the fullest and highest education of all. It is doubtful if even the efficiency of the public service is best promoted by selecting only the cleverest of the candidates for it. I believe that no organisation of men works well unless leavened with a large proportion of stupidity. I never saw a clever man worth much who had not a strong saving clause of stupidity in his composition. Lord Macaulay would, I am sure, never have chosen one of his typical competition wallahs for a trustee. But the great practical evil of the competitive system is that it encourages cram, and this evil the India-office despatch does not necessarily—though it may accidentally—remedy, and may encourage with a vengeance. The possible evil effects of the competition on national education is not thought of in it. The despatch tends to make over all the secondary schooling of the country to the crammers, or to reduce it to the crammers' system. The few crammers' houses at present existing as special institutions of artful study will become enlarged into popular schools, and, in the increasing competition with the crammers, the grammar and public schools of England will gradually become converted into cramming schools—schools not for education, but for the circumvention of examiners,

"And make one mighty Dunci d of the land."

Their deviation from their old character is here and there being already foreshadowed. They are making the entrance examinations year by year more and more difficult—as their first object must necessarily now be, not the moral and intellectual discipline of the boyhood of England, but to show an ever-growing percentage of success at the various competitive examinations always going on for the public services. They must therefore admit no boys not likely to swell their percentage of success, and advertise the credit of the school throughout Philistia. They must admit only sharp, and ready, and self-possessed boys, and reject the slow-developing, slow-thinking, and backward, who would only fatally weight them in the race with the crammers. The boys who can best take care of themselves have every care taken of them, and the boys most needing help are left helpless. "The devil take the hindermost" is fast becoming the ideal of education, even in our public schools. But children are sent to school not so much to be taught Latin, and Greek, and geometry as to be intellectually disciplined through being taught Latin, and Greek, and geometry, and chiefly for the moral discipline of school life; and every English boy is entitled to be admitted into the great public schools of England as his birthright, if he be only a thorough little gentleman, and is not so far below the average in intelligence as to be an unfit companion for his school-fellows. If not the sons of English gentlemen will gradually be deprived of the system of education especially suited for them, and the wealth and property of the country will gradually come to be administered by men without culture—a narrow caste, as vulgar, and exclusive, and politically mischievous as the old *noblesse* of France. Such a system of public school education is at least quite opposed to the spirit of Christianity, and, if it becomes general, will, I believe, sap the manhood of English people. The great merit of English education, besides its variety, is that it leaves Englishmen still boys to their last hour—men of undrained energies. This is an immense reserve of national strength. But if we seriously take to cramming little fellows of from 12 to 14 for entrance into the public schools, the rising generation will be used up before it reaches manhood. One of the most distinguished members of the old School of Indian Civil servants, lately resigned the Indian Council, because the day on which it met was changed to the day on which the hounds he hunts with meet. Is it possible to imagine a competition wallah being so hale and sound in body and mind at 75? Already, I am told by a well-known physician of great experience, the competition for all sorts of scholarships and appointments is showing its evil fruit in the increase of insanity, epilepsy, and chorea amongst young people of the age from 17 to 19, and especially amongst pupil teachers; and if admission into the public schools of England is for the future to be regulated by competition, St. Vitus's dance will soon take the place of gout as the fashionable disease of the upper classes. A public school must not indeed be turned into an infirmary for the incapable, but yet the noblest purpose of a school should be to serve as a true *Maison Dieu* in disciplining the minds of backward boys into normal vigour If a boy is merely backward, and especially morally backward—a duffer—and is not downright wanting in intellect, or morally perverse—the very best way to make a man of him is to place him under the system of our English public schools, which are meant to make men before they make scholars; and our great public schools should never consent to place any restriction on the education of such boys as English gentlemen. But restrictions are being enforced, and with increasing vigour. It is the inevitable result of the ill-digested and ill-regulated system of competition for the public service, and especially for the Indian Civil Service, which has prevailed; and I fear that the effect of the despatch of the 24th of February will only be to hasten the threatened revolution in our national secondary schools, and that the last state of cramming under it will be worse than the first. I should have thought these far-fetched fears two months ago, and would still wish to hope for the best, where there is so much ground for hoping good from the working of the despatch; but the fears I express are but the expression, in contrary terms, of the hopes of the crammers themselves. I am indeed informed that many of them are already making the necessary arrangement for extending their cramming houses into general schools of scholastic trickery and legerdemain.

I will say nothing of the baneful effect of com-

petition in reducing national education to a dead level of uniformity, as in France and Prussia, as it was fully discussed in my former paper. At present no two schools in England are alike, and this individuality of our schools is one of the most unmistakeable evidences of our intellectual soundness and vigour. It is wonderful, however, that our old schools should so long and successfully have resisted the inevitable tendency of competition. But the belief that education means book learning, and that the test of education is an examination, has had a great effect in perverting the educational action of the Board schools, established while the system of competition was still in its ascendancy, One would have thought that the fact of England being a great manufacturing country, and that the mass of the population are mechanics, would have decided the direction which the primary education of the country should take. That children should be brought up suitably to their station in life, and to fit them for their future calling, one would have thought was a self-evident rule of education. Rope-walks, brick-fields, breweries, farmyards, saw-pits, printing-houses, paper, and soap, and other factories, are as much schools of knowledge and schools of discipline as Board schools and grammar schools and colleges; and in London, above all places, it might have been expected that the School Board would have made arrangements with respectable builders, coachmakers, soap-boilers, and owners of gas works, &c., in the different parishes, by which their workshops and factories should have been used as regular Board schools. But no; the idea of competition and book learning was predominant, and every child must go to the *doctrinaire* Board school of the purely scholastic type. Parents may not even select their own schools for a child, under pain of its being dragged into a police-court, to be examined by a magistrate in geography and history, and the rest of it, as a test of the efficiency of the private school it may be attending. No attempt is made to compensate the parents for the loss of any wages a child may be earning at its father's trade when taken away to the Board school; and when the child is returned to them full of the dangerous conceit of a little useless knowledge, the trade learnt of his father has been forgotten; and even if he were able to take it up again, and wanted to do so, he would be shut out of his natural place in it by some one who had supplanted him during his absence at school. Meanwhile, parental authority and reverence for home have received a fatal blow. I am not protesting against compulsory education. Every one must be compelled to be educated; but do not force on the poor a spurious education which takes the bread out of their mouths, which unfits them to be labourers, and mechanics, and servants, and lures them into the ever-spreading slough of pauperism. Such, however, has been the rage for examinations, that ancient charitable schools, founded expressly for training the children of the poor for bettering themselves in life—if they showed the necessary ability—have, in violation of the founder's truly pious wish, been declared free only to those selected by a competitive examination, and have been thus taken from the poor, and made over to the rich, *i.e.*, to those who can afford to prepare their children for a competitive examination. Fortunately we are not yet a logical people, or our *doctrinaire* politicians might next abolish the laws of inheritance in favour of putting up every man's property on his death to competition by public examination. It is just as unfair, and far more unrighteous, to confiscate the inheritance of the poor in a "founder's" will, to make it a monopoly of the rich. The proposed abolition, under the Oxford and Cambridge University Bills, of close scholarships and professorships — "idle fellowships" as they are stigmatised—will similarly deprive the poorer middle classes, the children of poor professional men, of their best chances of a University education, and the nation of the advantage which always comes of placing the higher education of a country within the reach of all classes of the people.

Patronage is a greater political evil than competition, but it must not be forgotten that competition is only a choice of evils. We should not shut our eyes to the disadvantages of competition, even to the few which cannot possibly be cured. An accidental and remediable evil, besides those already referred to, is that competition encourages godless education. A parent negotiating with a crammer for his son, asked, "And on Sundays?" "I don't care what becomes of him on Sundays, so long as he does not come near me!" answered the crammer. Another youth was sent by his father to one of the heroes of the mutiny of 1857, to take his advice in preparing for the Indian Civil Service. The old soldier talked to him of nurturing his soul on the writings of the noblest English divines, and poets, and historians, when he was impatiently interrupted by the sordid exclamation, "That's no use; it doesn't pay. I want something which will fetch the examiners." And can you conceive anything worse than the present system of turning out in the moral Terai of London the successful candidates during the two years of their probation, without any supervision, and without, for the most part, either friends nor relations to care for them. Such a system could only end in the moral bankruptcy of the people who tolerated it; and this plague spot at least, the despatch of February 24 will tend to abate, if it does not extirpate it. But there are some evils of competitive examinations which are not accidental, but essential. The test prevents downright incapable men from getting into the public service, but it does not prevent the best man being rejected. This is very difficult, even in the case of simple pass examinations, as for degrees, and I have sometimes thought that examinations might be abolished even for degrees, and training, and the periodic reports of masters and professors made the one test, as it is the only real guarantee of practical efficiency. Nothing could induce some men to submit to any sort of test examination. Other men of the highest attainments and proficiency, and willing to submit to an examination, inevitably break down under the actual process. A well-known case in point is that of a gentleman known to many of us, and occupying a distinguished position in London, for which his qualifications are literally unique. Although willing, he cannot pass the required examination. He could answer off-hand at once the very questions which, printed on an examination paper, and set, of *malice prepense*, to test him,

confound him utterly. Fortunately there is no one capable of competing against him, and Government are obliged to let him hold his appointment, although the farce is, I believe, intermittently gone through of calling on him to submit to an examination. The best-conducted examination also is full of risks of deception and cruel injustice. It is difficult to imagine an examining body more competent, and catholic, and altogether fairer, or more generous in its disposition than the Hanging Committee of the Royal Academy. Yet this year they rejected two landscapes, which are the finest achievements of English art since the best days of Turner. It is the sort of error inseparable from every kind of systematic competitive test, and it is possible even under pass tests, if systematic. You have no real guarantee for character under competition. The Secretary of State requires the certificate of two householders to your respectability. They may be money lenders—a young civilian's slaveholders for life. I am told a practice has grown up during the last six years of money lenders educating likely boys for the Indian Civil Service, as a regular investment of capital. They run them for the competitive examination as a horse-jobber runs a horse for the Derby. That is, they pay all the young candidate's expenses under a contract that if he succeeds he will make over every year so much of his emoluments to them. Who can say what corruption and jobbery may not grow up in the future out of such obligations?

Under the system of competition, also, however zealous in duty a man may be, over and above what is exacted of him by his wages, that he should for his money give the money's worth, however distinguished he may become in the public service, all the respect, and influence, and interest he thus accumulates is wasted, is force thrown away absolutely. He can do no more for a son, however sound and vigorous in body and mind, however well educated, however admirably trained to follow in his own steps in the straight and narrow path of public duty—he can do more for him than for any other boy out of the streets. Both must submit to an imperfect and hap-hazard, and it may be really mischievous test, in which hereditary character, and training, and especial fitness go for nothing; and scholastic shuffling and sharp practice, and, above all, a long purse for the crammers—those parasites of competition—count for everything. A man who so served a merchant's office would be sure of an appointment for a son; and it is just as unfair and unwise to confiscate a son's chance of such an appointment, as it would be to confiscate a son's right to his father's fortune, and to put it up to public competition. You have no more right to confiscate the interest and influence than the personal and real estate a man accumulates; and it will never pay Government if its servants are forced to look outside the public service for the natural recognition of superior abilities and zeal.

The corrective I proposed in 1872 for the abuses of competition was to throw the public services open to the public schools, the Government inspected schools, and colleges, and universities, throughout the kingdom and British empire. I proposed to give whatever appointments were open by turns to every public school, college, and university in Great Britain and Ireland, and in India and the Colonies; and the appointments in the Indian Civil Services to the Universities of Oxford and Cambridge, Edinburgh, and Dublin. The selection of the candidates should be made by the college professors and tutors, subject to the veto of the Secretary of State, and, of course, of a medical Board. The best of examiners is the examiner of his own pupils. No man knows a boy's capacity, can measure his real knowledge like his teachers, and I would leave the selection for the Indian Civil Service wholly to the college professors, without any special examination except by a medical board. This plan I still prefer to that of the despatch of February 24, as it not only makes a University education compulsory on all candidates for the Indian Civil Service, but gets rid of a special competitive examination altogether, without touching the principle of competition. The appointments would be given to the candidates who proved themselves best qualified through three years of disciplinary University study, and in the judgment of men in hourly contact with them as professors and tutors during the whole of that period. And their judgment would be founded, not simply on the mental capacity of the candidates, but on their character and bearing as educated young Englishmen—and particularly on their constitutional fitness for service in India. This point, however, would have to be formally referred to the India-office Medical Board, as no provision is made in our Universities for the medical supervision and regulation of students. Nothing, indeed, is more amazing than the absolute way in which medical supervision is ignored throughout our English schools. There should be no school without its regular medical visitor, no School Board without its due proportion of medical members, no large school or college without its joint medical principal, not simply to look after the necessary sanitary arrangements and the school dietary, but more especially to regulate the studies of the scholars and students, collectively and individually, daily and hourly. I would guard myself against being misunderstood. I am not a difficult and querulous eulogist of bygone days as regards the old Indian Civil Service. Like all who have been in India, I have seen how much the welfare of our Indian Empire depends on the high character and efficiency of the Civil Service, and I feel the deepest interest in its honour and reputation. I look indeed upon our rule in India not simply as a system of government, but a system of religion. But my first anxiety is for our schools at home, in which Englishmen are bred up in those virtues which fit them for imperial rule, and I object to competition, as it has been hitherto carried out, for the Indian Civil Service, not only because its tendency is to degrade the service, but because it in fact is degrading secondary education throughout this country down to a barren and blighting system of cram.

But should the misgivings I have expressed of the effects likely to flow from the India-office despatch of February 24th prove only too true, parents have the remedy in their own hands. They must resolutely set their faces against sending their children into the Indian Civil Service, and the public services generally—*i.e.*, if cramming continues to be the only door to them. And if the public schools, the natural guardians of English educa-

tion, will not resist the swelling tide of cramming, they must send their children to private schools, where they can be thoroughly educated and trained up as Christian gentlemen. Man does not live by bread alone, and we dare not make shameful merchandise of the souls of our children. They are a sacred trust, or they have no more moral meaning than fresh laid eggs. The intellectual powers of boys should be as little strained as possible before 17 or 18, and no studies trying to the mind should be entered on before 16, and throughout the whole education of a boy all straining and over-exertion, and fitful exertion of the mind must be religiously avoided. What should be aimed at is regular moderate study, and sound and continuous discipline, to start the growing man in life in the healthiest bodily and moral condition possible. I therefore object to all prizes, or at least disapprove of children striving for them, whether in games or in studies. If with no more than an off-hand effort a child can win a a prize, well and good, but if it cost him an effort which he should not make to win it, he has lost something infinitely more valuable than he has won. The fewer the prizes gained at school, the more will probably be gained in life—that is, if the due training of the mind and care of the body have not been neglected. And I object on moral grounds to competitive prizes. I object to the emulations, the triumphs, the humiliations of the system, and these passions themselves try and exhaust the mind much more than study, and tend to destroy the power of study, which itself, if duly regulated, daily strengthens and developes the mind. All excitement of the passions in connection with studies must be scrupulously guarded against. It has much more to do with the precocious dissipation of French and German boys than people dream of. And in these days of cramming little boys of eleven and twelve for the public schools it is very necessary to insist that between nine and twelve all study should be at once intermitted during any fit of teething, and on anything like restlessness, irritability, flushing, inattention, incapacity, yawning, or langour being observed. Usually, a child gets a box on the ear, or a dig with a slate pencil in the head for the mischief brewing in its brain. And also in England, all children between nine and twelve should, on all fine days between October 1 and April 1, be at once sent out into the air and light for a holiday, and the usual lessons omitted. When German rationalists and French and Italian Ultramontanes join in equally extolling what one calls the practical sense, and the other the practical godliness of Englishmen, it is evident we have no great need to import continental novelties into our system of national education, and may safely rely on the inborn and inbred instincts of the race to maintain its practical superiority to the end.

It is one of the indirect effects of competition, through its influence on school education, that English parents have come to set so extravagant a value on Government service. The spirit of adventure which made England, from the time of Queen Elizabeth to George III., seems to be sinking within us under the weight of a spurious anxiety, fostered by the schools, about our children. Let our only anxiety be to educate them well, and let no temptation betray us into cramming them. Then the world will be before them where to choose.

> "The world before them, strength in every limb,
> Their God, their guardian, and their Faith in Him."
> ["Argo," by Lord Crawford and Balcarres.]

And to young men of high character and sound training there is no better opening than foreign trade, "which is," as Sir John Munn eloquently says, "the great revenue of the king, the honour of the kingdom, the noble profession of the merchant; the school of our arts, the supply of our wants, the employment of our poor, the improvement of our lands, the nursery of our mariners, the walls of our kingdom, the means of our treasure, the sinews of our wars, the terror of our enemies."

I have quoted this quaint and picturesque passage at length, in complimentary acknowledgment of our distinguished and accomplished Chairman's courtesy and kind consideration in presiding here this evening.

DISCUSSION.

The Chairman, in opening the discussion, said Dr. Birdwood had read a paper of great ability, and those who knew that gentleman knew that any conclusions to which he arrived were after the most careful and patient investigation, and were worthy the attention of all intelligent men. Originally he (the Chairman) did not like competitive examinations, for he thought it only imparted a superficial kind of book knowledge, and that under the Civil Service examinations, the ranks of the public service would not be filled with as high a class of men as those who, in the old Haileybury days, won so great a name for their order. But, after reading the minutes on this subject, written by men of the highest position under the Government of India, he had come to the conclusion that on the whole the system worked well, and could not now be dispensed with. At one time he thought with Dr. Birdwood that a better plan would be to give nominations for the public service to our great public schools and universities, to be bestowed as rewards to those students, who by their good behaviour during the time of their studies and their intellectual attainments, were deserving of them. But it now seemed to him all that could be done was to make such alterations as the experience acquired since the institution of the system had shown to be desirable, and he hoped that the arrangements the Secretary of State now proposed to make would be found to bring real and important benefits in their train. He cordially agreed with the reduction of the maximum of age from 21 to 19, and would have preferred it being compulsory that there should be a University training after selection. It was not so now, but he hoped it would soon be the rule, and for his own part he could not but expect that in course of time there would be what might be termed an Indian College—a second Haileybury under another name. That would revive the old *esprit de corps* which was so conspicuous among Haileybury men. As regards the effect of competition, he agreed with Dr. Birdwood, as to the evil effect it often had upon a boy's constitution alike to those who failed as to those who succeeded. A long time must in many cases elapse before the mind and body of a young man could quite recover from the strain put upon it. It was proverbial that doctors differed, and the medical testimony on the point was not unanimous, but the conclusion he drew from it was that parents would do well to assure themselves of the strength of a boy as well as of his abilities

before they entered him for competition in the Indian Civil Service. At the same time, it must be borne in mind that it was rivalry amongst the candidates themselves that made the standard so high, and not any inordinate or extravagant requirements on the part of the Government. He had heard it said that the prospects of the Indian civilians were no longer so brilliant as they had been, but it seemed to him that the prospects of Indian civilians are still so great as to make the position a most enviable one. What a career of usefulness and honour lies before them! What services they can render to their country! and even something better still, by example, energy, and purity of life! It was one of the highest careers open to the young men of England, and he trusted that noble service would never be deteriorated. It must also be remembered, that life in India was no longer what it used to be in the olden time, when many a man leaving home for India never saw brother or sister again, but remained there so long that he outlived all home ties. He hoped that the position of an Indian civilian would long be looked upon by the young men of England as one of the highest positions in public life.

Mr. W. Tayler gave his unlimited admiration and approval to the despatch of Lord Salisbury. It was a most masterly and statesmanlike remedy for many of the evils introduced by competitive examinations. Education had a wonderfully extensive meaning. It did not mean cramming, but it meant the bringing out of the whole faculties of thought and perception. Education meant the bringing out and not stuffing in, the meaning of the word had been a little lost sight of. It is true that we must stuff a little, but the great principle was to develop the intellectual powers of the mind, and at the same time give it something to feed upon. There must be a certain power to digest, and if what was given in was too much for the intellect to digest it, was rather like stuffing a child with too many good things, and making him ill. The system of the Civil Service examination had, in his opinion, led to terrible evil, and it was because Lord Salisbury's despatch met that evil that it deserved special approbation. Formerly, a young man coming up for examination was suddenly thrown into all the temptations of London life, and not unfrequently demoralised and ruined. The offer of £150 a-year to every student who had undergone the probationary examination to proceed to one of the Universities was not actual compulsion, but it was next to it. He very much doubted if one in fifty who had passed the preliminary education would decline to enter the University and receive the education there offered. A University education was a very different thing from the cramming system now in force. There would, therefore, be a different set of men in the public service. The ancient Persian maxim was that men should learn three things, viz., to ride, to shoot, and to tell the truth, and though, doubtless, as to the latter, civilians were as true as the former race of men, still they were often found wanting in the ability to practice the former, so conducive to health. We ought to recognise the necessity for high physical development.

Mr. Punnett referred to Professor Rogers' views as to cramming. Education was method. He differed from the Chairman as to the expediency of giving the heads of Universities nominations, as it would only be doing what the examiners do now. They would give them to the best student apart from his moral education. The heads of a college generally knew but little of their students. He also thought it would be unfair to confine such nominations to the Universities and public schools of the country to the exclusion of grammar schools or those who were educated under a private tutor. He believed the evil effect of a competitive examination on the nervous system was very great.

Dr. Heinemann differed almost entirely from Dr. Birdwood. He thought cramming ought to be defined in a different way. It was impossible to acquire some things by cramming. To understand the meaning of a language meant severe discipline. How could a man learn German by "cramming?" or Greek? Having had an opportunity of seeing 700 young men prepared for the examinations, two or three hundred of whom had passed, some of whom were the very men who had written the minutes in the Blue-Book referred to, he was led to differ from many of the conclusions of the paper. The system of competitive examinations was too deeply rooted to be got rid of; but he wished every candidate might be compelled to go to the University. He totally differed from Dr. Birdwood also in his conclusions as to the effect of cramming.

Dr. Burn spoke of the system of education which he remembered at Edinburgh as being that of a system of cramming, but cramming had various meanings. In Scotland, they made a rational use of the system, and exercised the reasoning faculties, more than was done in England. What was a man without his reasoning powers being well trained? Physical education ought to be more attended to, for it was utterly impossible to get a full development of the intellectual faculties without. Speaking as a medical man, he highly disapproved of the system of correction by boxing a boy's ears, and believed that many lads were seriously injured by it. The men, who in India practised field sports and lived in the open air were the men who enjoyed the best health, and therefore he agreed with what had been said as to the necessity of a knowledge how to ride and shoot.

Mr. Cooke corroborated the last speaker as to the evils arising from boxing the ears, from a case of permanent deafness having come under his knowledge.

Mr. Danvers said there was no greater proof as to the inutility of cramming than was afforded by the experience of the Government, when in 1854, they sought for engineers to carry on the great public works then being commenced. Application was then made to eminent engineers here, who of course were unwilling to part with their best men, and only sent second or third-rate men. Then Government resorted to examination, and a system of cram was the result, and the students had to undergo a so-called practical course of study, which practical course consisted of sitting for eight or nine months in the back room of an engineer's office at Westminster, and these men succeeded in passing the examinations. Those who trained the men were the best men to determine their qualifications. That system had broken down, and the Government now sent them to college. He thought Dr. Birdwood's suggestion, that more regard should be given to the physical powers of a man, a most important one and very valuable one, for a man going to India necessarily cost the Government considerable money, and if he did not enjoy robust health he broke down, and the expense was incurred in vain.

Dr. Long, speaking from a residence in India, knew that the opinion of the natives was that the men sent from Haileybury were superior in physical stamina and intellectual power to the new class of men. Of course they admitted there were exceptions. They had also mixed more with the natives. Lord Mayo had told him that he went out every Saturday to field sports in order to obtain information from the natives. The new men, he was told, as a rule, went from the book to the Cutcherry and back, from the Cutcherry to the book. He thought competition tested some qualities, while it failed to do so with others. He agreed with the necessity of a civilian bein educated in riding and shooting.

Mr. Forrest differed from Dr. Birdwood that the despatch of Lord Salisbury had been received with general rejoicing. The lowering of the age would, in his opinion, extend the evils of cramming, by making it commence at an earlier age before the powers of a lad were suffi-

ciently developed to endure it, and it would break into his school training when he was laying in a sound stock of knowledge, and force him to get up special subjects for the examination at the early age of seventeen.

The Chairman observed it would not necessarily be at 17; the maximum was 19.

Mr. Forrest remarked that few men passed the first time. He did not think that sending men to the University after they had passed would be a success. After a man had passed his examination the stimulus to a great extent was passed also, and he did not think that when a man knew he would have so much in England that he would enter upon the studies of the University. He thought the Government should allow extra years for a man who had passed in high honours at Cambridge or Oxford. The very best men who went to India were the first batch of civilians, and they were the men who had gained honours at Oxford and Cambridge; and of these University men a very small percentage died. Too often men now found they must either sacrifice the Indian Civil Service or their University degree, and, therefore, some of them choose to sacrifice the former. The man who was just too low for his fellowship was the best man to go to India.

Dr. Birdwood briefly replied to the observations which had been made, and remarked that he thought those who had spoken from a practical experience on the subject had mostly agreed with him, and those who had disagreed with him had somewhat misunderstood him. He looked forward to the most happy results from the despatch, but at the same time he feared it might throw the evil of cramming to an earlier age. He quite agreed with Dr. Heinemann that it was impossible to cram Latin or Greek, or German, and Greek was so difficult that it was only acquired by great intellectual capacity. The grammar of some languages, however, might be crammed, and that was the mischief. Geology and chemistry might be crammed, so as to enable a young man to pass, but practical knowledge of these and kindred subjects could only be acquired by years of patient study.

A vote of thanks to the Lecturer and Chairman closed the proceedings.

AFRICAN SECTION.

A meeting of this Section took place on Tuesday, May 30th, Sir Charles Nicholson, Bart., in the chair. The paper read was—

THE DEVELOPMENT OF CENTRAL AFRICA.

By Edward Hutchinson,
Lay-Secretary of the Church Missionary Society.

In placing before this Society and proposing for discussion such a subject as that I have chosen, I feel it will be expected that you should not be called upon to consider a mere chimera, or to listen to home-spun theory, but to such information and argument as will satisfy you that fairly reasonable grounds underlie the proposal contained in the words, "The Development of Central Africa." I do not venture to dogmatise on this subject, nor to say that the time has actually come when any attempt should be made to move in this direction. All that I shall endeavour to do is to place before you what our present information is on the conditions of the land and the people, and to suggest in what direction English influence may best be used to promote the spread of civilisation, commerce, and industry in regions apparently well-adapted to profit by their introduction. It will, I am sure, be hardly necessary for me to remark that, in dealing with the subject, this Society has regard, not only to the interests of the trader and English manufacturer, but to the welfare of the people among whom it is proposed to introduce Arts and Manufactures. What we have to consider is, not how a fresh market may be found for English produce in Central Africa, but how the introduction of English produce may serve to promote native industry, and foster such arts and manufactures as may develop the resources of the country, and promote the civilisation and welfare of the peoples.

Whether the time for the civilisation and utilisation of Central Africa has or has not come, there is no doubt that this subject is a prominent one at the present time. Much interest, under one form or another, is directed to Equatorial Africa. The last travels and tragic fate of Dr. Livingstone; the well-known operations of Sir Samuel Baker and Colonel Gordon, who have been endeavouring to grasp the prize on behalf of the Khedive of Egypt; the recent agitation in connection with the slave circulars and the East African slave trade, and the remarkable journey of Lieut. Cameron, all tend to keep the subject to the front, and to prepare the way for a general awakening of public interest in behalf of Central Africa. Let me also refer to the opinions expressed by that eminent authority, Sir George Campbell, formerly Lieut.-Governor of Bengal. In the *Fortnightly Review* of February 1st, he says, "the civilisation and utilisation of Africa is the great enterprise of the future." He speaks of "high Africa" as "the Great Lake region which occupies the centre of the African continent—a rich country of great capabilities, elevated several thousand feet above the sea, and the possessors of which, if sufficiently strong and organised, would dominate the bulk of the Continent."

The objection may here be fairly urged, what have all the efforts for the advancement of Africa, up to the present time, accomplished? What was the result of the labours of the old Sierra Leone Company, or the African Institution on the West Coast; and what is there in the conditions of Central Africa which point to a more hopeful result from the operations now suggested? The experience of the past may prove a guide for the future; it may, therefore, be well to glance for a moment at the history of the philanthropic efforts of the early part of the present century which made Sierra Leone the base of their operations. It is tolerably well-known that the colony of Sierra Leone was founded in connection with the exertions of Granville Sharp, who, in obtaining the judgment of Lord Mansfield in the case of the negro Somerset, established the noble principle that slaves, on touching British soil, become free. The Sierra Leone Company carried on their operations with varying success until the year 1808, when they surrendered their possessions to the English Crown, the company being well pleased to withdraw from their beneficent but arduous enterprise. The rising colony was then placed by the Government under the care of a new society, called the African Institution, and that body laboured most earnestly to introduce into Africa, through the young colony, the arts of civilisation and social improvement, and schools were established for general improvement. The growth of cotton, indigo, rice, coffee, and even silk, was encouraged, and, in short, no attempt was left untried to induce a taste for

agriculture and commercial enterprise. The Government also did what they could to assist, spending freely in support of the young colony. Hence one would suppose the experiment was fairly tried, and that we should be justified in asking for results in some measure commensurate with this lavish expenditure of life and money. Has Sierra Leone proved a centre whence the influence of English arts and civilisation have radiated to any extent? I fear, that as far as the immediate vicinity is concerned, we cannot say much for the beneficial influence of the colony. To the north, on the Bullom shore, separated by a few miles of water from the colony, British influence is unable to put a stop to tribal disputes, going the length of frequent murder and bloodshed. On the south, in the Sherbro country, the British commandant, Mr. Davies, recently nearly lost his life in endeavouring to reduce some hostile tribes to subjection; while, to the east, in what is called the Quiah country, the influence of Sierra Leone does not extend much beyond the borders of the colony. The explanation, however, of all this is not very far to seek. The chief cause of the apparent want of success in these philanthropic efforts was the constant warfare in which the Sierra Leone Company and the African Institution were engaged with the slavers of that time. Instead of being left free to carry out their benevolent designs, they were confronted at every turn by this accursed system; while, subsequently, the rapid increase of the colony through the liberation there of slaves captured by our cruisers, still further paralysed the attempt to systematically introduce English arts and agriculture. Again, the geographical position of Sierra Leone has prevented the spread from it of any largely civilising influence. It never has been, and never will be, a great emporium for trade; its exports and imports are insignificant, as compared with those of Lagos or the Gold Coast.

Can it, then, be fairly said that no fruit has been borne of all the labour on behalf of Africa? Has it all been swallowed up in the insatiable maw of that small peninsula, leaving no trace of vitality behind? We have to look to another part of Africa, more than a thousand miles away, for the answer; and we find it at Lagos, in the Yoruba country, along the Gold Coast, on the Niger, and to the north, at the Gambia river. At all these places, the native traders, who are carrying on a large share of the business, are men who have received their training and education at Sierra Leone; while the development of the trade of Lagos, with its imports and exports averaging more than £800,000 per annum, is due very largely to the return to their own land, from Sierra Leone, of large numbers of the Yoruba tribes who had been the victims of the West African slave trade, and had been brought under English influence. They were accompanied by the men who had been their teachers, who, when the returning immigrants reached their own land, directed their attention to the cultivation and collection of the cotton, palm-oil, and other products, which now form the staple of the exports of Lagos. In connection with trade here and on the Niger, the education given at Sierra Leone has proved beneficial. The affairs of a well-known trading company on the coast are now managed by a negro, and we have the testimony of a managing director of that company that they are admirably administered. We may also point with satisfaction to the large body of well-educated men who are filling the positions of chaplains, ministers of religion, doctors, and teachers, along the West Coast.

It may, I think, be fairly accepted that the obstacles which have barred the spread of a higher civilisation in West Africa have been mainly two:—1st, the deadly climate, preventing the constant presence, for any length of time, of the European, to whose example and force of character the aboriginal race always owes so much in the attempt to acquire new habits both of thought and action; and 2nd, the politically incoherent, unstable character of the people, caused partly by the disintegrating influence of the slave trade, and partly by the low moral condition to which incessant feuds and intertribal warfare have reduced many of the races with whom we come in contact. At the present time, with the exception of the general educational work of the Church and Wesleyan Missionary Societies, the industrial work carried on by the Basle Missionary Society on the Gold Coast and towards Ashantee, by Bishop Crowther at points on the Niger, and by the French mission at the Gaboon, no effort is being made for the introduction of arts and manufactures on the West African coast; and our more purely secular relations with West Africa, when not of the nature of a small war, are entirely of a trading character.

The question will naturally occur, in what respect does Central Africa differ from those parts of the Continent where it has been shown that all effort at development has been apparently useless. This question I propose to answer in the paper I have been asked to prepare. I shall endeavour to deal with the subject, by first describing the land, with its special characteristics, the inhabitants, the products of the country, and the present course of trade; adding, in conclusion, some remarks upon the direction in which effort may be made for the benefit of Central Africa, with the best hopes of ultimate success.

In speaking of Central Africa, a glance at the map will naturally direct our attention to a part of the Continent which in reality has been trodden by no European save Dr. Nachtigall. The term is, however, generally applied to a part of Africa which lies to the east and south of the true centre, a region which has been mapped out and described for us by Burton, Speke, Grant, Livingstone, Von der Decken, Sir Samuel Baker, Stanley, and last, though not least, Lieut. Cameron. It is, in short, that part of the highland region of Africa which encloses the collecting areas of two vast rivers, the Nile, flowing to the north, and the Congo, ultimately flowing to the west, and debouching into the Atlantic. As, however, I wish, in dealing with this subject, to present to you an enterprise which seems fairly to approach the practicable, according to the concurrent testimony of travellers and others, I propose to confine my remarks very much to that part of Central Africa which lies around and encloses the great lakes which belong to the Nile basin, viz., Tanganyika, and Victoria and Albert Nyanza, with the approach from the Eastern Coast. It will also be necessary to consider the subject of approach from the north through Egypt.

I shall not touch upon the recent discoveries of Lieut. Cameron; they lie beyond the field we are considering; and the plans for utilising them have not been more than shadowed out.

It will, I think, be not uninteresting to remark here that the inception of all geographical discovery in this part of the Continent of Africa was due to the information furnished to the Geographical Society by two worthy missionaries who were labouring at Mombasa, on the East African coast. Captain Speke, in his work entitled "What Led to the Discovery of the Source of the Nile," states that, on his return from the journey he had made in the Somali Land, on visiting the Royal Geographical Society, there was revealed to him for the first time the great objects of an expedition planned by Captain Burton. He says:—

"On the walls of the Society's rooms there hung a large diagram, comprising a section of Eastern Africa, extending from the equator to the fourteenth degree of south latitude, and from Zanzibar sixteen degrees inland, which had been constructed by two reverend gentlemen, Messrs. Erhardt and Rebmann. Missionaries of the Church Missionary Society of London, a short time previously, when carrying on their duties at Zanzibar. In this section-map, up about half of the whole area of the ground included in it, there figured a lake of such portentious size and such unseemly shape, representing a gigantic slug, or, perhaps, even closer still, the ugly salamander, that everybody who looked at it incredulously laughed and shook his head. It was, indeed, phenomenon enough in these days to excite anybody's curiosity! A single sheet of water, upwards of eight hundred miles long by three hundred broad, quite equal in size to, if not larger than, the great saltCaspian."

The result of the discoveries of this and other expeditions being that, although the monster inland sea reported by the missionaries does not exist as one body of water, separate lakes have been discovered, extending from north to south over 16 degrees of latitude.

The works of Burton, Speke, Grant, Livingstone, and Baker, furnish such full and accurate data as to the region we are to consider, that no information really needed for our purpose is wanting. For a general description of the eastern section of the central belt of land south of the Equator, I cannot do better than quote from the admirable Manual of Captain Burton, contained in the Proceedings of the Royal Geographical Society for the year 1859. He says:—

"This extensive tract of country may be divided geographically into five regions. The first extending from the shores of the Indian Ocean to the mountains of Usagara, or the Eastern Ghauts of Africa. The second is the mountainous belt of Usagara running parallel with the Eastern coast, and rising gradually from the alluvial maritime valleys. The third is a flat plateau or table-land, whose eastern limit is the Ugogi Dhun, or valley below the landward slope of the Usagara mountains. It contains the wilderness Marenga Mk'hali, the inhabited country of Ugogo, and the dismal waste 'Mgunda Mk'hali.' The fourth region, Unyanwezi and Eastern Uvinza, is a hilly table-land extending from the western skirts of Ugogi to the eastern bank of the Malagarazi river. The fifth embraces Western Uvinza and the now wasted lands of Ubha (Oha), extending from the Malagarazi river over the southern skirts of the Lunar Mountains to the Tanganyika, or sea of Ujiji.

"Near the coast are low littoral plains and rolling ground, with lagoons, savannahs, and grassy valleys, the courses of large streams, whose banks, inundated by rain-floods, retain in the dry season meers, morasses, reedy marshes, and swamps of black, infected mud. Beyond the maritime regions rise lines and mountain groups of primary and sandstone formation, ridges and highlands, often uncultivated, but seldom really sterile, with basins and hill-plains of exuberant fertility, traversed by perennial runnels and streams. Beyond the landward slope of these African ghauts begins an elevated plateau, now level and tabular, then broken into undulations and gentle eminences, displaying by huge outcrops of granites and syenites the activity of the igneous period, where rain is deficient, thinly clad with bush, broom, and shrubbery, with thorny and succulent thickets, cut by furrows and burnt by torrid suns, and veiled where moisture abounds with tangled jungle rising from shallow valleys, with umbrageous forests broken into glades of exceeding beauty, and with interjacent plains of emerald or amber-coloured grass, from which trees of the darkest laurel-green, and knolls and clumps, large and small, against which no feller has come up, cast thick shade over their subject circlets of underwood. Dull, dreary, and monotonous where lying desert, in parts this pleateau is adorned with a lavish Nature's choicest charms and varieties. Beyond it, again, the land sinks into the lake region, or the great central depression; the superabundant moisture diffused by its network of waters, fordable and unfordable, covers the land with a rank growth of gigantic grasses and timber trees, and the excessive luxuriance of nature proves unfavourable to the development of animal organisms. Throughout the line, to judge without statistics, in the more sterile parts about one-fifth, and in the more fruitful one-half of the land is under cultivation, whilst almost everywhere the abundance of the desert vegetation evidences the marvellous capabilities of the almost virgin soils.

"The superficial conformation owns four great varieties. When low the plains are reedy and muddy, when higher raised and well watered, they bear evergreen jungle and forest trees: in the deserts, where water lies deep beneath the earth, and rain is scarce, the plateaus produce short tufty grass, bush and scraggy thorn, and in rare spots the land is almost bare. The sylvan vegetation depends upon the proximity of water and the copiousness of the rains. In the lands of Ugogi, Ugogo, and its flanking deserts, Unyanyembe and Urori, where water is far below the surface, and where the dry season is long and severe, the woods are principally dwarfed mimosas, thorns, and gums. The banks of fiumaras and nullahs, which are temporarily inundated, supply the noblest trees. Wild fruits and fragrant flowery shrubs abound in the mountains of Usagara, and fine timber is found throughout Uvinza and Ujiji.

"The Western half of the fertile Central African land reflects the Eastern. The correspondence of the two coasts has frequently been the subject of remark. Modern travellers, Magyar, Graça, and Livingstone, who have penetrated into the interior from Loanda, met with the same maritime plain of rank and exuberant vegetation, cut by rapid streams, disemboguing into the Atlantic; a similar expanse of stony ridges and uplands forming the great western water-parting, deeply dented by straths, valleys, and Lupata or glens, here with wild and dreary woods, inhabited by a scattered population of hunters, there with shrubby and thorny wilds, where foxes bark, lions roar, and hyænas whimper throughout the 'blessed night.' As the travellers sank into the central depression they were entangled in the same labyrinth of waters, some sluggish and tortuous, others swift and straight: in places they traversed scenery 'presenting pictures of beauty which angels might enjoy;' in others low champaigns, deformed by reedy swamp, grassy marsh, and wide lagoons, the absorbents of surface drains, or the recipients of monsoon torrents, which, whilst drying under the tropical sun, diffused around them disease and death. The two climates, the diseases, even the effects upon the European constitution, resemble each other; there is the same alternation of damp cold and depressing heat, the same prevalence of malarious and dysenteric disease, the same sensation of invincible languor and oppression. The fauna —many of them purely African—are identical; lions and leopards, elephants and hippopotami, zebras and buffalos, giraffes, antelopes, and crocodiles. The ethnological developments, as the physiognomy of the two races, are parallel, there are the same cruel despotisms, eternal feuds, and bloody rites. On both sides of the continent the imports, piece-goods, and wires, cowries and beads, are bartered for similar exports, slaves and ivory. The dress of the inhabitants is everywhere unbleached cotton, skins, or grass-kilts; they even resemble one another in diet, goat's-meat, poultry, and river fish, holcus, manioc, beans, pulse, and the 'beer called Pombe.'"

The great central plateau described by Burton

in the passage I have read maintains a general elevation of about 3,900 feet above the sea, but running to the north it sinks somewhat until we reach the Great Lake Victoria Nyanza. As it begins to sink the land rises to the right and left of the plateau. On the right or eastern side hills of some elevation are found, and at about 250 miles due east from the lake this range of hills called by Burton the Eastern Ghauts, rise into the important ranges of Kenia and Kilimanjao, the highest peaks of which, with elevations of 18,000 and 20,000 feet, are covered with perpetual snow. On the left or western side of the plateau the land again begins to rise, attaining in the latitude of the lake an elevation of 5,000 feet, and presenting features of marked resemblance to our own uplands of Cumberland and Westmoreland. This elevated region is of some considerable extent, and lies between the two lakes, the Victoria and Albert Nyanza. Still further to the north, and forming the north-west boundary of the Victoria Lake, the land again falls, trending north toward the Nile, and resumes very much the character of the maritime region; the lower valleys abound in morass and swamp, the hill tops are healthy, until at last the level of the Nile is reached. From its highest western elevation, at a place called Mfuto, the great central plateau sinks away to the west with a gradual fall, until Lake Tanganyika, lying in its deep trench, is reached, its surface waters 2,710 feet above the sea level, while at its southern boundary the land rises to a considerable height, forming ranges of hills which separate the waters of the Upper Congo from those of the system of which the Lake Nyassa and Rivers Shire and Zambezi are parts. To the south of these hills, and forming the western boundary of the southern part of the plateau already referred to, lies the Lake Nyassa, at an elevation of 1,522 feet above the sea. This lake enjoys the privilege of access from the sea by the Rivers Zambezi and Shire, an advantage to some extent counterbalanced by the restrictive policy of Portugal, in whose hands are the mouths of the Zambezi. As I have already remarked, these lakes extend over nearly 17 degrees of latitude, and fully to describe the characteristics of their surrounding lands, and the people who inhabit them, would exceed the limits of this paper. As, therefore, Lake Nyassa stands somewhat alone, I shall confine myself to alluding at the proper place to the efforts that are now being made to carry civilisation to the shores of that lake, and proceed to enlarge upon the characteristics of the more northern portions of the part of Africa under our consideration. Captain Burton's admirable description of the region extending from the coast to Lake Tanganyika, gives us ample information, both as to the land and the people, while the writings of Speke, Grant, Stanley, and Cameron, supply detail to complete the picture. For particulars of the country to the north of the latitude of Lake Tanganyika, including descriptions of the Victoria and Albert Nyanza, we are indebted to Speke, Grant, and Sir Samuel Baker. Although we are more particularly concerned with the interior of the region described, yet as the means of approach to it must be fully considered, it may be well to devote a little time to the details of the coast region and the adjoining divisions, described by Captain Burton and the other travellers I have named. The first, or maritime region, is a strip of land stretching from Cape Delgado in latitude 10′ 41″ south to north of the equator, and varies in breadth from 200 to twenty or thirty miles, according as the Eastern Ghauts or hill ranges approach or recede from the coast. In the latitude of the island of Zanzibar, the Mrima, as it is called, extends inland for a distance of about 200 miles, rising very gradually to the spurs of the hills, with an elevation there of about 1,500 feet. Its general characteristics are an alternation of morass and rolling ground with dense vegetation, and in places a network of small streams, with one or two larger rivers threading their way through the soft soil. Four of these, the Pangani, the Kingani, the Wami, and the Rufiji, are streams of some importance, and during the rains are large and rapid rivers; they may yet play an important part in opening up access to the interior. Upon the coast open roadsteads, sometimes partially defended by coral reefs, take the place of ports and harbours. The shelving shore and fall of the tide compel the small native craft to remain shored up during low water, while large craft anchor at some distance from the land. The terrible rolling serf, so dreaded on other parts of the coast, is not feared here, nor do the rivers seem to form the bars so dangerous at the mouths of some of the West African rivers. There is little to call for remark in connection with our subject in this coast region; the climate is deadly, the people physically low and degenerate, and, though the land is rich and fertile, there is little produced beyond what is needed for the supply of the settlements upon the coast. An exception must, however, be made, for it is within this coast region that the famous gum copal diggings are found, which contribute largely to the wealth of Zanzibar.

Vice-Consul Elton, who visited the copal country which lies to the south of Dar es Selam, gives an interesting account of the working of these diggings. In a report addressed to the Foreign-office, No. 7, 1874, he says:—

"The 'Msandarusi,' or copal tree, is largely scattered over the extensive tract of country stretching from the Marui Hills and the Uzeramo, through the rich district of Kwale, away to the Matumhui range of mountains on the south-east of the Rufiji River, and lies within the limits which are bounded to the east by the sea-coast line of cultivation and settlement, and to the west by the highlands which form an irregular barrier to the Mrima at a distance of from 30 to 35 miles inland. Throughout these limits, immense quantities of the semi-fossil 'Amini' are dug by the natives, and this produce constitutes the most lucrative commerce of the Indian settlers at the small trading ports.

"The process of digging is a simple one. Twenty or thirty men, generally of the neighbouring tribes or free men, form a party, and spread over a stretch of country which they divide amongst themselves into claims, each of which is worked by five or six of their number. Operations are commenced in each instance by driving five holes to the depth of about 2 feet as a prospect. If the yield is encouraging, four more holes are driven, which are followed by the driving of the whole square to the orthodox depth of about 3 feet, deeper than which no shafts are sunk. One square being worked out, a new one is commenced and prospected in precisely a similar manner, until all likely ground is gone over; purely sandy soil without a substratum of fibrous and decaying vegetable remains being passed by.

"Below four feet no fossil gum is found worth taking, and, indeed, very few diggers appear to go beyond three feet in search of it; but all is grist that comes to the mill—copal from the tree, the copal dug beneath the branches, fossil copal, and the decayed gum—and the difficulty of arriving at any fair valuation of a quantity must, in consequence, be great.

"In peaceful years large quantities arrive from this part of the country at Zanzibar. Kwale and Delgado exported 40,000 dollars' worth so long ago as 1867-68, since which date I believe no correct returns of the southern trade have been kept.

"The Indian trader on the Mrima has many extortions to fight against and heavy duties to pay, neither can his life be a very pleasant one, spent as it is in one continual succession of haggling and quarrelling with the natives, competition with his neighbours, and a monotonous round of coast fever. The local 'Jumbe' extracts a ground-rent from him, and he is fortunate if only one claimant to territorial dues appears on the scene! The 'Jumbe' is followed by the Jemadar, who levies an arbitrary per-centage on his supposed profits, and besides estimates the amount himself, in order to save discussion. The custom-house then abstracts 20 frasilahs from every 100 frasilahs of copal shipped, as the Government duty, and in addition, charge him on expenses, storage, and delay; add to all this freight and interest on money, and a considerable addition is made to cost price.

"Three, to as high as $5\frac{1}{4}$, dollars are the Kwale estimated costs of the barter per frasilah of copal from Washenzi, prices varying according to the season of the year and the numbers of the men of the various tribes at work, demand, &c.; and at Zanzibar the merchants buy at from seven dollars to eight dollars according to their written agreements with the coast agent.

"Against all difficulties the trade undoubtedly prospers, and affords large gains to all concerned, whilst it is clear the apparently inexhaustible supply of copal under a settled rule, and with systematic working, would furnish the means of supporting a far larger community than that now sparsely scattered along the coast."

We now pass from the maritime region of Mrima to the highlands of Usagara, the second of Captain Burton's divisions. These highlands reach a considerable elevation, the pass at Rehenneko being nearly 5,000 feet above sea level. The descriptions given of this region by Burton, Speke, Stanley, and Cameron combine in praise of its beauty, fertility, and salubrity. Speaking of one particular spot Stanley says:—

"Who wishes to civilize Africa? Who wishes to open trade direct with Usagara, Useguhha. Ukutu, Uhehe; to get the ivory, the sugar, the cotton, the orchilla-weed, the indigo, and the grain of these countries? Here is an opportunity! . . . . Here is the greenest verdure, purest water; here are valleys teeming with grain stalks, forests of tamarind, mimosa, gum-copal tree; here is the gigantic mvule, the stately mparamusi, the beautiful palm—a scene such as only a tropic sky covers! Health and abundance of food are assured. Except civilised society, nothing that the soul of man can desire is lacking here!

"From the village of Kadetamare a score of admirable sites are available, with fine health-giving breezes blowing over them, water in abundance at their feet, fertility unsurpassed around them, with docile, good-tempered people dwelling everywhere at peace with each other, and all travellers and neighbours."

Burton says:—

"The climate of Usagara has two distinct varieties, the higher regions being salubrious, as the lower are unwholesome. . . . In the Upper heights, near the sources of the Mukondokwa River, the climate suggests the idea of the Mahabaleshwar and the Neilgherry Hills in Western India. Compared with Uzaramo or Unyanwezi, these mountains are a sanatorium. . . . After sunset, the gradual cooling of the atmosphere causes the deposit of a copious dew, which renders the nights peculiarly pleasant to a European."

It is manifest that here is a locality in which a station might be planted, which should serve as an important base of operations in any attempt to penetrate Africa from the east.

The Church Missionary Society hope to have a station here by the end of the year.

We now come to the third division described by Captain Burton, the commencement of the great central plateau. It extends from the western base of the Usagara Mountains for a distance of 155 miles, with an average elevation of about 3,500 feet. It is an arid sterile land, with no rivers; parts are, however, fairly productive, and the climate is not so much feared as are other parts of the interior. Captain Burton thinks that the land, if good shelter, pure water, and regular diet could be obtained, would be eminently wholesome. The principal tribe inhabiting this part are the Wagogo, among whom roam bodies of pillaging Wahumas. The former are apparently more civilised than the tribes hitherto met, but they are pronounced by the Arabs to be a rude and boisterous, and violent extortionate race.

The account furnished by Lieutenant Cameron of his passage through this region speaks somewhat more favourably of both the land and the people. He describes the western boundary of Ugogo as furnishing provisions both good and plentiful, and the climate as perfect, at any rate in the dry season.

From Ugogo we pass to the fourth division given by Burton—the hilly table land of Unyamwezi. The general character of Unyamwezi is rolling ground, intersected with low hills. The following description is taken from Captain Burton's work:—

"The Land of the Moon—the garden of Central Intertropical Africa—presents an aspect of peaceful rural beauty, which soothes the eye like a medicine after the red glare of barren Ugogo and the dark monotonous verdure of the western provinces. The inhabitants are comparatively numerous in the villages, which, rising at short intervals above impervious walls of lustrous milk-bush, variegate the well-ridged plains; whilst in the pasture lands frequent herds of many-coloured cattle, plump, round-barrelled, and high-humped, like the Indian breeds, and mingled flocks of goats and sheep dispersed over the landscape, suggest ideas of barbarous comfort and plenty. There are few scenes more soft and soothing than a view of Unyamwezi in the balmy evenings of spring. As the large yellow sun nears the horizon, a deep stillness falls upon earth; even the zephyr seems to lose the power of rustling the lightest leaf. The milky haze of midday disappears from the firmament, the flush of departing day clothes the distant features of scenery with a robe of gorgeous rose-tint, and the twilight is an orange glow that burns like distant fires, passing through an imperceptibly graduated scale of colours — saffron, yellow, tender green, and the lightest azure—into the dark blue of the infinite space above. The charm of the hour seems to affect even the unimaginative Africans, as they sit in the central spaces of their villages, or stretched under the forest-trees, gazing upon the glories around."

According to the same author, the yield of the soil averages sixtyfold, even in unfavourable seasons. The country is broken up into petty divisions, each ruled by its own tyrant, and the minor chiefs of the different districts are virtually independent of their suzerains. The chief Arab settlement of Central Africa, Unanyembe, is found in this country. Stanley gives the following description of the place:—

"Tabora is the principal Arab settlement in Central Africa. It contains over a thousand huts and tembes, and one may safely estimate the population, Arabs, Wangwana, and natives, at five thousand people. Between Tabora and the next settlement, Kwihara, rise two rugged hill ridges, separated from each other by a low saddle, over the top of which Tabora is always visible from Kwihara.

"They were a fine, handsome body of men, these Arabs. They mostly hailed from Oman; others were Wasawahili; and each of my visitors had quite a retinue with him. At Tabora they live quite luxuriously. The plain on which the settlement is situated is exceedingly fertile, though naked of

trees; the rich pasturage it furnishes permits them to keep large herds of cattle and goats, from which they have an amply supply of milk, cream, butter, and ghee. Rice is grown everywhere, sweet potatoes, yams, muhogo, holcus sorghum, maize, or Indian corn, sesame, millet, field peas, or vetches, called choroko, are cheap, and always procurable. Around their tembes the Arabs cultivate a little wheat for their own purposes, and have planted orange, lemon, papaw, and mangoes, which thrive here fairly well. Onions and garlic, chillies, cucumbers, tomatoes, and binijalls, may be procured by the white visitor from the more important Arabs, who are undoubted epicures in their way. Their slaves convey to them from the coast, once a year at least, their stores of tea, coffee, sugar, spices, jellies, curries, wine, brandy, biscuits, sardines, salmon, and such fine cloths and articles as they require for their own personal use. Almost every Arab of any eminence is able to show a wealth of Persian carpets, and most luxurious bedding, complete tea and coffee services, and magnificently carved dishes of tinned copper and brass lavers. Several of them sport gold watches and chains, mostly all a watch and chain of some kind. And, as in Persia, Afghanistan, and Turkey, the harems form an essential feature of every Arab's household; the sensualism of the Mohammedans is as prominent here as in the Orient." ("How I found Livingstone," p. 264.)

The governor of the Arab colony mentioned by Stanley is appointed by the Sultan of Zanzibar.

At Unanyembe the traveller is within 25 days' march of the lake to the West, Tanganyika, and about the same distance in a direct line from the great lake to the North, Victoria Nyanza.

Continuing the examination of the country towards the north, we find in the very interesting work of Colonel Grant, "A Walk Across Africa," the following description:—

"The whole route was fine; never once did we lose sight of trees, wooded hills, or valleys, while water was everywhere abundant. The forest was what might be called 'Donkey or Zebra forest'—bare-poled trees and no underwood. The hills, now close, now distant, were richly clothed and exceedingly graceful, reminding me of the Trosachs. Grey rocks looked out in fantastic shapes from amongst the trees. Huge blocks lay one over the other, or abruptly ended a range of hill. The valleys had been cleared by the axe, the wild grasses were most luxuriant, and palisaded villages were often met with. We had not to leave the path in order to pluck the Indian corn. Our way led from one valley to another, or threaded the green forest, which rang with the songs of our followers. Generally the road was of fine sand, which, when lately washed by the rains, was loose and yellow. Once it crossed a quicksand, the only one I recollect seeing in Africa—very shaky and watery—along which a patch of rice grew.

. . . .

The general elevation of the country is 3,400 feet, rising gently up to the low ranges of hills everywhere around. It is more open than Unyanyembe. Mists rarely lie, except on the hill-tops after rain. The greatest fall measured was three-fourths of an inch in half an hour, after a storm, which burst overhead with fearful concussions of thunder at 3 p.m of the 13th April. This may be described as the grand *finale* to the rainy season. Every morning the dews lay heavily, and a S.E. wind blew, but the coolest breeze was when from S. by W. The daily temperature inside a hut was 78° to 80° at 1 p.m. During the day the sky was generally clear, with a fierce sun; but the air in the mornings and evenings was deliciously cool, a fire at night being cheery and comfortable. No dust-storms troubled us, otherwise the open huts would have been uninhabitable. Drinking water was always sweet and refreshing. At Mineenga a copious spring gushed out of the shell of a tree lying level with the earth in the centre of a rice-field. This was the well of the village; from its position it was considered a phenomenon, and was looked on with veneration, as it afforded cool water the whole year round—a rare blessing." ("A Walk Across Africa," p. 58.)

Of the route beyond Ukuni Grant says:—

"The first sixteen marches from Ukuni were through very pleasant undulations of tall soft grass and umbrageous forest-trees, spots here and there being cleared for cultivation, and capable of yielding grain for one or two thousand travellers throughout a season. On getting into Usui the watershed had changed; all ran to Victoria Nyanza. Our paths crossed three or four escarped hills, tailing gently off to lower ground in the north. About Lobagatte there was picturesque scenery. Delightfully wild rocks and crags interspersed with trees overhung the valleys, reminding one of the echoing cliffs over the Lake of Killarney. A waterfall, too, added a rare charm to this part of the journey."

Here the plantain was met with, regularly cultivated; Indian corn and manioc, with sweet potato, were abundant; poultry, goats and cows were more expensive than in Unyamywezi.

The description we have given in the foregoing pages is of the route taken by Speke and Grant in 1861. It should, however, be remembered that there are other routes from Kazeh to the north. Speke in his first journey went due north; he left Kazeh on the 11th July, 1858; he passed through country at first thinly inhabited and desert, but in a short time reached an open, well-cultivated region. Continuing his march, he reached the southern extremity of the great lake by the 1st of August, having by the itinerary of the route travelled 165 miles. The journey was made in the summer, and Speke describes the temperature as moderate and the weather as pleasant.

It will be noticed at once that the character of the country has much changed as we pass to the north, and we now arrive at the kingdom of Karagué, which occupies the high land I have already referred to. The following accounts of this kingdom are taken from Speke's "Nile Sources" and Colonel Grant's "Walk Across Africa":—

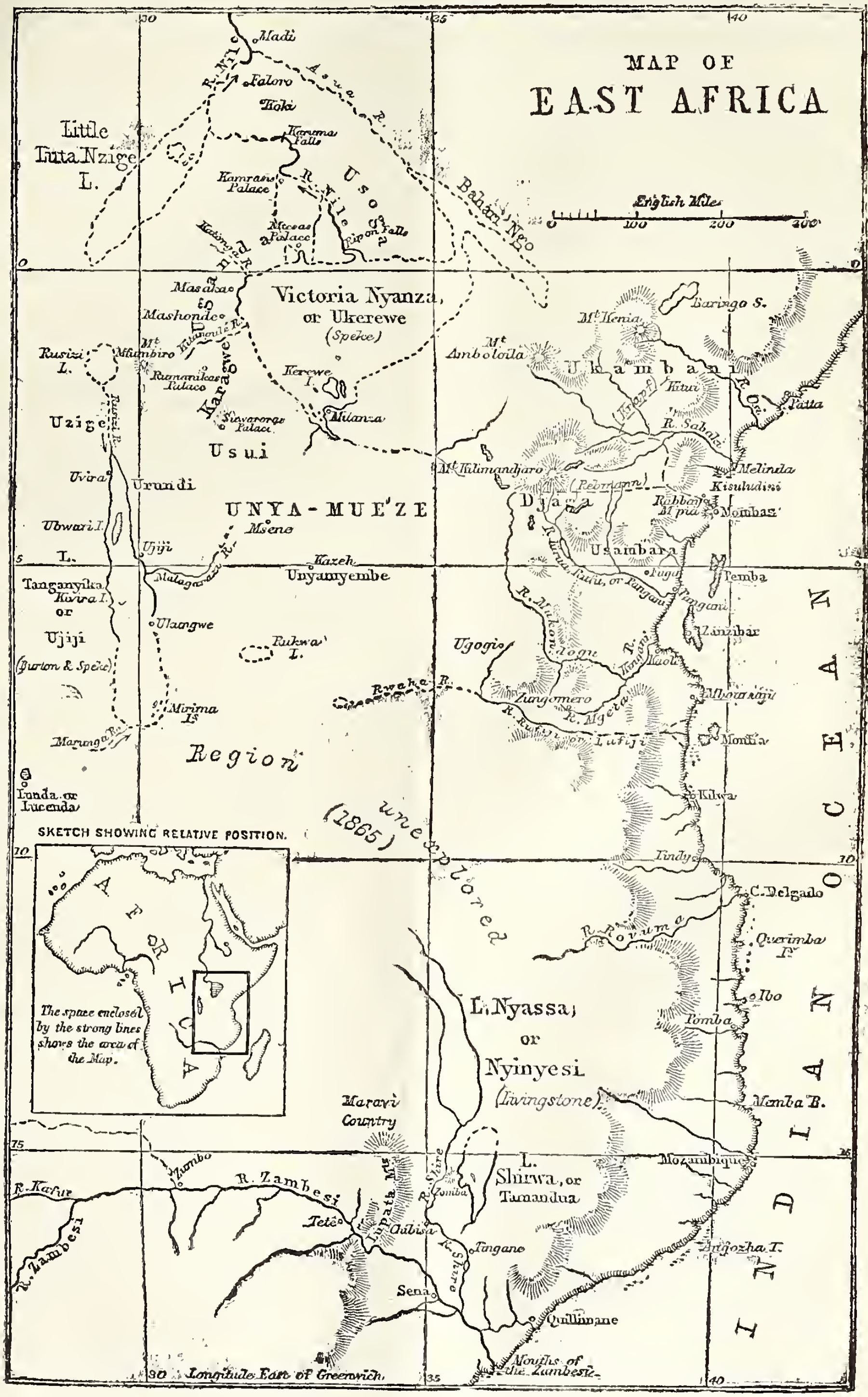
"As many clergymen, missionaries and others have begged me to publish what facilities are open to the better prosecution of their noble enterprise in this wild country, I would certainly direct their attention to the Karagué district in preference to any other.

"There they will find, I feel convinced, a fine healthy country; a choice of ground from the mountain-top to the level of the lake, capable of affording them every comfort of life which an isolated place can produce; and being the most remote region from the coast, they would have less interference from the Mohammedan communities that reside by the sea. . . . As that country must be cold in consequence of its great altitude, the people would much sooner than in the hotter and more enervating lowlands, learn any lessons of industry they might be taught.

"Of all places in Africa, by far the most inviting to missionary enterprise are the kingdom of Karagué, Uganda, and Unyoro. They are extremely fertile and healthy, and the temperature is delightfully moderate. So abundant, indeed, are all provisions and so prolific the soil, that a missionary establishment, however large, could support itself after the first year's crop. Being ruled by the kings of the Abyssinian type, there is no doubt but they have a latent Christianity in them. These kings are powerful enough to keep up their governments under numerous officers.

"The capital of Karagué is 1° 40′ south of the equator, within a complete belt of vapour the whole year round. Fruitful showers seemed to fall continually. There are no very marked seasons, as winter and summer. On the same day, sowing, gathering, and reaping may be seen, and from November till April the fall of rain increases or diminishes according as the sun becomes more or less vertical to our position.

"The country of Karagué rarely affords space flat enough for a single tent to be pitched, but there are thousands of acres now in grass which are perfectly capable of profitable cultivation. Captain Maury, of the United States navy, at the British Association in 1863, stated his opinion that this region, from its equatorial position and moist atmosphere, would make an excellent coffee-growing country; and as many parts resemble portions of the Himalayas, where


MAP OF
EAST AFRICA
English Miles
0
100
200
300
Madi
R. Nile
Faloro
Asua R.
Little
Luta Nzige
L.
Kamrasi's Palace
Ripon Falls
Usoga
Baharingo
Victoria Nyanza,
or Ukerewe
(Speke)
Mashonde
Rusizi
L.
Kerewe I.
Karagwe
Uzige
Msalala
Usui
Urundi
UNYA-MUE'ZE
Msene
Ubwari I.
L.
Ujiji
Kazeh
Unyanyembe
Tanganyika
or
Ujiji
(Burton & Speke)
Ulaungwe
Rukwa L.
Mirima Is.
Region
(1865)
unexplored
Lunda or
Lucenda
Baringo S.
Mt. Kenia
Mt. Amboloila
Ukambani
Kitui
R. Sabaki
Patta
Mt. Kilimanjaro
Djaga
(Rebmann)
Melinda
Kisuludini
Rabbai
Mpia
Mombas
Usambara
Tuga
Pemba
Zanzibar
Ugogo
Rwaha R.
Zungomero
R. Mgeta
R. Rufiji, or Lufiji
Monfia
Kilwa
Lindy
C. Delgado
R. Rovuma
Querimba Is.
Ibo
Tomba
L. Nyassa,
or
Nyinyesi
(Livingstone).
Mozambique
Marayi Country
L. Shirwa, or
Tamandua
R. Zambesi
R. Kafue
Zumbo
Tete
Lupata Mts.
R. Shire
Zomba
Tingano
Sena
Quillimane
Mouths of the Zambesi
Angozha I.
INDIAN OCEAN
SKETCH SHOWING RELATIVE POSITION.
AFRICA
The space enclosed by the strong lines shows the area of the Map.
30 Longitude East of Greenwich
35
40

tea is grown, and there are no frosts at Karagué, I think it is admirably adapted for the culture of tea as well as coffee. Wild grapes were occasionally gathered in the lower grounds, but no beds of gravel similar to those at home or on the Continent, where the vine flourishes in such luxuriance, are to be seen. A few clumps of wild date-trees grow in the valleys; but the natives are ignorant of the sexes of the trees, and never had any fruit. Sugar-cane is seldom or never grown. There are two heavy crops in the year—sorghum and plantain; while peas (English Garden), a specie of bean or calavance, called 'maharageh,' Indian corn, &c., are grown at other seasons. All these we see ripe or ripening, and fresh shoots of plantain were being set, while other fields were prepared for the heavier crop of red sorghum, sown in March.

"English garden-peas were first seen in this part of Africa by Speke, and with the aid of the Sultan we were able to lay in a supply of this delicacy, not in their green form, but dry and dead ripe, boiling and making them into a mash. They were grown broadcast in considerable quantities about Meegongo.

* * * * *

"Of the natural products of the equatorial regions, such as slaves, ivory, salt, copper, iron, bark-cloths, coffee, and sugar-cane, Karagué scarcely yields any, but it is a great depot for trade. Arabs and coastmen bring up beads, cloths, and brass wire, and trade with them for ivory and slaves. Copper and salt are brought from beyond Paroro to exchange for brass wire. N'kole is justly celebrated for its tobacco, though every hut here has its garden of it."

Speke's narrative abounds with praise of the fertility and beauty of the land. The soil he describes as rich loam with the presence of iron clearly indicated. The valley of Uthenga he describes as bound in by steep hills more than a thousand feet high, as prettily clothed as the mountains of Scotland; whilst in the valley there are not only magnificent trees of extraordinary height, but also a surprising amount of land of the richest cultivation. The average level of the country is about 1,500 feet above the sea level. The soil is everywhere fertile, and capable of growing anything. The mean temperature for six months ranged from 64° to 70°. The extremes of heat and cold were in November —heat 84°, and cold 57°. The rainfall ranged from 13 in. in February, to 4 in. in the middle of April. The prevailing winds are easterly; the rain chiefly falls in sudden showers with thunder storms.

To the north of this kingdom lies the more powerful kingdom of Uganda, governed by the now well-known King Mtesa.

The travellers noticed that as soon as they passed into the domain of Uganda the aspect of the country changed. Broad straight roads ran through the land—a strange contrast to the wretched tracks in adjacent countries. Speke says:—

"At Meruka, where I put up, there resided some grandees, the chief of whom was the king's aunt. She sent me a goat, a hen, a basket of eggs, and some plantains, in return for which I sent her a wire and some beads. I felt inclined to stop here a month, everything was so very pleasant. The temperature was perfect. The roads, as indeed they were everywhere, were as broad as our coach-roads, cut through the long grasses, straight over the hills and down through the woods in the dells—a strange contrast to the wretched tracks in all the adjacent countries. The huts were kept so clean and so neat, not a fault could be found with them—the gardens the same. Wherever I strolled I saw nothing but richness, and what ought to be wealth. The whole land was a picture of quiescent beauty, with a boundless sea in the background." ("Discovery of the Nile," p. 273.)

The observations which both Speke and Grant made during their passage through Uganda of the character and circumstances of the inhabitants were, from their limited opportunities, not very full. Speke's narrative is mainly confined to the details of Court life; still, as any mission attempting to enter Uganda must, in the first instance, visit the king at his capital, it is manifest that the welfare of the mission will depend upon the behaviour of the people about the Court. The traveller's observations are, therefore, most important. There can be no doubt that the people are a remarkable race, courteous to strangers, and ingenious. In some parts the country is healthy; and assuming permission given and continued, a mission might prosper in some parts of Mtesa's dominions. But so complete and despotic was the Government, that the whole future of the mission, unless things are much changed, would hang on the favour of the king, while any advantages held out to the people as inducements to them to learn would be neutralised by the knowledge that any improvement in their position or wealth would only lead to their being either plundered or put to death.

Stanley, however, regards Mtesa as a changed man, and referring to the request he made for teachers, says:—

"What a field and a harvest ripe for the sickle of civilisation. Mtesa would give him anything he desired—houses, land, cattle, ivory, &c., he might call a province his own in one day. It is not the mere preacher, however, that is wanted here. The Bishops of Great Britain collected, with all the classic youth of Oxford and Cambridge, would effect nothing by mere talk with the intelligent people of Uganda. It is the practical Christian tutor, who can teach people how to become Christians, cure their diseases, construct dwellings, understand and exemplify agriculture, and turn his hand to anything, like a sailor—this is the man who is wanted."

We have, however, the testimony of another traveller as to the reality of the change in Mtesa of which Stanley speaks, Colonel Long, an envoy sent by Colonel Gordon, reached Mtesa shortly before Stanley, and no doubt his visit very materially prepared the way for the change which Stanley reports in the manners and customs of the court of Uganda. Colonel Long started for Gondokoro in April, 1874, and after fifty-eight days of weary marching reached Uganda. He says:—

"The country of Uganda is mountainous and picturesque, soil fertile, and impregnated with iron, crystal, and *l'argile*. Climate insalubrious and debilitating for Europeans. The valleys are cut by morass and marsh, the wallowing-ground of herds of elephant and buffalo. The jungle-fever is prevalent, and even the native is not proof against its deadly influence. Products: coffee grows wild; is chewed by the M'Ugandi; no decoction. Tobacco is largely cultivated, superior quality, and resembles 'Perigne' of Louisiana. Sugar-cane, Indian corn, sweet potatoes, yams, beans, pomegranate (only in the garden of Mtesa, but does not perfect), banana, and plantain of excellent quality; the whole country is a banana-forest. The population I estimate at half a million. The army has no organisation, consisting of say 50 soldiers, armed with guns of most ancient system. All M'Ugandi are armed with lance and shield. A General-in-Chief, called Kongowee, makes raids and despoils his own people. The character of the people is mild and childlike, superstitious and timid; in nowise warlike. The M'Ugandi works but little, or not at all; his pipe and merissa the haven of his happiness. Mtesa is absolute. He holds council every day; his Mtongoli on bended knees render their report. He adjudicates only in serious causes, and his verdict is death. I remained twenty-nine days as the guest of Mtesa; frequent visits were honoured by the decapitation of eight or ten on each occasion. Although thus honoured (?), I claim for Mtesa a higher intelligence than any other African prince; he has many qualities that distinguish him from his *confrères*.'

From all the foregoing descriptions it is manifest that there exists a considerable extent of country in the interior of Africa, suited for the residence of the Europeans, and capable of producing all necessaries for their support. Thus we find one of the elements we need for any successful work in Africa, some locality where, with moderate care, the health of the European may be maintained. Sir Bartle Frere, speaking of the remarks of Dr. Steere on this subject, says, in his report to Parliament:—

"I cannot but think that Dr. Steere takes too unfavourable a view of the effects of the climate: Zanzibar and the East Coast of Africa appear to me to be unhealthy from the same causes, and apparently not in much greater degree, than the West Coast of India; and the precautions taken in the latter place for the preservation of health would probably be equally efficacious if strictly observed in Zanzibar and East Africa. Caution against unnecessary exposure either to the sun or malaria, care with regard to drinking-water and food, and other obvious sanitary precautions, would probably go as far to lower the rate of mortality in Africa as they have done during the memory of living men in India.

"I saw at these stations, as elsewhere in East Africa, much which leaves on my mind the impression that the insalubrity which is now ascribed to the climate, is often due to a neglect of sanitary rules, which would cause similar results on any part of the coasts of India; and I, everywhere in Eastern Africa, found Europeans living in positions and under circumstances which any medical officer of ordinary experience in Indian cantonments would pronounce to be incompatible with healthy existence."

I now turn to the question—Is there anything in the character of the people of East Africa which offers more favourable conditions for successful effort in their behalf, than have been found in West Africa? On this subject I am bound to say that the account furnished by Captain Burton attributes to the East African negro every variety of vice, depravity, and mental and moral degradation, without one redeeming feature. Add to this the fact that for a considerable extent of country there is a repetition of just that succession of petty tribes, hostile and independent, which we have assigned as one of the obstacles to the spread of a higher civilisation in West Africa, and we must confess that the prospect is not inviting.

Captain Burton's observations are, however, limited to the tribes who occupy the eastern approach to Central Africa proper. I am happy to say, that from personal experience and from the accounts we have from East Africa, we are able to express our dissent from the unfavourable view taken by Captain Burton. I have alluded to them, in order to bring out in marked contrast the characteristic of the tribes who occupy Central Africa proper.

According to Captain Speke, the country which now demands our attention was formerly known by the name of Kittara, for this name was formerly given to the northern portion of it. The inhabitants were originally called Wahuma or Wamau (Speke's "Discovery of the Nile," page 46; Krapf, p. 548). This race Speke considers to have had their origin in Abyssinia, or among the Gallas. His theory is that during the time that Abyssinia was under the rule of the Gallas the governing clan gradually pushed their fortunes in all directions. Attempting Mombas, they were repulsed, fell back into the interior, crossed the White Nile, and ultimately settled down and formed the kingdom of Kittara. Here it is supposed that they lost their religion, and changed their name to Wahuma. By degrees they extended to the south, absorbing other provinces until at last the region inhabited by the Wahuma extended from the junction of the White Nile and Albert Nyanza on the north to nearly the latitude of the north end of Lake Tanganyika on the south.

This family or race connection has an important bearing on any effort to work among these people. Speke says:—

"It appears impossible to believe, judging from the physical appearance of the Wahuma, that they can be of any other than the semi-Shem-Hamatic race of Ethiopia. The present kings retain a tradition that they had been once half white and half black; they also believe that Africa once belonged to Europeans, and they regarded the approach of white men as auguring an intention to take the country from them." ("Discovery of the Nile," p. 246.)

The original kingdom of Kittara is now divided into two, Unyoro and Uganda; these are bounded on the north by the White Nile and Baker's Albert Nyanza, on the east by the Nile and the Victoria Nyanza, and on the south and west by the River Kitangule and the subordinate kingdoms of Karagué and Nkole. From Kittara the Wahuma stock spread south, and formed the kingdoms of Nkole, Karagué, and Uzinda.

In these kingdoms the Wahuma race are found in the position of the governing class, the junior branches of the race herding cattle, while the aboriginal tribes are the tillers of the soil. Speke says that he found the Wahuma kings and Wahuma herdsmen holding with the agricultural Wazinzi in Uzinzi, the Wanyambo in Karagué, the Waganda in Uganda, and the Wanyoro in Unyoro. The Wahuma are found still further south, under the name of Watusi, tending their cattle all over Unyamuezi.

The kingdom of Uganda is without doubt the most important and powerful of the kingdoms in this part of Africa, and is extremely interesting, inasmuch as the Government there is as different from other surrounding countries as those of Europe from the Government of Asia.

Speke informs us that the kings of Uganda have all carried on the same form of government as that commenced by their first king Kimera seven generations ago. Suddenly rising to power, he grew proud, and gathered around himself a strong clan, from whom he chose his officers, or "Wakungu." These he rewarded well and punished severely. He soon became magnificent, and nothing would content him that was not of the best. Fleets of boats were built for war, and armies formed, that the glory of the king might increase.

This system of government has been pursued by successive kings, until at last in the young ruler Mtesa there seemed to unite—at least, when Speke and Grant were there—all the worst qualities of a capricious and savage despot. Throughout the whole country there prevailed a strong form of government. Every place of any size had for its governor a king's officer, and the inhabitants were in such complete subjection that no one dared to sell food to the travellers, Speke and Grant, the king having forbidden it.

A remarkable similarity exists between this form of Government and that obtaining in Madagascar under the Hovas. It may be that they are in some

way connected with Wahumas, whose most southerly branch, the Watusi, bear a remarkable resemblance to the Kaffir tribes of South Africa.

Of the character of the people of Karagué both travellers speak favourably. The governing class, the Wahuma, appears to be present in larger numbers than in the other kingdoms; the Government, though much milder than that of Uganda, is firm, and the people in proper subjection; the laws are well observed, and although in some parts the Wanyambo peasantry are turbulent and evil disposed, on the whole the country presents the appearance of a peaceful, prosperous land. Shortly after entering the land, Speke writes:—

"To enhance all these pleasures, so different from our former experience, we were treated like guests by the chief of the place, who, obeying the orders of the king, Rumanika, brought me presents as soon as we arrived of sheep, fowls, and sweet potatoes, and was very thankful for a few yards of red blanketing as a return, without begging for more. The farther we went in this country the better we liked it, as the people were all kept in good order, and the village chiefs were so civil that we could do as we liked." ("Nile Discovery," p. 197.)

Colonel Grant's long sojourn with the good King gave him ample opportunity of studying his character and that of his people. I venture to think that land, people, and ruler all invite just the enterprise we are considering, viz., the introduction of civilisation into Central Africa.

To sum up this part of my subject, I think we have found that in the vicinity of Lakes Tanganyika and Albert and Victoria Nyanza, there exist the elements for successful enterprise. A salubrious climate, products not only suited to maintain European life but to repay outlay, and lastly, races of a higher type and under more stable government than have been found in the lowlands of Africa.

But granting all this, comes the question who shall undertake the task, and how shall an approach be made. Mr. Stanley has indicated the Nile route, in connection with the operations of Colonel Gordon, as the most practicable. Others, too, consider that Egypt and the Nile are the real and only means of reaching High Africa.

It will be remembered that Sir Samuel Baker, after an immense deal of labour, succeeded in clearing away the obstacles to a free water passage on the White Nile, and carried a force up as far as Gondokoro; from thence he penetrated south into the territory of Unyoro, but was attacked by Kabba Rega, the king of that country, and made his way back with much difficulty. Sir Samuel Baker planted certain posts in the Unyoro country south of the point where he crossed the Nile; these posts he left on his return to Egypt. Col. Gordon, on taking command, found, however, that no safe or open communication existed between Gondokoro and Unyoro or Uganda. The task which lay before him was the gradual establishment in the countries which lie in the south of Gondokoro of a firm Government with a safe route for traffic.

From Gondokoro to Uganda, Colonel Long, Gordon's envoy to Mtesa, took fifty-eight days of weary marching, and on his return journey had to fight his way through the hostile forces of Kabba Rega. From all that is known of the character of Kabba Rega it is anticipated that he will continue to oppose Col. Gordon's efforts to establish friendly relations with Egypt, and it is much feared by some that Mtesa may be induced to make common cause with his ancient foe, in order to oppose the entrance of the Egyptian power. In spite of Col. Gordon's pacific desires and intentions, the gradual advance of the Egyptians is regarded with suspicion, and it is impossible for him so entirely to control the course of events, in carrying out the avowed intention of Egypt to annex those countries, as to avoid all acts which would tend to embroil him with the natives. It is a remarkable commentary upon Mtesa's profession of friendship that both Colonel Long and Linant de Bellefond were attacked at the same place, and that he informed Kabba Rega of the departure of those officers. It does not require any very acute foresight, therefore, to enable us to see that many political difficulties must be overcome, before the Nile route would either be safe or available for a party to approach Uganda from the north.

It is now known that Colonel Gordon has succeeded in placing small steamers almost upon Lakes Albert and Victoria Nyanza, but it has for some time been manifest that the Egyptian Government has been unable to give him effective support. The following extract from the letter of the Alexandria correspondent in the *Times* of the 1st of the month, shows that the prospect of the utilisation of Central Africa is not likely to be accomplished by Egypt unaided. He says:—

"I have before me the most recent news of Colonel Gordon contained in a letter written by him on the 25th of February to a friend in Alexandria. The letter, which was eight weeks on its journey, is dated from Dufli, two degrees north of the Equator, on the White Nile, about 100 miles south of Gondokoro, near the formidable series of cataracts which form the greatest barrier to river communication between Khartoum and the Equatorial Lakes. It confirms the news already received from Fatiko (100 miles further south), and sent forward a month ago to England. Colonel Gordon is on his way home, in good health, but leaving his work unfinished. 'I hope,' he says, 'to be in Cairo by September.' But the work is unfinished from no fault of Colonel Gordon. The letter tells the old story of the failure of grand conceptions for want of support, while it incidentally confirms the explanation given in *The Times* of the expedition to Zanzibar, which was abandoned by the Khedive at the request of England. The history of the Baker Expedition is well known. How he went forth to suppress the slave trade, to open to steam navigation the Equatorial Lakes, and to develop the commerce of Central Africa; how in two years, to use his own words, 'in the end every opposition was overcome; hatred and insubordination yielded to discipline and order;' and 'a paternal Government extended its protection through lands hitherto a field for anarchy and slavery.' Yet, somehow or other, after the return of the Pasha, the slave trade continued; the steamers, built of steel in London, carried across the Nubian Desert in plates and sections, lay unused, some of them not even put together, at Gondokoro; the commerce of the Equator still remained a magnificent dream of the future; and pessimists whispered that something still remained to be done. Then Gordon went southward to complete the work of Baker. The pacification of the Equatorial Provinces and the opening to steam navigation of the Equatorial Lakes was again undertaken. A chain of military stations and commercial depots was again to be established. A further task was imposed on Gordon—namely, to extend the line of communication from the Victoria Lake to the shore of the Indian Ocean, and at the same time a force was to be sent frem Suez to occupy a point on the coast where Gordon might debouch on. Hence the mysterious expedition under Admiral MacKillop Pasha to the East Coast of Africa, when serious collision with the Seyyid of Zanzibar was only avoided by the discretion of the English commander. However, this expedition by sea was useless. Gordon, on arriving in the interior, deemed failure

inevitable if he attempted to march to the coast. 'The utter insufficiency of the troops, the impossibibility of urging them on beyond Victoria Lake,' 'the immense difficulty of the long land march;' 'haviog had precious little support, everything in the way of work has been left for me to do;' 'no fit officer has been given to me;' these are some of the reasons given why no attempt should be made to move the troops beyond Victoria Lake. The coast of the Indian Ocean is the natural outlet for the trade of Equatorirl Africa; but, as Gordon says, some other man will open the road. He says:—'The road should first be explored before stations are made, and the exploration should proceed from the sea to Lake Victoria, and not from Lake Victoria to the sea.' The Ozy River might be followed by the surveying party for its supply of water as far as Mount Keoia, a distance of 200 miles, and from there to the Lake is not more than another 100. But, with a mere handful of troops and an unsettled Province to govern, it was impossible for Gordon to undertake the task. He writes:—'I have done my best under very hard circumstances, up here; the Khedive has or will have the two lakes, and I have utilised Baker's steamers and boats.' This is all Colonel Gordon says of his two years' work; but from other quarters there is ample proof that he has laboured incessantly at the consolidation of the Provinces under his charge with a zeal and steadfastness of purpose which must have produced complete success if he had received anything like the co-operation and assistance which he was promised."

To the same purport is the article by Sir G. Campbell, to which I referred at the commencement of this paper and from which the following is an extract:—

"Behind Egypt is Africa. The civilisation and utilisation of Africa is the great enterprise of the future, and it seems pretty clear that the only present available entrance to what may be called 'High Africa,' is by way of Egypt. In South Africa we come in contact with the Kaffirs, the most warlike and unsettled and least laborious of African races. There is no prospect on that side of a settled and progressive native dominion in Africa to be reached by other than very slow steps. On the west coast our settlements are separated from the interior by difficult and unhealthy jungles. The line of the east coast is held by Portuguese and Zaozibarees, who are not equal to a great enterprise. On the north the Desert separates the outer fringe from the interior.

"We know enough to be assured that a strong and civilised power commanding Egypt may open up easy communication with, and navigation of, the great Lake region which occupies the centre of the African continent—a rich country of great capabilities, elevated several thousand feet above the sea, and the possessors of which, if sufficiently strong and organised, would dominate the bulk of the continent. Seeing how admirably fitted for labour the African race have shown themselves to be, how wretched and miserable is their condition in their own country under a barbarous anarchy and bloody slave-dealing customs, and how tractable, amiable, and good tempered they are under civilised control, one cannot doubt that any great power which could and would perform for Africa the functions which we have performed in India, would immensely benefit the human race. And profitable as has been the labour of Africans in other continents under all the disadvantages of limited numbers, slavery, and a degraded position, it must be that the great native population of Africa would add prodigiously to the resources of the world in their own fertile continent, if, political order being maintained, personal freedom and security were guaranteed to them, and European energy and capital were introduced to direct free labour. The high Lake country in particular appears to be eminently fitted for such a settlement—healthy, fruitful, and fitted both for native and European residence. At the present time some of the most profitable productions in the world are those only produced in the peculiar climate afforded by the combination of a tropical latitude with an elevation which secures against great heat and malaria. Such a climate is sufficiently available elsewhere; in Africa there is a vast extent of it. Already the best coffee comes from High Africa, and pepper, quinine, and many other things would be abundantly produced there. Following the course of the many rivers which radiate from the elevated region, tropical countries of great richness and large populations would be reached as they cannot be reached from the pest-ridden coast. No doubt to any power which can undertake such a work, Africa offers a field greater than India, and one where intervention would be still more justifiable in the interests of humanity. Africa might become a gigantic Java or Ceylon."

In the opinions expressed by Sir G. Campbell as to the possible future I most heartily concur. But notwithstanding all that has been said as to development through Egypt, and Sir G. Campbell's dictum that Africa lies behind Egypt, there is much that may be said in favour of development through and in connection with Zanzibar.

From whatever quarter the effort to utilise and civilise Central Africa is to proceed, I think we may agree with Sir G. Campbell that the effort must be under the direction and with the assistance of an European power. It is very evident that if we regard Egypt as the door to Central Africa, and admit with Sir G. Campbell that an occupation of or protectorate over Egypt must precede any effort in its behalf, we are at once confronted by political and financial complications of considerable magnitude, the chief being the natural jealousy of the European powers, and the fact that Egypt is heavily laden with debt. I venture to think that these difficulties disappear the moment we recognise the fact that the natural door to Central Africa is Zanzibar.

His Highness the Sultan of Zanzibar has possessions extending about 660 miles from Toongee, the frontier of the Portuguese territory beyond Cape Delgado on the south, to Warsheek in about 2° 30′ north, which is the most advanced post actually held by his troops and under his flag to the north. Eastward the ocean limits his possessions to the continent and islands adjacent; westward his flag is said is said to fly in Unyayembe, 300 miles from the coast, but his actual dominion does not extend much beyond the forts and ports on the coast held by his officials, at most of which customs are levied in his name; and a few spots, like Tabora, in Unyayembe, where a sort of Arab colony has established itself. Some of the tribes on the coast even opposite Zanzibar own a sort of allegiance to the Sultan, but regularly pay tribute to some petty Negro potentate in the interior, who is better able to protect or annoy them; and on no part of the coast can his authority be said to be more than skin-deep, extending very rarely beyond the shore and the points which can be reached from his vessels. The southern and eastern limits of these possessions are fixed. To the north and west, his Highness and his subjects, if they have any thought to such a question, would consider him justified in advancing his garrison as far as his means and the weakness of his neighbours might permit.

The following statements on the trade of Zanzibar are taken from the correspondence respecting the slave trade, &c., presented to Parliament in the year 1872.

It is impossible to obtain accurate and reliable statistics of the trade of Zanzibar, every one being interested in representing the imports and exports less than the actually are. The Customs master, by showing the true imports from abroad, and from the African Coast, would disclose the amount of his profits, and thus draw competition into the field, while the foreign merchants have alike no desire to induce others to think of establishing rival houses. The statement of imports is,

however, of others relating to Zanzibar commerce, the most easily obtained, and the following may in general be relied on as an approximate to the truth. If we exclude from former reports the coast produce, we find that there has been a steady increase, thus:—

Imports at Zanzibar Custom-house, exclusive of Coast Produce.

Year.	Value imported.
1861-2	£245,981
1862-3	332,092
1863-4	294,613
1866-7	380,051
1867-8	433,693

The following table shows in dollars the imports of the year 1866-67, from the 23rd August to 23rd August:—

Imports in 1866-7.

From what country.	Amount. Dols.
United Kingdom	311,020
British India	408,769
Rutch	266,052
Arabia	71,169
France	66,900
United States	297,160
Hamburg	384,175
Total	1,805,245

The first three items representing the whole British interest, or 985,841 dols., being nearly three times greater than that of any other nation, exclusive of the indirect British imports brought in Hamburg and French vessels.

Produce of the Zanzibar Dominions on the Coast and adjacent Islands, imported in Zanzibar in 1867-68.

	Dols.
Copal (animi)	100,000
Cereals	45,000
Hides	51,000
Ivory	663,500
Orchella Weed	50,000
Sesamam Seed	100,000
Slaves	270,000
Other products	248,300
Total	1,527,800

Estimate of the Exports from Zanzibar to Foreign Countries.

	Dols.
Produce of the Island of Zanzibar	525,000
Produce of the Coast, not consumed in the Island	1,213,000
Goods in transit	118,000
Total Exports	1,856,000

Unyanyembe, the great Arab emporium already described, is, as the crow flies, only 360 miles from the coast opposite the island of Zanzibar, and here the authority of the Sultan of Zanzibar is recognised. Arab traders find their way not only from Bagamoyo, but from Tanga and Mombasa to the interior, and they carry on the whole trade from Central Africa to the Zanzibar markets; in fact, they at the moment monopolise the whole of the traffic of Central Africa. Rough and rude as may be the means of transport, these traders keep up regular, though slow communication, from the various depôts to the coast.

I have been advised by Lieut. Cameron, in connection with an attempt to send a large party to Karagué and Uganda, to which I shall presently allude, that some of the best Arab traders at Zanzibar would contract for the organisation and despatch of the whole expedition, with every prospect of fulfilling the engagement.

It is, I think, tolerably well known that there is nothing more difficult than to deflect existing traffic from its recognised lines. Moreover, a glance at the map shows us that even supposing a tolerably safe route, established between Victoria Nyanza and the Mediterranean by the railways in Upper Egypt and steamers on the White Nile, the cost of establishing and maintaining that route would so weight the cost of carriage, that for the traffic of Central Africa the Nile route never could compete with the ocean highway, which, as far as Europe is concerned, runs side by side with the Nile route along the East African coast and the Red Sea.

I have thus shortly endeavoured to show that at the present moment the communication between the interior and Zanzibar is of such a nature as fairly to entitle that State to be considered the door to that part of Central Africa with which we are concerned; and I venture to think that were the effort suggested by Sir G. Campbell directed upon that State instead of upon Egypt, the result would justify his anticipations as to the future that lies before Africa.

I have said that the political difficulties which would attend any effort on our part to work through Egypt would not arise were we to operate through Zanzibar. I shall now endeavour to justify that statement, and to show that, so far from any such difficulties arising, our relations with Zanzibar are of such a nature as to afford a strong argument in favour of our relying upon that State in any effort to civilise and utilise Central Africa.

I have reserved for this part of my subject one marked characteristic of East Africa, viz., the accursed system of the slave trade.

That system, which was so long the curse and blight of Western Equatorial Africa, has for many years preyed upon the eastern and central continent. The markets of Egypt, Turkey, Arabia, Persia, India, and Madagascar have been supplied to an enormous extent with negro slaves, torn from their homes under circumstances of the most revolting cruelty. The slave-hunters have succeeded in depopulating and rendering waste thousands of miles of once inhabited and productive lands. The principal channels of supply have been the Nile for Egypt, and the territory of Zanzibar for Arabia, Persia, India, the Red Sea, and Madagascar. The energetic measures of Sir Samuel Baker and Colonel Gordon have, it may be hoped, checked the trade on the Nile to some extent, and England is now embarked in the effort to put down the trade through Zanzibar.

The journals and letters of Livingstone have made us familiar with the scenes of horror connected with this accursed traffic. It met and thwarted him on all his journeys, surrounding him at times with an area of bloodshed and misery from which he revolted. It is not to be wondered at that, meeting this accursed trade far to the south, on the Zambezi and Shine rivers, then passing on for hundreds of miles over ravaged

lands and desolated villages, and seeing with his own eyes the ruthless murder of hundreds of unsuspecting victims at the very northernmost point of his travels, at Nyangwe, on the River Congo, he should have realised to the full the curse and the blight thrown over the unhappy land, and in his solitary despair have penned the words which are now graven on his tomb. May Heaven's richest blessing come down on all who will help to heal this open festering sore of the world.

Such is the extent of the trade that Sir Bartle Frere, after full inquiry, puts the export at 35,000 per annum, and he endorses to the full Livingstone's computation as to the awful waste of life connected with the trade.

Under the treaty of 1873, which Sir Bartle Frere went out to negotiate, permission was given to the British Government to establish a practical blockade of the coast, and it was hoped that the trade would be checked.

It was feared, however, that the blockade by sea could be evaded by passing the slaves along from the south to the north by land, and accordingly Captain Elton was sent to inquire as to this land-traffic between Kilwa and the north.

Captain Elton states that between the 21st December, 1873, and the 20th January, 1874, 4,096 slaves passed him on the road for the north.

Captain Elton states that agents will pay thirty or forty dollars for each slave, and adds :—

"As long as such prices can be procured the trade will flourish, and I can see nothing to stop the inland route (all arrangements are carefully completed, and no insurmountable difficulties in the way) but rooting out the trade root and branch."

The Rev. W. S. Price, writing in November, 1875, from Mombasa, says :—

"The Christian philanthropists of England have not yet half realised what East African slavery is, or they would not rest till the treaty which provides for the capture and liberation of slaves by sea is amplified, so as to legalise the liberation of slaves conveyed by land. Till this is done, comparatively little is done to heal the 'open sore' which is a disgrace to humanity, and which brings a curse upon the fair country in which it is suffered to exist. It is a fact that within twenty miles of this place, there passes from south to north an almost contiouous stream of miserable creatures—human beiogs, men, women, and children—exposed to every hardship and cruelty by the men-stealers, who have caught them in their toils."

The hunting grounds of the slaver have chiefly been in the vicinity of Lake Nyassa. Livingstone found the slave-hunters at work to the west of Lake Tanganyika; Stanley meets them on the Victoria Nyanza; the latest accounts from the Scotch Missions on Lake Nyassa state that five dhows are now on that lake collecting slaves, and Bishop Steere, who has recently travelled by land to the vicinity of Lake Nyassa states that at least 10,000 slaves must have passed to the north along the coast just before his visit. All these slaves will most probably be marched down to the coast, and then driven along to the north, to such ports as for the time may not be watched by our ships.

It is manifest that further measures are needed for the suppression of the trade. The land-traffic must be checked.

I have already said that the civilisation and utilisation of Central Africa, whether it proceed by way of Egypt or Zanzibar, must be aided by a European power. I have sought to show that for many reasons that aid may best go *via* Zanzibar, and I shall now endeavour to show that the entire crushing of the slave trade is the most effectual aid that can be rendered to the introduction of civilisation into Africa.

It is manifest that the existence of such a trade must be an effectual barrier to the introduction of civilisation into Central Asia. The experience of West Africa teaches us that its removal is a matter that affects the interests, not only of the philanthropist, but of the merchant.

Lord Palmerston in a speech in the House of Commons, February 26, 1860, referring to the West African trade, stated :—

"I cannot too strongly express my concurrence in the opinion, that if the abominable crime of slave trading could once be put an end to on the coast of Africa, that continent would be a source of wealth, not only to Europe, but to the whole world to such an extent, that the imagination itself could hardly follow it."

A late senior officer of the West African Squadron thus describes the extent of the coast on which the slave trade formerly prevailed, and the consequent extinction of legitimate commerce:—

"Until 1840 the slave trade had been carried on to its full extent along the greater part of the sea-board of Western Africa—from the River Gambia, in the north, to Little Fish Bay, in Latitudo 15° south—subject only to such slight checks as it received from the operations of our squadron.

"At this time the legitimate commerce of West Africa was comparatively trifling in amount, in many places entirely unknown, it was in others feebly striving for existence against the baneful influence of its barbarous rival.

"The interior of the continent was devastated by cruel and bloody wars carried on by one tribe against another, solely for the purpose of procuring captives for sale. The shores presented the melancholy spectacle of crowded barracoons, filled with unhappy wretches, who had been driven down in chains, hundreds of miles from the interior."

As a contrast, let us turn to a letter from Bishop, then the Rev. S. Crowther, written in 1852, from Lagos :—

"Sept. 22.—Our little schooner anchored off the place from which I was shipped for the Brazils in 1822, thirty years ago. I could well call to recollection many places I knew during my captivity, so I went over those spots where slave barracoons used to be. But what a difference! Some of the spots are now converted into plantations of maize and cassava; and sheds, built on others, are filled with casks of palm-oil and other merchandise, instead of slaves in chains and irons, agony and despair. The resources of the country are being called forth since the abolition of the slave trade at this place.

"I can assure you, from personal knowledge, and from the expressed admission of many chiefs in this part of the country, that the abolition of the slave trade at Lagos, and they hoped from Whydah also, was the greatest deliverance that ever was wrought on behalf of this country. The barriers which had been put between one tribe and another, and which made travelling very unsafe, are now being removed, so that one tribe is open to another; and they are travelling together in the interior for mutual trade and intercourse, while the farmers in many parts begin to feel security in the pursuit of their peaceful occupations."

In 1851 it became necessary to seize Lagos. It was the last stronghold of the slave trade, and the port for the embarkation of the slave gangs brought down from the Yoruba country.

Various tribal disputes between the Egbas, whose capital is Abeokuta, and the Yorubas of Ibadan have somewhat interfered with the prosperity of Lagos; but as formerly it was the port for the slave trade, so it is now the emporium for all the legitimate traffic, which consists of the export of the native products from the interior, and the import of manufactured goods from Europe.

It was a liberated slave, Bishop Crowther himself, who pointed out to the chiefs of the interior that the benni seeds, palm kernels, ground nuts, palm oil, shea butter, and other products so little prized by them would be highly prized by the English manufacturers. Efforts were also made to establish the cultivation of cotton, with some success; and what are the results now?

The following returns show the value of the imports, with the revenue and expenditure of Lagos, for the years 1867, 1868, and 1869:—

	Imports. £. s. d.		Exports. £. s. d.
1867....	321,977 19 10	..	513,157 18 3
1868....	340,815 6 10	..	517,253 17 11
1869....	416,869 3 8	..	669,445 0 7
	1,079,662 10 4		1,699,856 16 9

	Revenue. £. s. d.		Expenditure. £.
1867	29,774 13 11	..	30,195
1868	33,896 3 9	..	33,711
1869	40,622 11 7	..	39,431

Thus, in three years' time, Lagos has imported European commodities to the amount of £1,079,662, and has exported African produce to the value of £1,699,856; and the revenue of the settlement has more than balanced the expenditure.

The principal articles of African produce thus exported are palm kernels, palm oil, raw cotton, and benni seed; and the following statement contained in the report of the Deputy Collector of Customs, addressed to his excellency Captain Glover, the Administrator, will show the steady increase in the trade of Lagos in the one item of cotton:—

"In the year 1868 the export value of this staple was £51,375 13s. 7d. That of the year 1869 reached £76,956 17s. 4d. I must here state that in 1869 the price of this article of commerce had considerably fallen as compared with that of 1868. This will at once show that a very much larger quantity was exported during the year 1869."

I have also said that the difficulties which Sir G. Campbell points out in the way of England's aiding Egypt to develop Central Africa do not arise when we take Zanzibar as the channel of help. Zanzibar has no debt, though a poor State, and we start in a peculiar relation to it, first from its quasi-connection with our Indian empire, and secondly from the close and peculiar contact which our action in regard to the abolition of the slave trade has placed us in.

In addition to all that has been at our request conceded by the Sultan of Zanzibar, he has quite recently entered into a treaty with us for the abolition of the land traffic; nay, he has commenced the abolition of slavery itself in part of his dominions. He has shown himself to be personally quite alive to the importance of all these movements. But what is really wanting is the power to enforce his own decrees. On the main-land over even the Arabs, and with some Coast tribes, his power is nominal, and the poverty of his exchequer is the bar to his putting his decrees into force. To effectuate his concession as to the land traffic he needs assistance. This England can give. She may fairly, as far as political reasons go, give the aid, and the aid needed is just the aid that would help the effort to introduce civilisation, and lead to the utilisation of Central Africa. The great want, the pressing need, is a safe and practicable road to the interior.

The present rude method of transport, the dangers and impediments on the route, render travelling to the interior both dangerous and expensive. The means of conveyance, as a rule, are porters; each carries a load of 70 lbs.; a guard is needed, and the caravan must carry the cumbrous clothes, or wine, or beads, needed to procure provision by the way. The paths are mere tracks through the jungle or forest, and added to all these difficulties are the desertion and insubordination of the porters, or the hostility or avarice of the petty tribes who command the route.

Imagine, in place of all this, a good safe road in existence, with the possibility of using vehicles upon it, stations at intervals, garrisoned by native police forces, gradually becoming small centres for trade and cultivation. How rapidly would the markets of the interior open up, and how steady would be the flow of commerce along such a road. Further, let the road stretching for 400 miles from Bagamoyo to Unanyembe, be patrolled by the police force, with authority to stop every slave gang attempting to pass. If the slaves were received into settlements along the road, they would soon support themselves, and bring waste land into cultivation, running up a line of villages along the course of the road. The Sultan might also be assisted in establishing friendly relations with the interior tribes, and with Kings Mtesa and Rumancha.

To carry out such a plan as that suggested would involve probably something more than a mere subsidy to the Sultan of Zanzibar. Possibly a limited protectorate might be necessary, but we venture to think the details and carrying out of such a plan might well be managed by our Indian Government, of which for a time Zanzibar might be a dependency.

There is nothing in the enterprise now suggested half so formidable as the almost insuperable obstacles encountered by Baker and Gordon. The real difficulty lies in the fact that without foreign aid the Sultan of Zanzibar cannot undertake the task. He has, however, fairly challenged this country. He has explained to us fully his powerlessness to deal with the slave trade. In compliance with our urgent requests, he has done all in his power, and now it rests with this country to offer him such aid as will effectuate decrees and proclamations which are of no force outside the Island of Zanzibar. I would also suggest that aid might be given to establish a fortnightly mail communication with Zanzibar, without the present very inconvenient break at Aden, and also a coast service. By such intervention and aid England will at once remove the principal barrier to the civilisation and utilisation of Central Africa, and throw open the door for the introduction of that enterprise and industry which is necessary for the development of Central Africa.

In conclusion, I desire to draw attention to the pioneer efforts that are now being made for the welfare of Central and Eastern Africa, as an additional argument in favour of operating through Zanzibar. In a little time, if all goes well, the great inland chain of lakes will be occupied from north to south. No less than five distinct missions are advancing from the East to take

possession of the ground. To the south, three missions, two from Scotland, in memory of Livingstone, and one, the Universities mission with a trading party, are establishing themselves on Lake Nyassa, with a total I am told, of 30 Europeans, the whole expedition well provided and rejoicing in comparatively easy access by the Zambesi and Shire rivers to the lake.

A second mission, under the auspices of the London Missionary Society, is about to be organised for Lake Tanganyika. It is not impossible that a similar expedition may ultimately advance from the west, under the Baptist Missionary Society, The Church Missionary Society has already despatched a strong party of nine English and Scotch agents, whose destination are the kingdoms of Karagan and Uganda. This last expedition is fully equipped, not only to establish permanent settlements but to introduce among the natives such teaching, both religious and industrial, as will elevate their character and serve to stimulate and develop the industries and manufactures of the countries. A powerful steam launch of light draught, will, as I read these lines, be about to ascend the River Wami, in the hope of utilising that river up to the slopes of the Eastern Ghauts, where a permanent station is to be formed. Efforts will also be made to open up communications from Mombasa by the Arab traders with the Lake Victoria Nyanza across the Highlands of Chagga.

Meanwhile at Mombassa the same society has formed a large settlement, where at this moment 350 liberated slaves, once the victims of the East African slave trade, are maintained and taught, in the hope that among them may hereafter be found artisans, teachers, and Evangelists, who may assist in the civilisation and development of Central Africa.

DISCUSSION.

Col. Grant said he had listened with great pleasure to the admirable paper, and spoke of his journey with Capt. Speke. That route was perfectly safe for travellers, provided they acted like gentlemen. Further north it would be more difficult, as the races were troublesome and extortionate. The country was there divided into districts, and before you could get through one you had to pay the greater part of what you possessed. The country further on was very hilly and suitable for a mission station. There were beautiful undulations and vales, and the country was rich in cattle. As to the capabilities of the people for civilisation they showed great intelligence. Though none of them could read or write or knew anything of language, they all possessed some notion of what was right and what was wrong, and were as capable of education as any race he ever met. As to the best means of getting into the interior, he thought the Egyptians stood in the way very much. He did not care what became of them, but they must be got rid of, so as to open up a means of communication. Then Central Africa could be communicated with by water the whole way. As long as they exist, no man would ever pass through them, for they resisted any attempt to pass through the country from the north. He thought a very good plan for communication with the interior would be the establishing of posts along the route from the eastern coast at Zanzibar, say at from 50 to 60 miles apart, and also the effecting of telegraphic communication from Mombasa right across to Mtesa's country. The great difficulty in the way of the civilisation of Africa was tho slave trade. That must be put down. It was absolutely necessary, and he thought a man of war cruising along the coast would bo the most effectual means.

The Rev. Mr. Johnson (an African) said it gave him great pleasure to be present and hear the instructive lecture of Mr. Hutchinson. But what pleased him most was the determination to put down the slave trade. That was the curse of his country. Africa would never progress so long as the slave trade was allowed to continue, and the people of England seemed determined to put their foot upon it, and to kill it altogether. As an African he knew the possibilities of his race. If slavery were put down altogether Africa would rise. He believed that the grand results which were taking place in the West Coast would also take place in the East, and in Central Africa, and Christianity would soon bring to the dark continent all the blessings which the people could enjoy. He thanked the English people in the name of Africa for all they had done, and he prayed they would not be weary in well-doing, for in due season they would reap, if they fainted not.

Sir Fowell Buxton said he had felt great and deep interest in the suppression of the slave trade, and in the very great and marvellous prospects which were opening up in reference to the interior of that great country. A vast mass of information had been brought before them regarding the condition and state of the tribes of Central Africa, and he could not help inquiring why was there this sudden change from ignorance? A few years ago all was blank, and the map of Africa was marked as a great desert across which no man had trodden. Now all was changed, and they had a vast amount of information as to the country and the habits of the peeple. What the result of all this was to be he knew not. Some people had even expressed the hope that the Sahara would be converted into a sea with thriving sea ports along its coast and commerce carried on by the people. But the question was, How was this great continent to be governed? All the waste places of the earth had been governed from Europe, and he supposed this would be also. The reader of the paper was looking forward to the day when England would have a hand in the government of this vast country. It might be so, and he heartily hoped when we did undertake it, it would be for the good of the people, and the suppression of the accursed traffic in slaves. He was rejoiced to hear of the missionary settlements which were to be formed, and by which Africa would learn about us, for he felt that the intercommunication must be of great advantage to that people.

Mr. Stewart, M.P., was deeply interested in this great question of the suppression of the slave trade, as he had taken part in the recent debate in the House of Commons. This nefarious traffic had been stopped along the sea line, but the stream which came northward was not all stopped. He hoped, however, good fruit would be borne as the result of the communication they had had from the Sultan of Zanzibar. He thought one great means for the suppression of the slave trade would be the establishing of a settlement or colony upon the coast, from which point trade should be carried into the interior. At a recent meeting a gentleman had offered a sum of £10,000, in order to set on foot some enterprise of that sort, and he had had various communications from persons most anxious to see something of the kind established. The question was also being viewed from a higher point. People saw the necessity of Christianising first and civilising afterwards, and he was delighted to know that the Scotch had sent out missionaries. They ought to do all in their power to assist missionary societies, and carry on scientific explorations and develop traffic in Africa.

Vice-Admiral Erasmus Ommanney C.B., F.R.S., was very glad to hear such prominence given to Zanzibar. There could be no doubt that it must be the only base of operations for communication with Central Africa,

and to talk of Egypt in comparison with it was to talk nonsense. There could not possibly be a better station. A friend of his had suggested that the island should be bought. Years ago it might have been for a couple of hundred thousand pounds, but he did not think it could be now. It must not, however, be forgotten that however much the Sultan of Zanzibar might be disposed to help us in our great work of extending the benefits of commerce and civilisation to Central Africa, he was a Mohammedan and could not get over his prejudices. It was said that the slave trade was as much carried on now as ever, and that, in fact, it had been increasing of late years, and he sincerely hoped the Government would put a stop to it. To accomplish any good it was not only necessary that the missionaries should work amongst the people, but commerce must be extended. The two things must go hand in hand to accomplish any good. The missionary could do little good unless he encouraged industry and trade. These two things were inseparable; the one alone would not succeed without the other.

Mr. C. E. Mast thought it was correct to put missionaries first as pioneers, and civilisation and commerce second. But there was a third factor that must be taken into account. The Romans, wherever they went carried civilisation with them. They made roads. The English did the same, and made their roads and canals, and if we wished to civilise Central Africa we must also make such communications. He could imagine the time when a railroad would cross to the Lakes from the coast, and then the blessings of commerce and civilisation would spring up all along the route. But the question was how they were to go about practically to work it. He thought the best way to get to Central Africa was to cut a road right through to the Lakes. England, whether it was done by a company or by the Government, must acquire land, and as soon as they had planted a footing there civilisation would follow. A railway had recently been made in Caffraria, and he did not see why there should not be one penetrating into the very interior. Until the railway whistle was heard in the very heart of the Continent he feared the slave trade would exist, but no longer.

Dr. Badger was much interested with the paper. The sum total amounted to this, that in the centre of Africa there was a very fine country, which was open to agriculture, to civilisation, and to commerce; and the question was how to get to it? When people talked of Egypt as the way, they must have a bee in their bonnet. He could, however, sympathise with Col. Grant in his view about Egypt. It was the intolerable Government of Egypt which was the cause of all the mischief. The way to Central Africa, or at all events to the Lake District, must be from the East Coast. It was a very rich country, and there was not the least doubt that if English enterprise and English money were brought to bear on the question, the greatest results would follow. He was glad to hear that so many mission stations were about to be formed. That augured well for the country. The first settlement made in New Zealand, he believed, was made by the missionaries. Commerce followed. He quite agreed with the last speaker that, make a road in the centre of Africa, and they would soon dispose of the slave trade. He had been very glad to hear a letter of the Sultan of Zanzibar alluded to by Mr. Hutchinson. He had received a despatch in Arabic and English from the Sultan, in which he said he had been asked to declare the abolition of the slave trade as far as Mombasa, and he had done all he could to that end, and here was the proclamation that he had issued. And they must not forget that it was a very great thing for a Moslem sovereign to do that. He was, however, ably helped by Dr. Kirk, for whom the Sultan had the highest respect. But the question was whether the proclamation would be obeyed. At all events the Sultan had done all he could; and it should ever be remembered he had given up that which had formerly yielded him an annual income of from twelve to twenty thousand pounds. He had come over to England, and gone back almost an Englishman in spirit. In his letter to him the Sultan said that he had done all he could; but had added, "you know we are obliged to be very cautious in our language, or else we should create disturbances among the people." In fact, unless he has British support, not only would his life, but the life of Dr. Kirk himself be in danger.

The Chairman proposed a vote of thanks to Mr. Hutchinson for his most able and interesting paper. With regard to the settlement of Africa, there were some points to which great prominence had been given, but one fact which the experience of the last 300 or 400 years had established had not had sufficient prominence given to it, and that was that Europeans could not live in the tropical regions of Africa. The lecturer might have enlarged upon the frightful mortality which existed in some parts. It was demonstrable that no European could enjoy health in those regions. Therefore, if ever Africa was to be occupied by European races, it must be in the interior. Of course, there were regions in Africa, the climate of which was perfectly compatible with health and vigour; but they would all agree how futile it was to suppose that it could ever be peopled by Europeans, as was proved by the insuperable difficulties met with by Col. Gordon. With reference to the influence of missionary labour and commerce, there could be but one opinion, that the two ought to go on *pari passu*, and he hoped that the missionaries would not interfere with each other, but each keep to his own station. Mischief had resulted sometimes from the spirit of rivalry and jealousy which occasionally existed between them, and they had destroyed the value of each other other's work.

Mr. Hutchinson briefly replied, and said he was glad that the various speakers so entirely concurred with him. Missionary enterprise ought to combine not only teaching and training in higher things, but such industries and knowledge of trades as would be useful to the people, amongst whom they laboured. The Church Missionary Society had anticipated such a need by sending out practical men who had surveyed the river, and found how far it was available for traffic, and he had no doubt that it would be made available, and that roads would be constructed. They had in this last instance sent out one ordained minister and eight artisans of a high class, and an engineer had also been engaged taking the levels.

A vote of thanks to the Chairman, proposed by **Admiral Ommanney**, closed the proceedings.

HEALTH AND SEWAGE OF TOWNS.*

The following paper came to hand too late to be presented to the Conference:—

SEWAGE TREATMENT AT CHELTENHAM.

By D. J. Humphris, Borough Surveyor.

Cheltenham, certainly, can scarcely be said to have been backward in availing itself of the important aid afforded, by the Public Health Act of 1848, to local authorities for carrying out important public works of a sanitary nature. Early in the following year (1849) in response to a petition from certain inhabitants, an official inquiry before one of the inspectors of the General Board of Health was instituted in reference to its sanitary condition as to its sewage, water supply, and other matters of a like nature. And in the year 1852, a Local Act of Parliament was passed embodying

* The report of the discussion will be continued in subsequent numbers of the *Journal*. For the convenience of those wishing to have the account of the proceedings in a more compact form, the same will also be published as a pamphlet, which can be had in a few days on application at the Society's House. Price 2s. 6d.

with the general powers of the Public Health Act, many clauses and provisions of a special character, which were called for by the position and circumstances of the town.

Prior to this period cesspools were in use, and these, sunk in the sandy soil on which the houses were erected, greatly contaminated the source of water supply which was derived from the soil beneath. To a partial extent, however, sewers existed, but these had been formed without any general or comprehensive plan, and they were made to discharge into the nearest or most accessible stream adjacent to the locality. The results of such a state of things need hardly be described.

The powers of the new special Act were not allowed long to be in abeyance. First of all, three main intercepting sewers were formed along the line of the streams which serve naturally for the drainage of the water-shed, thus allowing of the purification of these streams by the diversion of the sewage therefrom. And as soon as practicable, an extensive and complete system of branch sewers was carried out throughout the town, and, further, a general system of house drainage into them was made compulsory. The immediate cost consequent upon carrying out the public works comprised in this scheme was about £34,000, including the purchase of some existing works belonging to the Sewers Company which had previously existed; and thus, upwards of 25 miles length of sewers were at once constructed or acquired by the Board of Commissioners. It formed a part of the scheme to convey the whole of the sewage of the district into two sets of tanks, situated below the town, and through these the fluid passed off into the streams, the solids being arrested by filtration through gravel, and a certain amount of purification being attained by the application of lime before the discharge of the sewage at its outlet. The carrying out of these extensive works had an obvious and marked beneficial influence upon the health and general sanitary condition of the town; but although the streams in their passage through the district were purified and greatly benefited, the discharge of the sewage of some 40,000 inhabitants at only two points into streams of comparatively very small flow under ordinary circumstances, gave rise to serious complaints from residents and owners of property adjacent to the brooks; and thus the troubles of the local authorities began, and as early as 1863 these complaints assumed a threatening aspect. There was, however, every disposition on the part of the Board to do all in its power to prevent injury to the adjacent district, and no litigation has ever taken place here upon this subject. In the first place, chemical treatment of the sewage at the tanks was resorted to; and under the advice of Sir Joseph Bazalgette, perchloride of iron was used as a precipitate, instead of lime as previously used. The system known as "Bird's process," was also tried, but the result was not in either case satisfactory; and it is only just to Sir Joseph Bazalgette to state that from the first time that he was consulted by me upon the subject, he recommended the application of the fluid sewage to the land. And to this object I have ever since uniformly given my attention, and striven to carry it out.

Cheltenham had at the census of 1871 a population of 41,923, and with the adjacent parishes of Charlton Kings, Leckhampton, and part of Prestbury, which are at a somewhat higher level, and drain through Cheltenham, the population of the entire district draining into the one system of of sewers cannot be far short of 50,000. The general altitude of the town is from 200 to 250 feet above the Ordnance Datum; and there is a gentle and gradual fall in the surface of the land below the town, which forms a most extensive vale towards the Severn, into which the smaller streams referred to fall. I was thus led to turn these circumstances to account, and by making certain alterations in the construction of the tanks, and reducing the fall in the outlet sewer, which at these points was somewhat excessive, I was enabled to bring the fluid sewage to the surface of land not far distant, instead of discharging it into the stream in a polluted state. This experiment, which with the friendly aid of certain proprietors of the adjacent land, I was enabled to effect, afforded the clearest proof that the plan was practicable, and that it only needed extension to render it effectual. And it may be well to state what has since been done, and to describe as concisely as may be, how the sewage of the locality generally has been dealt with.

The practical result then has been that the Board, about 1868, formally adopted the principle of irrigation, and having negotiated for the purchase of land suitable for the purpose, they approved of the terms of purchase of an estate of 131 acres, situated at Haydon, in the parish of Boddington, at the rate of £80 an acre, including some cottages, and the timber thereon. This land being without the district of the local authority, the Board could not well have availed themselves of it, but for the assistance of the Sewage Utilisation Act of 1867; and the necessary public notices having been given as required by the Act, an official inquiry was held before Robert Rawlinson, Esq., C.B., who having entered into the matter in the fullest and most painstaking manner, recommended the sanction of the scheme by the central authority. This involved the raising by loan (to be repaid in 30 years) the sum of £18,000, and the scheme comprised the purchase of the land already referred to, and the formation of about 9,000 yards (or upwards of five miles) of outfall sewers, as well as adapting the land for the purpose of utilising the fluid sewage thereon. And the Secretary of State made it a requirement that a supply of pure water should be secured to the inhabitants of the hamlet adjacent to the sewage farm, one of the objections to the scheme having been that the existing supply derived from the ponds and watercourses around would be injuriously affected. This the Commissioners were enabled to effect by utilising a spring arising on land near the farm, to which arrangement Lord Hatherley (to whose family the land belongs) assented, and the engagement has been carried out.

The sewage of the town having been conveyed to the tanks has the solids carefully intercepted and removed, so as to allow only the liquid portion to flow off. There is a fall of upwards of five feet between the inlet sewer into the tanks and the point where the outfall sewer to the land leaves them; and thus this head of water is made available,

with a flow per diem of upwards of a million gallons, to work a turbine which gives the motive power to a chain pump, by means of which the thick portion of the sewage is raised and mixed with ashes in the tank yard; this compost is readily sold to farmers and others for agricultural use, at the rate of 2s per cubic yard. The tanks are in duplicate, and they are regularly emptied alternately twice a week, thereby preventing any solid matter being conveyed through the outfall sewers and creating a nuisance upon the land.

The outfall sewers are laid with great care and regularity, and have an average inclination of about 8 feet in a mile, which is found to answer extremely satisfactorily. The natural fall in the streams which drain the district is greatly in excess of this rate, but by reducing the rate of fall in the outlet sewers it allowed of the sewage entering the land purchased at a comparatively high elevation; and as the land is undulating and has a good fall to the streams contiguous, great assistance is afforded to the means of dealing with the fluid sewage thereon. The tanks are on the west and south side of the town, but from both of them the outfall sewers are made to contour around the slopes which intervene between the two water-sheds, and they both arrive on the land at nearly the same point, thus allowing the distribution of the fluid sewage to be under the same control. It must be remarked, too, that the outfall sewers are in their course made available for other land through or adjacent to which they are laid, and thus an income is derived, as a charge of about 7s. per acre is made for each of such applications of the sewage, which is used on upwards of 200 acres of land, besides the farm purchased.

The land belonging to the Board was nearly all old pasture when purchased, and only a limited portion has since been broken up, on which Italian rye grass has been cultivated. The pasturage is still used, but great care is taken to secure the intermittent and not too frequent application of the sewage, and to prevent its becoming stagnant and causing nuisance.

The land is a tolerably stiff clay, but a good deal of subsoil drainage has been done, and also a good deal of expense incurred in the construction of distributing drains, whereby the objectionable open carriers are to a great extent avoided, and efficient means afforded for carrying the fluid sewage from one portion of the farm to another without observation and without annoyance in those portions not at the time under irrigation. The filtration of drains has also been carried out to some extent with success, and it seems desirable that the the sewage through a porous medium into the system should be extended.

The Board does not undertake the risk and responsibility of farming operations, but for the last six years the land has been let, usually in suitable lots, to the occupiers of farms or land adjacent, and there has been always a fair competition for it. The rent paid includes rates and taxes. It also includes the man's time in attending to the distribution of the sewage, which is entirely under the control of the surveyor, who is entitled to apply it at just such times and in such quantities as he may think right; a power which is, of course, necessary for the protection of the Board, but needing also to be used with justice and fairness. No charge, however, of the abuse of this power has ever been made.

The general results of the operations of the Board have been extremely satisfactory. The complaints as to the fouling of the streams have been duly removed. A fair effluent has been obtained. No charge for nuisance or injury to health arising from the operations described has ever been substantiated; and in regard to the financial view of the case, the various details as to cost and other particulars, as here given, will show how light the burden upon the ratepayers has been; and although the extension of the sewage area, so as to embrace other parishes with which arrangements have been entered into, may render it the duty of the Board to acquire additional land, or to execute extended works of filtration in connection with what at present exist, they have no reason to regret their decision in affirming the principle of irrigation to be the mode specially adapted to the circumstances and requirements of the district over which, as the sanitary authority, they have the responsibility and the control.

SEWAGE FARM.—BALANCE-SHEET.

1871.

Receipts.	£	s.	d.	Payments.	£	s.	d.
Rents	899	12	0	Wages, tradesmen's bills, and other expenses	286	2	11
Fluid sewage	75	10	0	Rates and taxes	26	19	8
Deficiency	134	15	0	Interest on loan	796	14	5
	£1,109	17	0		£1,109	17	0

1872.

Receipts.	£	s.	d.	Payments.	£	s.	d.
Rents	868	15	10	Wages, tradesmen's bills, and other expenses	280	15	5
Fluid sewage	142	0	0	Rates and taxes	27	14	10
Deficiency	80	11	5	Interest on loan	782	17	0
	£1,091	7	3		£1,091	7	

1873.

Receipts.	£	s.	d.	Payments.	£	s.	d.
Rents, &c.	936	19	6	Wages, tradesmen's bills, and other expenses	286	7	
Fluid sewage	131	10	0	Rates and taxes	52	2	
Deficiency	38	7	5	Interest on loan	768	7	
	£1,106	16	11		£1,106	16	11

1874.

	£	s.	d.		£	s.	d.
Rents, &c.	848	14	9	Wages, tradesmen's bills, and other expenses	253	3	4
Fluid sewage	86	12	6	Rates and taxes	47	4	0
Deficiency	118	4	1	Interest on loan	753	4	0
	£1,053	11	4		£1,053	11	4

1875.

	£	s.	d.		£	s.	d.
Rents, &c.	890	8	5	Wages, tradesmen's bills, and other expenses	396	5	4
Fluid sewage	145	18	0	Rates and taxes	31	4	9
Deficiency	128	11	0	Interest on loan	737	7	4
	£1,164	17	5		£1,164	17	5

Sewage Tanks.

	Working Expenses.			Receipts for Manure.			Overplus.		
	£	s.	d.	£	s.	d.	£	s.	d.
1871	293	13	0	333	1	0	39	8	0
1872	279	10	0	390	1	0	110	11	0
1873	237	9	8	293	7	4	55	17	8
1874	310	10	9	315	8	0	4	17	3
1875	294	0	0	347	5	0	53	5	0
							5)263	18	11
Yearly average overplus ..							52	15	9

This account does not embrace the ashes delivered at the tanks for mixing with the manure, the estimated value of which is about £150.

The discussion on the first day of the sitting of the Conference (May 9) dealt with water-carried sewage, under the heads of Sewage Farms and the Treatment of Sewage by Subsidence. After the introductory remarks, given in the *Journal* for May 12, p. 609, the Chairman (the Right Hon. JAMES STANSFELD, M.P.) called upon the representatives of the towns from whence returns had been received in their alphabetical order.

The first town that responded to the call was:—

CHELTENHAM.

Mr. Humphris (Borough Surveyor of Cheltenham) said he need not go into the details as to the general drainage of the town, further than to state that some years ago a general system of branch sewerage and house drainage had been carried out. The streams into which the sewage was formerly conducted were purified by means of large intercepting sewers, and the whole sewage was conveyed to large tanks where it was filtered. For a considerable period they had adopted the lime process, and subsequently, under the advice of Sir Joseph Bazalgette, perchloride of iron. That gentleman, however, did not recommend it as a permanent scheme, but expressed a hope that irrigation would eventually be resorted to. That was ten or twelve years ago, and they took great pains to carry out the idea by making arrangements with the landlords below the district for land upon which to put the sewage. The locality was particularly well adapted for such a purpose, and after a time they had an offer of 130 acres of land at a reasonable rate, and, under the advice of the Secretary of State, they were able to carry out a tolerably complete irrigation scheme. Tanks were arranged, and the only treatment applied to the sewage was to effectually cause the subsidence of the solid portion by straining the fluid matter, so as to insure the sewage being conveyed to the land as free as possible from the grosser particles. They had to construct several miles of sewers in order for the sewage to pass on to the farm, but the Act of 1867 gave great facilities for that purpose. The works had been inspected by Mr. Rawlinson, and notwithstanding the opposition of some residents in the neighbourhood, the scheme was carried out, and had now been at work for about seven years with great success. There was an average fall of 8 feet per mile on the outfall sewers, and they could command a large space of land on which to utilise the sewage, another important feature being that adjacent occupiers were willing at times to take the sewage and pay for its application. The expenditure on the works was about £18,000, including the purchase of land, and since the scheme had been carried out no complaints had been substantiated against their proceedings, though one or two charges had been made which on inquiry had been found to end in nothing. The scheme was devised with a view to avoiding very heavy expense to the town, but although economy had been studied, it practical result had been efficient and satisfactory. The exact figures he would hand in.* In connection with the tanks, as there was a fall of several feet between the inlet and outlet sewers, he had been able to utilise the stream of fluid sewage, amounting to between one and two million gallons daily, to work a turbine which sets in motion a chain pump, whereby the more solid portion of the sewage is raised and removed twice a week, thus avoiding the expense of steam or other power. The solid matter is mixed with town ashes and sold at two shillings per yard cube. There is always competition in the demand for the sewage. With regard to the health of the district, Dr. Wright, the Medical Officer of Health, would be better able to speak.

Dr. Wright (Medical Officer of Health for Cheltenham) said the district of Cheltenham was very favourably situated, the town being 200 feet above the River Severn. The soil was a retentive, lower lias clay, which was not perhaps the best suited for irrigation, but, being judiciously managed, it had hitherto done very well. He had known the place for nearly 40 years, and, comparing its former state with what it was now, he could trace a wonderful improvement. A sewage farm would occasionally give rise to insufferable odours, but the land was chiefly under grass, that being found the most convenient way of applying the sewage. Perhaps if they had more arable land they might be able to dispose of it better, but there really was no serious objection, and the health of the district was as good as could be found anywhere. One resident proprietor, an inveterate opponent of the scheme, had raised many difficulties, and had memorialised the rural sanitary authorities for Tewkesbury upon the subject, so that he

* See Mr. Humphris' paper, *ante*, p. 704.

(Dr. Wright) had been obliged to make a detailed examination of the district to meet this gentleman's allegations. It had been asserted that cases of typhus fever had been occasioned by drinking sewage water, but he had gone carefully into the matter, and traced all the deaths for several years in the district in which this was said to have occurred, and found that nothing of the sort had taken place. The death-rate of Cheltenham was 17·2 per thousand. Last year it was 19·2, in consequence of severe attacks of bronchitis in the spring, but the average for ten years was 18.

Mr. Edwin Chadwick, C.B., asked if the house drainage and sewerage was complete and self-cleansing?

Mr. Humphris said it was made compulsory; it was general and efficient.

Dr. Wright said there was a constant inspection of the sewers, which were very efficient; in fact, Cheltenham, he believed, was the only town in the kingdom which had a sewers company, and some years ago very capital sewers had been constructed. They had recently taken in the urban sanitary district of Leckhampton, with a population of 3,400, and they were now taking in another, Charlton Kings, with 3,700.

Mr. Woodward (Mayor of Worcester) said he knew the gentleman who farmed the sewage land at Cheltenham, and had made a few inquiries of him as to results, the answers to which were as follows:—Liquid sewage was by far the most effectual for application to land; he did not know what was the best mode of disposing of the solid matter, but liquid sewage was more suitable for grass land, although it might be used on tillage where the subsoil was very porous. Rye grass was the most profitable crop. The result of his experience was very favourable, not only in quantity, but also in quality for grazing, though the quality was not so good for hay. There was no danger to the cattle from the use of sewage produce, but on the contrary, colts matured more rapidly, and cattle did better, and milked better than on other land. The quality of the milk has been most excellent. The grass was rather too rich for young sheep, except in dry weather. The best mode of disposing of sewage was to put it on the land, the only point being to take care that there was plenty of land, so that the land should be in excess of the sewage, and not the sewage in excess of the land.

Mr. Edwin Chadwick asked if any annoyance was found from sewer gases?

Mr. Humphris said no; there were openings in the streets for ventilation, and also pipes at intervals. The system had not been carried out as fully in some places as it might be, but they had found no evil results from sewer gases. As he had before mentioned, they were specially favoured with a good fall, so that the sewers never became choked by floods.

The Chairman said the returns from the Cheltenham district were not so complete as might be wished, as was the case from some other places; he had no doubt Mr. Humphris would do his best to supply any deficiencies.

Mr. Humphris said he would make the information as complete as possible.

The Chairman said it was desirable in the case of every town, the system of which was discussed, that some one should either furnish them at once with full and reliable information for future reference, or would complete it and send it in. He understood that the quantity of land irrigated at Cheltenham was 130 acres.

Mr. Humphris—Yes; but in addition there were upwards of 200 acres of adjoining land to which the sewage was applied occasionally, and for this the occupiers paid at the rate of 7s. per acre for each application.

The Chairman—The irrigation is practised with the effluent water after the subsidence of the solid matter?

Mr. Humphris—Yes. In answer to a further question, he said the population was 42,000, but they were now taking in the two adjoining parishes which would bring it up to 45,000 or 50,000.

The Chairman asked if the sludge mixed with ashes was stored in large quantities, or was it readily disposed of?

Mr. Humphris said it was stored in moderately large quantities, but they had never had an accumulation; it was readily got rid of.

The Hon. Dudley Fortescue asked whether the irrigation was continued all the year, including wet and frosty weather?

Mr. Humphris replied in the affirmative. In reply to another question, he said the figures published of 1,600 water-closets were far below the mark; he did not know how that number was arrived at. The closet system was universal, although the water supply was not as plentiful as could be wished.

The Chairman inquired if the figures handed in showed the profit and loss on the sale of the sludge?

Mr. Humphris said they did. The receipts had exceeded the working expenses during the last five years by £52 15s. 9d. per annum, but that did not include the value of the ashes. If that were taken into account, it would probably involve an outlay of about £100 a year for the sludge. That was distinct from the working of the farm. Last year the total expenditure on the farm was £1,167, and the receipts in the shape of rent, £890, and for the application of fluid sewage, £145, showing a deficiency of £132, which was about a fair average. This did not amount to a halfpenny in the pound on the rating of the town.

Dr. Wright, in reply to another question, said there was no typhoid fever or diphtheria in Cheltenham at present, and at all times they were extremely rare.

Mr. Watney asked how often the farmers of the adjoining land applied for sewage, and whether they did so at all times of the year, or only during the summer and autumn months?

Mr. Humphris said some of them once a year, some twice, and some three times; they generally preferred having it in the drier part of the year, not in the winter months. They had had applications in the winter months, though not to the same extent.

Mr Papillon (Mayor of Colchester) asked what the sludge was used for?

Mr. Humphris replied for arable land, which being a stiff clay, the mechanical action of the ashes was very favourable to it; if, however, they were finely screened, it made a very good dressing for grass land.

Mr. J. Stokes (Mayor of Dudley) asked if the whole of the rain water passed into the sewers, or, if only partially, how it was separated?

Mr. Humphris said there was no duplicate system of drainage. He had used every effort to separate the storm water as effectually as possible, but what fell on the curtilage of premises would always go with the sewage, and many of the streets were too far distant from the streams to allow the surplus water to flow into them.

The Chairman asked how they got rid of any possible surplus of effluent water?

Mr. Humphris said they had not found any difficulty, though it would be more convenient if they had a larger area of land, and they were trying to obtain some more for the purpose. He had also recommended the adoption of the filtration system in combination, and had carried that out on the land they had, as effectually as he could.

Dr. Gill (Liverpool) asked if there had been any particular complaints made after the liquid sewage was put on the land?

Mr. Humphris said the complaints had never been substantiated, and there was only one landowner who had opposed the scheme from the first, and wished another to be adopted. Another large landowner, who lived very near, and who had experienced great annoyance from the former state of things, was perfectly satisfied with what had been done.

Mr. Sharman (Town Surveyor, Wellingborough) asked how far apart the street gratings for ventilation were placed, and whether any charcoal traps were used; also whether any smell arose from the drains?

Mr. Humphris said there was no systematic ventilation, at any regular distances. He had tried charcoal, but did not find it necessary, because there was no nuisance arising from the free ventilation of the sewers.

Mr. Chadwick understood the sewage was delivered on to the land fresh, and not in a putrescent state.

Mr. Humphris said that was so; there was no deposit.

Mr. Chadwick remarked that there being no deposit they had not probably found it necessary to go into any elaborate system of traps for ventilation.

Mr. Humphris said they always insured as much as possible there should be efficient traps in houses.

Lieut.-Colonel Jones, V.C. (Wrexham), asked if the street surface drainage was connected with the sewers?

Mr. Humphris replied in the affirmative, though there were streams which served as drainage to the watershed, and the surface water was carried into them as much as possible.

Colonel Jones said he supposed there were storm water overflows.

Mr. Humphris—Yes.

Colonel Jones asked if the water at the time of storms did not fill the drains?

Mr. Humphris said no; the overflow never acted except in case of very heavy floods, arising from a thaw after snow, or a thunder storm.

Mr. H. J. Yeld, M.D. (Medical Officer for Sunderland), asked if they had entire control over the house drains, and whether they insisted on the water-closets being ventilated?

Mr. Humphris replied there was a bye-law requiring all closets to be ventilated, but the new bye-laws had not been long sanctioned, and he could not say they were carried out yet to their full extent.

Mr. Sharman asked what was the fall of the sewers?

Mr. Humphris said the gradient of the outfall was eight feet in a mile. The drains in the town would be some of them 1 in 50, some 1 in 100, and some 1 in 300, but that would only be in the case of a main drain where the stream was constant, and with that incline it was always free.

Mr. T. Eyton Jones, M.D. (Mayor of Wrexham), asked if any analysis had been made of the effluent water as it passed off the farm?

Mr. Humphris said the River Pollution Commission had taken samples and made analyses, but he was not prepared to state the results.

Mr. Coghlan (Borough Surveyor for Sheffield) asked what were the difficulties that were experienced in the disposal of the solid matter?

Mr. Humphris said they never had any difficulty.

Mr. Councillor Walker (Leeds) inquired of what material the sewers were constructed, and if there was any system of flushing them; because sewage gas would not arise from liquid sewage, but from its absorption by the materials used in the construction of the drains.

Mr. Humphris said up to 18 inches the drains were formed of glazed pipes; those of larger capacity were brick sewers.

Mr. Payne asked if any other material was used for deodorising the solid matter except ashes?

Mr. Humphris—No.

The Chairman said Cheltenham appeared to be rather an unusually favourable example of the success of the water-carriage system, especially as the authorities had control over the pipes and closets in the houses. The drains seemed to be well constructed, and there was a good fall, besides which, as far as he could ascertain, there was little or no nuisance occasioned to the inhabitants of the neighbourhood. As to the question of cost, this appeared particularly satisfactory, because, apart from the question of construction, which had not been gone into, the expenditure appeared to be altogether about £230 a year, and if at that cost the sewage of a town of 42,000 inhabitants was satisfactorily disposed of, it was a state of things which many other places would be very glad to follow, if they could.

Croydon.

(**Mr. Stansfeld** being here obliged to leave, the chair was taken by **Lord Alfred S. Churchill**, Chairman of the Council).

Dr. Alfred Carpenter (Croydon) next gave the substance of his paper with regard to the Beddington Sewage Farm.*

* See page 614, *Journal* for May 19.

Mr. Chadwick asked if the sewage delivered on the farm was in a state of putridity, or whether it was distributed fresh?

Dr. Carpenter said in theory it was delivered fresh, but, unfortunately, they had a good many badly constructed sewers, which somewhat interfered with the result, and it was not always so fresh as it should be.

Mr. Chadwick said that would be corrected by the adoption of a new system of self-cleansing sewers.

Mr. Adam Scott asked if any analysis had been made of the subsoil water?

Dr. Carpenter said many analyses of the effluent water had been published, some having been made within the last few months. The water drained into the Wandle, and many people drank it. Subsoil water had also been analysed.

Mr. Walker (Leeds) asked if the sewage was distributed by open drains over the farm, and if so, if there were any deposit in them, so as to become a nuisance?

Dr. Carpenter said the sewage was conveyed in open carriers over the farm, and if the manager did not do his duty, and allowed it to remain there, or if they were not flushed out after each time of using them, undoubtedly a smell would arise, but that was not perceived twenty or thirty yards off.

Mr. Chadwick said there had been lately cases of typhoid in Croydon; what had been the condition of drainage at those points especially?

Dr. Carpenter said that an epidemic of typhoid had arisen last year, which was caused in the first instance by interference with the water supply. The water had been delivered containing typhoid matter. A number of cases of fever occurred in that way. The excreta of the patients found its way into some of the badly-constructed sewers, and the gases thence arising, unfortunately found their way into some of the houses run up by speculative builders, which were not constructed as they ought to be. Wherever typhoid cases were found

there was some defect in the sewer arrangement, by which the gases found their way into the houses, or into the water supply, or both.

The **Chairman** asked where the effluent water from the farm went?

Dr. Carpenter—Into the River Wandle, and thence into the Thames.

Mr. Coghlan said he understood they had had large experience at Croydon of Latham's patent ventilators; he should like to know the result of this experience.

Dr. Carpenter said the sewers were ventilated some years ago on the principle of having openings in the crowns of the sewers, and occasionally they were fitted with Latham's ventilator containing charcoal, but those had all recently been removed, and he had always been of opinion that the freer circulation there was through the sewers the safer it was for people who lived near, and that with a constant current of air there would be no necessity for charcoal; at any rate, unless the sewers were of a character which ought not to exist in any town; and, unfortunately, the Croydon sewers were some of them bad.

Mr. Walker said he supposed typhoid germs lodging in the open carriers would be rendered innocuous by exposure to the air.

Dr. Carpenter said that was so.

Dr. Wilson (Medical Officer of Health for Rochdale) inquired if any cases of typhoid had been traced to the use of the effluent water?

Dr. Carpenter said he was not aware of any such cases, and none certainly had been traced to that cause; at the same time he must not be supposed to advocate the use of effluent water for drinking purposes; for he believed that water from a sewage farm should never be used for drinking.

Mr. Alderman Tatham (Leeds) asked if it was not a fact that trout flourished in the stream below the inlet of the effluent water?

Dr. Carpenter said there was an abundance of trout in the stream.

Dr. Kenyon asked if it was not the case in time of heavy rain, when the stream overflows acted, that a good deal of the effluent water ran into the Wandle without going through the land, and in particular if that had happened during the time of the typhoid epidemic?

Dr. Carpenter said the water could not pass into the Wandle without going over the farm. There might be times, certainly, when heavy rain-falls took place, that some of the ditches near the farm got flooded, but they were supplemental drains, running into the Wandle from other watercourses. The sewage never went into the stream before it had been over the farm.

Mr. Watney asked if that meant going along the carriers, or going over the land?

Dr. Carpenter said by the arrangement of the carriers it was impossible for the water to reach the Wandle without going over the land, except by design. In reply to another question, he said the land was not under-drained at all; it had a gravelly subsoil, and some amount of earthy matter above. Three or four hours after the sewage had been on the land it drained itself entirely. Perhaps there were two or three places of half an acre or so where it did not dry sufficiently, and thence there was subsoil drainage, but these were the only exceptious.

Mr. Towle (Oxford) said their was quite a mountain just outside Croydon of street rubbish, ashes, and the like, which it seemed a difficult matter to dispose of. It struck him this might be made into a filtering bed, and the ashes turned into something which would be very profitable to farmers.

Dr. Carpenter said they were in a difficulty with regard to the ashes and sweepings, for which they had no sale, but if they were to soak them with sewage they would create an enormous nuisance. The straw, cabbage leaves, and matters of that kind were picked out and mixed with the solids from the sewage before it went on the land, and sold at about 2s. 6d. a load, which did not quite cover the cost of making it. With regard to the refuse, they would be very glad to make Mr. Towle a present of it if he would take it away.

Mr. Whitley asked if any delicate test had been applied to the gases ascending from the highest point at Croydon, as they were liberated from the sewers?

Dr. Carpenter could not say that such had been done, nor had they seen the necessity for it.

Mr. Whitley thought, to use the words of the Chairman, that there were insidious gases which it was the imperative duty of the authorities to have tested.

Mr. Arnold (Chichester) asked if a disagreeable smell did not arise from the farm when the atmosphere was heavy, and spread over the surrounding neighbourhood?

Dr. Carpenter had heard of such a thing occurring on two or three occasions, and it was not impossible in certain states of the atmosphere, when the weather was foggy, that there should be a disagreeable odour. At the same time, he had never perceived it himself, though he had been on the farm at all hours of the day and night.

Mr. Chadwick said he believed the method of applying the sewage to the land was that known as submersion.

Dr. Carpenter said it was simply sent by means of carriers over the surface of the land. They had no chemical treatment, but the sewage passed through a kind of colander, called Latham's "extractor," which wss a pretty plaything but not a necessary part of the treatment; it took out the solid matter, and the sewage then passed directly on to the land. There were no subsidence tanks or chemical treatment of any kind.

Mr. Chadwick said they had not heard the comparative death-rate in Croydon previous to and subsequent to the works.

Mr. Arnold said he was just going to ask that question, and whether any estimate had been formed as to the prevalence of typhus and zymotic diseases before and since.

Dr. Carpenter said the mortality for last year was given in the paper at 21·71, that being considerably raised on account of the typhoid epidemic, the ordinary death-rate being 18 since the establishment of the farm. At Norwood it was seldom above 16 or 17; at Beddington it averaged about 14 to 15. Since the sewage had been treated in this way the mortality had diminished materially in Croydon. It used to be 24 and 25, and sometimes 28. Last week there were 47 births and only 6 deaths, but, of course, that was exceptional. Zymotic diseases had been much diminished since the sanitary works were carried out.

Mr. Bolton (Aberdeen) asked if the sewage was put on the land throughout the year?

Dr. Carpenter said it flowed on to the land night and day, the whole year through; the land had to provide for it, and did provide for it.

Mr. Rock (Hastings) asked a question as to the natural subsoil drainage. At Cheltenham the soil appeared not to be porous, whilst at Croydon he understood it was so. Had Dr. Carpenter traced the course of the water that passed through the soil, and could he inform them whether it had any influence on the wells and springs in the neighbourhood?

Dr. Carpenter said there were about three million gallons of sewage going over the farm every day, and in ordinary weather, when the air was very moist, about the same quantity went off, but in **dry seasons**, when

evaporation was going on rapidly, a large portion passed off in that way, whilst a considerable portion was absorbed by the neighbouring ground, which was also giving off moisture by evaporation. When certain fields were being irrigated, the different watercourses in the neighbourhood of the field rose and discharged effluents, which went off indirectly into the Wandle; and in some of the wells attached to cottages upon the farm, in two or three instances, when the fields in the neighbourhood were irrigated, the water rose, and fell when it was taken away, showing that they were affected by the irrigation.

The Chairman asked if there were means of diverting the sewage from one field to another at pleasure?

Dr. Carpenter said yes. The sewage passed on to one portion of the farm, a plot of ten or twenty acres, where it continued to pass on for some hours, and it was then shut off, and passed from that on to another portion. The sewage, therefore, went always twice, and sometimes three times over the land before it finally left it; occasionally, when there was a large amount of storm water, some of it only went over a grass field, which was used for the purpose of purifying it. The whole farm consisted of 460 acres, and there would be perhaps 20, 40, or 50 acres under the sewage at one time. It went from one part to another, according to the arrangements of the manager and the character of the crop, the order being that no sewage should be put on any field on which the crop was nearly ready for harvesting.

The Chairman asked what length of rest was given to the land before the sewage water was again put on it?

Dr. Carpenter said it depended upon the crop; sometimes it was put on every second or third day for a fortnight, and then had a week's rest, after which the crop, supposing it to be rye grass, would be cut, and then would be sewaged again. That would take place three or four years, and then the field would be broken up and planted with roots. During the time it was so used sewage was not applied so frequently, and if cereals were sown not at all.

Mr. Rowley Hill, M.P. (Worcester) asked whether in the case of well-water rising in connection with the irrigation, it had been ascertained whether such water contained organic matter, or whether it appeared to be filtered by passing through the soil?

Dr. Carpenter said repeated analyses had been made of the effluent water, often by persons watching their operations with the intention of taking proceedings against them if the opportunity arose, but the results had always been comparatively satisfactory as to the power of the soil to deal with the sewage. It contained rather more organic matter than the water supplied to the inhabitants of London for drinking purposes, sometimes twice as much. He should not like to have it thought for a moment that he should advise anyone ever to drink effluent water from a sewage farm, because it was possible mischief might arise. Mischievous people often broke down the carriers and other works, and let the sewage run where it ought not to go, in that way it might get into the effluent water.

Mr. Walker said one point ought to be made perfectly clear with regard to the epidemic of typhoid at Croydon. They had heard that the sewage gases passed in an opposite direction to the liquid, and the districts affected thereby would probably be the higher portion of Croydon. That showed, at all events, that typhoid fever might arise from sewage gases, but if it did so in one portion of the sewage system it might do so in another, and he should like it to be made perfectly clear what steps were taken to stop that epidemic.

Dr. Carpenter said the first step was to stop the intermittent water supply*, and the next to ventilate the sewers, remove the deposit which had taken place within them, and flush them well out. The third, which perhaps ought to come first was, that every person who had fever in his house set to work to remedy the defects which existed in his own services. Whatever deposit there was in the sewers, and whatever gases were formed, if the house services were right and everything connected with the fittings sanitarily correct, there would be no possibility of getting typhoid fever from the sewers. It could only arise through the drinking water, and against that danger the local authorities had now taken precautions, so that polluted water would be impossible in future. The idea of its having any connection with the sewage farm had never entered into the minds of anyone who had inquired into the subject, and there was sufficient evidence to prove that there was no connection whatever between the two things as cause and effect.

Mr. E. J. Purnell (Coventry) inquired what was the course of the sewage when it left the carriers; did it percolate through the soil, or merely run over the surface?

Dr. Carpenter said it percolated through the upper 10 inches of the soil, the carriers did not reach to the bottom of the field, but stopped about two-thirds down, and that which flowed from the ends must go through the land. In different parts of the carriers stop-boards were placed which caused the sewage to flow over the land, the carriers being 25 or 30 feet apart. It then went into the catch-water drains, from whence it was conveyed to the next portion of the farm, where it was treated in the same way. He considered it one of the most important points to be observed, that the vegetation on the surface of the earth should deal with the sewage, which should not get into the soil to any great depth. If it escaped the roots of the plants, there was a chance of matters like typhoid germs finding their way into the deep subsoil, and becoming the possible means of conveying danger to persons who drank from surface wells. If it were kept on the surface, and the vegetation were able to deal with it before it sank into the ground, the vegetation would absorb every particle of organic matter, and leave the water to pass off perfectly pure. The great point was to keep the sewage as near the surface as possible, as by that means he believed the whole of the noxious matter would be taken out.

Mr. Purnell asked if there were any means of ascertaining when the ground was wet that none of the sewage went over the surface and got into the lower carriers without passing through the soil?

Dr. Carpenter said such a thing was possible if the waterman neglected his duty, and allowed it to remain 48 hours or more on the land, but that was a consideration of neglect which ought not to take place, and the evils which may arise from neglect of duty should not be taken as objections to a principle.

Mr. Rugg (Medical Officer for Wolverhampton) asked if any cases of typhoid were traceable to the milk supply.

Mr. Wilson inquired how far the facts stated by Dr. Carpenter were borne out by the health of the cottagers and workmen on the farm.

Mr. S. M. Webster (Mayor of Warrington) asked if with such a large extent of sewage there was not a considerable risk of germs being a source of danger?

Dr. Carpenter said if any gentleman would look nto the accounts it would be seen that for the year ending March, 1876, the sales of milk from the farm had amounted to £826, and in the preceding year to £847. Inquiries were made with reference to those who had consumed it when the fever broke out, and it was found that the majority of those who took milk from the farm did not have the fever. The whole of it was consumed in Croydon; and fortunately the majority of those using it escaped the fever; it might have been different without the milk being at fault. He believed

* See Mr. Baldwin Latham's letter, page 679 of last weeks *Journal*.

it was held now that the excreta from typhoid patients was not infectious for the first few hours after discharge, and if they were taken or mixed with earth or ashes at once they were altered in character, and did not become poisonous at all. That was a great point with regard to the treatment of the excreta of patients suffering in this way. It was the retention of this matter in the sewers that gave rise to the evil, and the sooner you got it on the farm the better, because directly it reached vegetable life, or the earth, it became so altered, that there was no further danger of typhoid germ. No danger, therefore, was likely to arise from a sewage farm if conducted as it ought to be. With regard to the cottagers on the farm the mortality was given in the table. Since the farm was in operation he had kept a detailed account of every birth and death in the district, and the mortality had never yet been above fifteen per thousand; zymotic disease was not so high as in the country generally.

Lieut.-Col. Hope, V.C., said he had three questions he wished to put. First, if the effluent water which finally left the farm did not get into the channel by which it left the farm off the surface and not through the soil; secondly, if Dr. Carpenter could explain the loss which he had shown over the twenty years, whether it arose from simple mismanagement, or from the fact that he did not get out of the sewage used the proper proportion of manure, whether, in fact, there was not a large waste going on somewhere; thirdly, if he was personally responsible for the system adopted, or whether there were any points which, if he had his own way, he would like to alter.

Dr. Carpenter said, when dealing with storm waters, it might occur that somo went over the channel without going through the earth, and then it would be simply filtered through the grass. With regard to the loss, his impression was it arose in a great measure from mismanagement. They had a manager who did his best, but he thought he knew some persons who could do it better. He was not personally responsible for the details of management, being only one out of five, and therefore he could not have his own way, nor did he know that they would be much better off if he had, because he did not pretend to be a farmer. With regard to the loss of manurial value, he apprehended Col. Hope referred to the loss of nitrogen passing off in the effluent water. He contended that the loss was very much smaller in quantity than would be the case if it was not abstracted, and that by keeping it near the surface of the land the power of abstracting it was increased. Unfortunately, their crops were not managed in the way they should be. The rye grass was sometimes allowed to run to seed, instead of being cut at the proper time, and sometimes the crops got to market rather too late. He felt certain that if the farm were in Col. Hope's hands much better results would be obtained, though he did not think even he would improve the quality of the effluent water.

Mr. Henry Morgan (Lodge Farm, Barking) asked if the effluent water from this farm would bear comparison with that from other sewage farms?

Dr. Carpenter said it did, even taking the analyses made by hostile parties. It was not so perfect at all times as he should like it to be, and he believed that at Cheltenham they had occasionally beaten them.

Eton.

The Rev. C. Wolley Dod, chairman of the Eton Sanitary Authority (who had furnished the Conference with a paper on the Eton Sewage Farm), not being present,

Mr. Whitehouse (surveyor for Eton) said they used the separate system there, the rain-water being kept distinct from the town sewers. It flowed by gravitation into a large tank about half a mile out of the town, whence it was pumped up to a farm of 50 acres, though they only used 30. It was tolerably successful, but he could not give the details.

Mr. Tatham asked if it was successful financially?

Mr. Whitehouse said the produce of the farm was sufficient to pay the expense of pumping. In reply to another question from the Hon. Dudley Fortescue, he said he could not give the details of the returns.

The Secretary inquired the cost of the farm.

Mr. Whitehouse replied about £5,000.

Mr. Papillon (Mayor of Colchester) asked if the profit of £120 stated in the printed paper included or excluded the expense of pumping?

Mr. Whitehouse said he did not understand that item of £120. He could only say the cost of pumping was £270, and the produce of the farm was £278.

Mr. W. Botly asked how it was if it was found so profitable they did not irrigate the whole farm?

Mr. Whitehouse said they had not sufficient sewage.

The Conference then adjourned for luncheon.

Wrexham.

Lieut.-Col. Jones, V.C., whose paper on the Wrexham sewage farm was brought before the Conference on their re-assembling, said there were two main points in connection with sewage irrigation, first, whether it was effectual in purifying the sewage, and, secondly, whether it could be made financially successful. Those who had read a pamphlet of his, published by Longmans, entitled, "Will Sewage Farming Pay?" or the paper printed in connection with the Conference, would see what his views were on the second of these questions, which he now proposed to deal with. Many years ago he was satisfied that the earth and plant life afforded the most efficient means for purifying town sewage, and anyone who had compared the foul liquid often put over a field of rye grass with the pure effluent passing from the surface of a crop in a vigorous state of growth, would be prepared to bear out that assertion. Some five years ago, however, there were no precise data on the economical question as to whether it would pay, and with a view of settling this question, he determined to take a sewage farm into his own hands, and keep a ledger account of every acre of ground and every crop, in order also to determine which were the best crops and how far on the whole it would pay or not. Some of the details of this experiment would be found in the paper; the general result amounted to this. The returns of sewage farming were more constant than those of ordinary cultivation, inasmuch as they were not subject to the losses often experienced in excessively dry seasons. Secondly, when the sewage could be brought to the highest point upon a suitable area of land, and it was only fair to expect towns to do that, if proper use was made of it, the crops might be made to pay a rent for the land of something like £5 an acre, to pay the farmer interest upon his capital, and contribute towards a sinking fund which would repay the cost of such works as might be necessary to spread the sewage over the farm, within a reasonable term of years, and still leave him a fair farming profit for his trouble. He feared that those who had exaggerated notions of the value of sewage derived from the chemical analyses in vogue some years ago might feel disappointed with these results, and, on the other hand, those who said there was nothing in sewage farming, and that it must always be a dead loss, would be quite as indisposed to agree with him; but he hoped that some of the more moderate members of the Conference would be disposed to look for the truth somewhere about midway between the two extremes, and thus to accept the view he put forward. With regard to the sanitary part of the question, during his military service of nearly 20 years, in the course of his duty as an officer in the Quartermaster-General's department, and as a member of various sani-

tary boards, sanitary matters had been brought to his notice, and as a father of six young children, he was not likely to be indifferent to their sanitary surroundings. The Wrexham sewage frequently flowed along a carrier which passed within 250 feet of the front door and windows of the cottage which he and his family occupied, but he experienced no annoyance, nor did the dairyman who lived at the farm-house in the centre of the irrigated land, and who had four healthy children; nor were any evil effects observed amongst the consumers in the town of Wrexham of the milk from the farm; in fact, the medical officers of the town were amongst his best customers. There had never, indeed, been a case of injury to health connected with the sewage as cause and effect. The Mayor of Wrexham, an eminent medical man, who had watched the farm during the whole time of his occupation, and who had come up with Mr. Schone, a civil engineer, as a deputation, would bear him out in these assertions. The latter gentleman was much engaged as an engineer on behalf of the rural sanitary authorities in the neighbourhood in laying out sewage works, and was doing his best to introduce the separate system for which he had contended for many years. One encouraging point was that the farmers in the neighbourhood were beginning to understand that sewage was valuable, so that these rural sanitary authorities had not the difficulty which was found in some places in finding customers willing to pay a rent for land irrigated with sewage. He did not think sewage farming had ever yet had a fair and honest trial for want of a separate system of drainage. The area of Wrexham sewered was about 100 acres, which was more than the size of the farm itself, and an inch of rain falling upon that would amount to two million gallons. The sewage, however, from the population was only about 300,000 gallons, and the maximum he could receive was about half a million, so that any excess of that must go straight to the brook by certain fixed overflows over which no one had any control. Where the rainfall was introduced into the sewers, it was necessary to provide an outlet for it, and the engineers who arranged those schemes no doubt understood that where a heavy rainfall came, the natural watercourses were so full as to wash away all tho foul matter which came into them from the sewers with the rainfall, but they forgot that sometimes the rainfall was confined to a very small area, as in the case of Wrexham, where with a local shower of rain, the brook which had its source in the distant mountains might bring so small a quantity of water that the foul matter going into it would cause a deposit on the banks and bed and thus create an intolerable nuisrnce. This he had often found, as the brook flowed through the centre of his farm. He hoped sooner or later this would be remedied, because as the brook flowed through the centre of the town nothing could be easier than to disconnect the surface water and turn it straight into the brook. He mentioned this point because engineers did not always sufficiently recognise the difficulty of dealing with a large extra body of water in the time of storms.

Mr. Chadwick asked what was the state of sewage delivered to the farm; were there water-closets, and were the sewers self-cleansing?

Colonel Jones said the water-closets were about 30 per cent. or perhaps rather more. The drainage was fairly conducted as a combined system, the sewers were self-cleansing, and the flow of sewage pretty constant in all the main sewers, but there were instances in which the fall was not sufficient, and these often gave a deal of trouble; consequently he did not get the sewage as fresh as he should like it. His view was that the sewage ought to come straight on to the land within a few hours, before fermentation began.

Mr. T. Eyton Jones, M.D. (Mayor of Wrexham), said since Colonel Jones had turned his sword into a ploughshare he had relieved them in Wrexham of a vast deal of trouble in connection with the sewage farm. They took it about 1870, and for two years or more under the amateur farming of some of the councillors they were getting deeply into debt, the farm was becoming like a wilderness, and at last they decided to let it by tender; happily they received an application from Colonel Jones, and during the four years he had been in possession, he had not only altered the whole aspect of things, but had made it remunerative, aud had also enabled them to dispose of the sewage matter, which had given a very offensive odour from the tanks placed below the town. Instead of running the sewage into tanks he took it direct into the farm, and disposed of it as the crops required, and had been enabled to supply the town and collieries in the neighbourhood with sewage grass at a less price than they could obtain it elsewhere. Looking at the mortality from iufectious diseases in the district below the outfall of the water from the farm, and in those above, he had found no instance of such disease occurring below the town, whilst the water in the river, before Colonel Jones took possession, showed as much as seven grains per gallon of organic matter. This arose simply as the result of the storm water forcing down sewage matter, not only from the town, but from the tanks, and sending a large quantity into the river. He had recently obtained an order for another analysis, not only of the effluent water from the farm, but of that which came into the town. The analyst, however, said he did not like to give the result simply from one analysis, but as far as he had gone he knew of several waters used for drinking purposes which possessed more organic matter than that which came from the sewage farm. He could only say that, although he was the medical adviser of Colonel Jones, he was very seldom troubled, except in case of accidents, and those living on sewage farms enjoyed as good health as ordinary individuals under favourable circumstances. If they wished to obtain pure effluent water it might be possible to establish filtration beds at the extremity of the farm. Whilst, however, they were able, by the gravitation they possessed, to adopt this plan, he was of opinion that in districts were the population was not dense, the dry earth system might be of service, because, where the community was small, it could be well regulated, and the cost would not be great. The precipitation process was tried by some gentlemen, who came down for the purpose, but the Council did not approve of it and determined to take the farm instead. He agreed with what had been said by Dr. Carpenter, with reference to the excreta of typhoid patients, and the same thing would apply to cholera and other infectious diseases. If the sewage was discharged into the earth boforo it decomposed they need not fear the results, even if the effluent water should find its way into the drinking water. He should wish to see the system proposed by Mr. Stansfeld adopted for an inquiry system throughout the country, and at any rate the medical officers of health over large districts might, he thought, be entrusted with duties similar to the inspectors of the Poor Law Board, and they might thus arrive at some comprehensive opinion respecting the requirements of the country. In conclusion, he would only say that the result of Colonel Jones' taking the farm had been to enable him to make a profit out of it, but it must be remembered that he was a gentleman who had an indomitable will and energy in the management of anything he took in hand. If any one else wished to succeed in the same way, they would have to follow his plan of getting up at four o'clock in the morning and regulating everything themselves.

Mr. Chadwick remarked that the death-rate mentioned of 26 per 1,000 was rather high for so small a place.

The Mayor of Wrexham said he had ascertained the number of zymotic diseases during the last year, and the calculation being made upon 8,300, whereas the population was over 10,000, it would be seen that the real rate of mortality was about 21·8. Although that looked large, they had only four cases of puerperal fever in January last year, and one in February, when it was epidemic throughout the country. In March there was one case of typhoid fever, and that was imported into Wrexham. In May there was one case of scarlet fever, and in September one of measles and one of scarlet fever. For eight months they had no infectious disease whatever.

Mr. Whitehouse understood that they had not adopted the separate system at Wrexham.

Colonel Jones said there was no separate system in the town. By separation he meant keeping the rainfall out of the sewers.

Mr. Whitehouse asked how the storm water was excluded from the sewage?

Colonel Jones said he wished that could be done, because he should know better what he had to deal with. When the rain-water went into the sewers, at times, when the weather was dry, he got very little sewage, and then during heavy rain there might be a flood of water all over his fields, he might get two million gallons over it, which he did not know what to do with. He thought every one engaged in treating sewage in any way should insist upon having a separate system, because, if they had to deal with the sewage they ought to know what quantity would be sent them. He would never touch town sewage if he did not know that, at any rate, he was protected by such overflows as they had at Wrexham, which, as he said, limited his maximum quantity to half-a-million gallons, and he should insist on knowing what the maximum would be. No reasonable man would undertake the responsibility, if at times he had a greater quantity of water than he wanted coming suddenly upon him.

Mr. Isaac Schone, C.E. (Wrexham) said Col. Jones' indefatigable zeal and energy had so completely innoculated the whole of the people of the district with his ideas, that the urban and rural sanitary authorities were now directing their attention to the adoption ultimately of his views on the question. As a member of the Corporation, he looked on Col. Jones as a perfect godsend, for sewage farming could not be well conducted by corporate bodies. His observations on the working of the farm showed him that if a separate system had been adopted, Wrexham would stand A 1 in its management of sewage irrigation.

Mr. Papillon asked how far Col. Jones was responsible to the Corporation for the purity of the effluent, and whether he would recommend such a system for adoption in a district where there was not a continuous supply of water.

Col. Jones said he was responsible for purifying the sewage in case of dispute to the satisfaction of the Rivers Pollution Commissioners, and although he did not know whether that body was now in existence, he was prepared to submit to any competent authority. He was, however, only responsible for his own acts and defaults, because he took particular pains not to make himself answerable for the sewage *per se*. For all he knew there might be an Act of Parliament passed that sewage should be defecated by chloride of gold, or any other expensive material, and he was only answerable for putting the sewage over the land, and that it should reach the natural water carriers in a purified state. He did not think an intermittent water supply affected the matter, provided there were 15 gallons per head of the population in the 24 hours. If you came to a rural place where there was very small water supply, and that from wells, he should advocate the dry earth system, which he adopted in his own cottage and farm His cottage stood on the roadside with high ground behind, and when he went there he found a most horrible old fashioned privy with a cesspool exactly behind the larder and drawing-room in a particularly porous soil, not even pretending to be cemented. The first thing he did was to sweep it entirely away and introduced an earth closet, which he had found perfectly successful. He did not think, however, it would ever do to cart the earth in and out again for a whole town.

Mr. Towle (Oxford) asked whether it was necessary to adopt any system to separate the storm water from the sewage?

Col. Jones said yes. The rain had always come down since the days of Adam, and if towns got waterlogged it would be very easy to improve the existing drains and carry it off. Under modern arrangements, it was very easy to ascertain exactly the quantity of water carried into a town, and to calculate the size of the sewers necessary for taking the foul water away after it was used, so as to secure a perfectly continuous flow of sewage from the town, and that it should get on to the land in a very few hours.

The Chairman said he gathered that Col. Jones was not desirous of having the storm water in addition to the town sewage, because a superabundant quantity would cause it to run over the land instead of filtering through it.

Mr. Arnold asked how Col. Jones proposed to deal with the question of flushing the sewers?

Col. Jones said he supposed sewers would be made on the separate system, and, if they were properly arranged, on a much smaller scale than at present, a very small amount of water from the works would flush them. Moreover, there were easy methods of stopping the flow along the sewers from place to place wherever a level section occurred, until it got to a certain height, and then letting it down, so that the flushing was very easily arranged. Trusting to the rainfall for flushing sewers was, to his mind, a most absurd idea, because the sewers began to smell in hot dry weather, when there was no rain to flush them, and when the rainfall did come it often left along the bottom of the sewer an immense quantity of road detritus, this prepared the way for a fresh accumulation of sewage, which thus collected and created a nuisance.

Lodge Farm, Barking.

Mr. Morgan was asked by the Chairman if he could give any further information on the subject of sewage farming generally. He said he had contributed a paper giving the statistics* for the last six years of the Lodge Farm, Barking, but the point to which he wished particularly to draw attention was this, that the time seemed now to have arrived for ascertaining correctly whether or not the announced value of town sewage was correct. The Lodge Farm was established for the purpose of ascertaining whether the application of sewage to the land would be attended with the results which were predicted, and he feared the results he had shown would not be found so satisfactory as could be wished. As far as the sanitary conditions were concerned, everything was absolutely perfect, and the agricultural condition of the farm had always been maintained in a high state of efficiency. The *Agricultural Gazette* for 8th November, 1873, compared the value of town sewage from an estimate of the ammonia contained in one gallon with the constituents of Peruvian guano, and showed that the latter contained in 100 lbs. as much ammonia as town sewage in 100 tons. Dr. Frankland found that by the intermittent application of sewage all evil effects were destroyed, and that method was largely carried out at the Lodge Farm, where the soil formed a

* See page 715.

EXTRACT FROM ACCOUNTS OF THE LODGE, FARM, BARKING, ESSEX.

Total area about 212 *acres.*

Years...	1869 & 70. Ending Aug. 31st.	1870 & 71. Ending Aug. 31st.	1871 & 72. Ending Dec. 31st (16 months).	1873. Ending Dec. 31st.	1874. Ending Dec. 31st.	1875. Ending Dec. 31st.	Notes.
	a. r. p.	a. r. p.	a. r. p.	a. r. p.	a. r. p.	a. r. p.	
Acres under sewage	112 3 23	162 3 6	189 2 23	117 2 30	112 2 30	71 2 8	The years ending Aug. 31, 1870 and 1871, were favourable to sewage, being without rain. The land was new to sewage, and we were also selling milk, which is perhaps the most profitable mode of turning sewage to account.
Acres not under sewage	71 1 0	26 3 17	......	71 3 32	76 3 3	117 3 15	
Pasture	13 0 0	7 0 0	7 0 0	7 0 0	7 0 0	7 0 0	
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	
Total No. of tons of sewage	508,871	622,324	624,876	622,648	526,743	609,880	
Average tons per acre	4,400	3,800	3,300	5,200	4,600	8,500	
Average No. of tons to Italian rye per acre	5,000	5,600	6,500	4,800	7,000	9,000	
Tons of grass cut (average per acre)	20¼	23	22	18¼	25½	24	The increase in the area of land was obtained when the high-level iron troughing, strongly recommended by Mr. Hope, V.C., was in use. The decrease is marked by the rotting away by this superstructure.
Average per acre from special plots	36	31	42	44	49	43	
	£ s. d	£ s. d	£ s. d	£ s. d.	£ s. d.	£ s. d	
Gross receipts and valuation	10,147 15 7	10,190 5 9	11,013 10 11	9,254 1 7	9,325 5 6	9,421 11 3	
Less previous valuation	4,529 12 3	4,068 9 4	4,908 12 5	4,724 13 7	4,715 13 1	4,945 8 4	
	5,618 3 4	6,121 16 5	6,104 18 6	4,529 8 0	4,609 12 5	4,476 2 11	
Total payments	4,998 19 3	4,797 4 11	6,195 9 11	4,972 10 3	4,845 13 5	4,768 9 11	......
Profit	619 4 1	1,324 11 6	......	......	...	......	This leaves an average profit of £145 per annum for the 6¼ years
Loss	......	......	90 11 5	443 2 3	236 1 0	292 7 0	

The average cost of pumping the sewage to a height varying from about 35 to 40 feet, through a main rather over one-and-a-half miles in length, is about £450 per annum, without allowing anything for depreciation in machinery, &c. This is not included in the list of payments, which are merely those of the farm.

natural filter bed. They also applied it in much less quantities than in a filter bed and at greater intervals, and they also had vegetation in operation. At the same time the effluent water which went away contained more than two-thirds of the value of the ammonia, or nitrates, which the sewage originally contained. If Dr. Frankland was right, and he believed he was, the combustion which took place in the land prevented it from holding or storing up the sewage; if, however, he were wrong, then the land would in time become choked, and the action which he stated took place would not occur. It appeared to him the truth was the land had merely the opportunity of seizing as fast as it could that which it was enabled to take, as the sewage went past on its way to the drains. He thought they must come at last to the conclusion expressed in the sentence once made use of by Sir Henry Cole, that towns must pay to be clean.

Mr. Chadwick asked the comparative produce of the Lodge Farm as compared with market gardens?

Mr. Morgan said that their produce was sold in the London market and fetched the highest prices, and not only were they satisfied, but so was Dr. Smee, who had been down to visit them.

Mr. Chadwick—Did the yield exceed that from market gardens?

Mr. Morgan said the yield was greater, but it did not come into the market quite so early because sewage water did not force the plants during the early cold weather as much as farm-yard manure.

Mr. Chadwick asked if he had compared the cost of the distribution of sewage with the cost of manuring market gardens?

Mr. Morgan said he could not arrive at that very satisfactorily. The cost of distributing the sewage would be less, but the cost on the land altogether was more. A great deal of dirt came down with the sewage, and the weeds grew tremendously if they were not constantly kept under.

Mr. Adam Scott said by irrigation the excreta returned to the earth, which was its proper destination; but whether or not it should be returned by that means was another question. They had heard particulars of some sewage farms which had been very successful, but it was well known there were others which had not turned out so well, and they had heard nothing about them, and very little had been said about the possible evils of irrigation farms. He thought it would be worth while to refer to what had taken place on the Continent, where they had gone more scientifically into the subject, and had taken the trouble to examine the subsoil waters of sewage farms, which had not been done here. It was there found that a considerable portion of the nitrites and nitrates was left in the subsoil water. It was also important to remember that at the present moment they were not sufficiently informed as to what were the morbific elements in sewage. Mr. Simon said that until chemistry learnt to identify the morbific elements themselves, it was incompetent to declare them absent in any effluent water, and the water which chemical analysis would not condemn, might possibly carry the seeds of infection. Dr. Carpenter very properly said he would not recommend that any effluent water should be used for drinking purposes, and on the Continent they had not only ascertained that pollution did go away by the subsoil water, but they had also analysed the subsoil itself, and found in it the existence of bacteria to a large extent, which showed the presence of fermentative elements. Dr. Liedner, of Dresden, said that so largely did these exist in some cases that they actually formed the substance by which the grains of sand were held together. It did not follow that the same thing happened at Croydon, or any other sewage farm, but it would be at least desirable to examine those subsoils. It was said that no illness had arisen from sewage farms, but still in many cases the causes of ill-health might exist without producing the anticipated effect, in the same way as persons might live drunken lives for 90 or 100 years. It did not follow that drinking to excess was the cause of longevity. Whether they had arrived at the power of destroying these morbific elements was another thing. Dr. Frankland said no, and he had produced startling evidence in the case of Lausanne, which was published in a recent number of *Nature*. It appeared that typhoid fever broke out in the small town of Basle; the excreta went into a

stream which was used for irrigating the land. A mile away on the other side of the hill, was the town of Lausanne where typhoid fever also broke out, the springs were more than a mile from the irrigated land, but they had certain relations to it because it was noticed that they sensibly rose when irrigation took place. The suggestion arose that the typhoid material somehow got through the land into the springs, especially as it only occurred in houses where that particular water was used. The next question was, was there any communication between the irrigated land and the springs, and to test this, a large quantity of salt was mixed with the water, and the result was, an enormous increase of chlorine was found in the springs, showing that there was a connection between the irrigated land and the springs. Then to ascertain whether there was a direct channel, or if it arose from filtration, a large quantity of flour was mixed with the water, but this did not pass, and the conclusion, therefore, was that it filtered through the earth and caused the spread of disease in that particular neighbourhood.

Mr. Bryan, Borough Engineer for Blackburn, said they had a sewage farm at Blackburn. The average rainfall was about 46 inches, but they separated the storm water from the sewage in all the new sewers, and these being of very steep gradients, the separation was comparatively easy. Before irrigating, the sewage was defecated by the addition of four or five cwt. of lime, the amount of sewage being under two million gallons daily. The lime simply removed the grosser solid matters in suspension, and the resulting sludge was sold, if possible, but at times they had a difficulty in disposing of it. At present they were erecting drying sheds for preparing it better. The farm was two miles from the town, and the Corporation had just acquired some land six miles away, where the conditions would be more favourable. They adopted the old system of ventilation, charcoal having been found to interfere with the free circulation of air. With regard to cost, he could not give the particulars; £700 or £800 was the amount of working expenses, but the cost of the land and law expenses were so exceptionally enormous that it would not be just to include them in any estimate.

Sir Henry Cole, K.C.B., asked the size of the farm?

Mr. Bryan replied a little over 300 acres, but the greater portion was not under irrigation, perhaps 100 acres. He could not tell what the cost was exactly; the litigation had only just closed, and had amounted to such a large sum that the figures would be quite misleading. The law expenses had been over £20,000.

Sir Henry Cole asked if it would be within the mark to state that the town had paid 100 years' purchase on the rental of land in the neighbourhood?

Mr. Bryan thought that would be about right.

Sir Henry Cole—Should you be suprised to hear it was 150 years' purchase!

Mr. Bryan would not be surprised if in one case it cost 200 years purchase.

Sir Henry Cole said his information was tha somebody had got the purchase money of about 200 years on the usual rental of the land in the neighbourhood of Blackburn.

Mr. Bryan said in one case a man made a claim which was referred to arbitration, and the arbitrator awarded him half as much again as he had claimed.

Sir Henry Cole asked if the Corporation would be willing to furnish full information on these points for future reference?

Mr. Bryan said in the course of another year they would probably be able to do so, but not before.

Mr. Chadwick said the separate system as against the combined system meant the separation of the rainfall from the common sewage, but in towns that would hardly be a wise course to adopt, because in some places, certainly in London, where 1,000 loads of dung were deposited on the surface daily, the manurial properties of the water taken from the surface of the streets was as great, if not greater, than that obtained from the water of the houses. Another point bearing on this was the question of keeping the water-closet drains separate from the sink and scullery drains. It had been shown by the Rivers Pollution Commissioners that the difference in the manurial quality of the matter between a water-closeted town and one where that system was not adopted did not amount to more than one-sixth. He would ask if Col. Jones had observed that distinction in the case he had dealt with at Wrexham.

Colonel Jones said he could not give any information on that point.

Mr. Adam Scott said the Rivers Pollution report as to the difference between sewered towns and towns without water carriage was entirely misleading, because in the non-water-closeted towns, in the majority of cases, the cesspools emptied into the sewers, so that the manurial liquid passed into them practically in the same way as if there were water-closets.

Dr. Vacher (Liverpool) said the statement made by Mr. Adam Scott that they did not at present know what were the morbific elements in typhoid fever had struck his attention. He had quoted something from the medical officer of the Privy Council, but if he would read Dr. Klein's recent report he would find there a very good idea of what the morbific element was. He subsequently referred to *bacteria* as having something to do with carrying contagion, but recent research had led to the belief that *bacteria* had nothing to do with contagion at all, especially if he meant by *bacteria* the little rod-shaped animalcules as distinguished from *vibrios*.

Mr. Adam Scott said all the medical faculty acknowledged that they were simply at the beginning of knowledge with regard to contagious diseases, and therefore nothing could be said upon it with certainty. With regard to the *bacteria*, he had merely quoted what was said by Dr. Liedner of Dresden.

Dr. Wilson (Rochdale) said Mr. Scott appeared to think typhoid fever might be carried by effluent water from a sewage farm, and in support of that he had referred to an article in *Nature* by Dr. Frankland, in reference to a case in which typhoid excreta was supposed to have been carried a mile distance through the ground. That was too serious a matter to be passed over without further inquiry. On reading that paper he wrote to Dr. Frankland for further information, and he believed Mr. Scott had now referred to what Dr. Frankland had stated in reply to him. The proof given was that salt was put in at one end, and found by chemical analysis at the other, but any gentleman would agree with him that the fact of such a large quantity being found afterwards would indicate that there was some kind of direct communication. Then as regards the flour, it was not impossible for water containing flour floating in it to pass out quite free from it, after going through a very thin stratum of earth. After all it came to this, that if typhoid poison would go through a whole mile of different strata, they could never be sure that the best formed water-works or reservoirs would not be contaminated by some case of typhoid at any unknown distance.

Professor Wanklyn said the supposed Swiss case appeared to call for a few remarks. He had made experiments on the action of porous filters on a very diluted solution of organic nitrogenous matter, and he found that a few inches of a given filtering material would entirely destroy such matter. It was quite certain that

the ultimate atoms of typhoid fever must be some form of albuminous matter; whether it were a plant or an animal, or a poison like strychnia, or some other powerful poison, they could not tell, but it was certainly something allied to albumen. Now, it was perfectly certain that all bodies of this description were destroyed by passing through any considerable length of porous material, and it was also certain that where flour would not pass typhoid poison would not. He had no doubt that anything like a mile of porous material would destroy the typhoid poison. When Dr. Frankland brought this matter before the Chemical Society, it struck him that, not being a medical man, he had not investigated the matter with that care which was necessary. He could name a dozen ways in which probably there was direct communication between the house and the fever. In all probability the same medical man attended both, and, without speaking disrespectfully of Continental medical men, he was bound to say they were not quite so cleanly in their habits as our own. It was well known that medical men did carry infectious diseases with them, although it was not much spoken about. There was no necessity, therefore, to believe that poison could pass through a mile of ground.

Mr. Adam Scott said it was rather remarkable that in the houses where the water referred to was not used no cases of fever occurred.

Lord Alfred Churchill being obliged to leave, Sir Henry Cole, K.C.B., Vice-President of the Society, took the chair.

TREATMENT OF SEWAGE BY SUBSIDENCE.

CANTERBURY.

Mr. Hall (Surveyor for Canterbury) said Canterbury had a purely separate system, keeping the storm water separate from the sewage proper, with the exception of what fell on small back yards, and such like. The sewers were thoroughly well ventilated, and were self-cleansing to a great extent. They were also flushed regularly. Ventilating shafts were carried up from the sewers two or three feet above the tops of the chimneys. The sewage was treated in five settling tanks, each about 40 feet by 20, and it flowed on until it came to the filtering beds, and these were in duplicate, and were each about 50 feet long by 4 feet wide. In the first place, it fell through two yards of gravel and straw combined, then it came up through a layer 4 feet wide and 8 inches thick, went back again down through another of straw and coke, then up through another, and away to the river. It had been in operation about four years, and the works had been extended.

The Chairman—Do you use any precipitants?

Mr. Hall—No, it is simply subsidence.

The Chairman asked what interpretation Mr. Hall put on the words "fairly successful?"

Mr. Hall said the water passing from the sewage would naturally increase the growth of weeds slightly, but they had had several analyses—one or two from Dr. Attfield—of water taken a quarter of a mile above the outlet of the sewer, and a quarter of a mile below, and from the latter place it was really better than from above. That was explained simply by the washings of the road going into it. They had had no injunction against them, but there was no doubt in the end they would adopt irrigation.

Mr. Towle asked what was done with the sludge?

Mr. Hall said they sold it for £150 a-year. It was laid out in thin layers 4 to 6 inches thick until it was dried, and was carted away every week and mixed with the city refuse, and put on the farm. There was no difficulty in getting rid of it. The quantity was about 500 cubic yards in the year. Formerly, there was sometimes a difficulty in getting rid of it, some wanting it at one time and some at another, therefore, the contractor for the city now gave £150 a year for the whole of it.

Mr. Chadwick said the death-rate in Canterbury was 23 or 24 per 1,000, but in well-drained towns of that size, it ought not to be above 13 or 14.

Mr. Sharman (Wellingborough) asked how often the filter beds were changed?

Mr. Hall—Every fortnight.

Mr. Sharman—Would the filter going down and up twice, as it had been described, last a fortnight?

Mr. Hall—Yes.

Mr. Sharman asked the quantity of sewage that went through?

Mr. Hall said from half a million to a million gallons per day.

Mr. Larkins asked of what materials the filter was composed? He thought it was a remarkably small area for so large a quantity of water.

Mr. Hall repeated the ingredients he had already given.

Mr. Bolton (Aberdeen) asked whether the gravel was available again after exposure to the air?

Mr. Hall said yes, it was laid out in thin layers, and was ready for use in a fortnight.

COVENTRY.

Mr. J. C. Melliss, C.E. (Coventry) then gave an account of the operations at Coventry with reference to his paper.*

The Chairman asked if he, Mr. Melliss, was paid by the Corporation?

Mr. Melliss said no.

The Chairman then asked whether the Corporation was paid by him.

Mr. Melliss replied that they were not.

The Chairman—Do you sell all your produce, or what quantity?

Mr. Melliss—Not all; it is just developing into sale, it was very slow indeed at first. The last order was for 150 tons at about £2 a ton.

The Chairman asked where the company's remuneration came from?

Mr. Melliss said in this instance it would come from the sale of manure, but in any future case it would have to come from a subsidy paid by the town.

The Chairman—Then the company has arrived at the conclusion that the towns must pay to be clean. Had the company paid any dividend for the two years it had been in operation?

Mr. Melliss said that was not his department.

The Chairman said he had observed that was just the point on which the company did not give any information. Could not Mr. Melliss say whether it was a profitable operation or not to the company? He believed every one said it was a success scientifically.

Mr. Melliss said, as an engineer, he did not know anything about the financial part of the question, but as to the idea of purifying sewage to make it pay he was certain it could not be done.

The Chairman—That is your abstract opinion, independently of the company's point of view, that it is not profitable?

Mr. Melliss said that was his view.

The Chairman—Then if you go to any other town you must have a subsidy?

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* See page 628 of the *Journal* for May 19.

Mr. Melliss—Yes; a moderate subsidy. He should call £1,000 or £1,500 a-year a moderate subsidy for a large town like Coventry.

Mr. Papillon (Mayor of Colchester) said he had, in company with a deputation from Colchester, visited Coventry within the last three days. To his mind the great value of the system was that where the sewage had to be poured into a tidal river or into the sea it produced an effluent direct from the tanks, which was sufficiently pure without any other filtration. They tasted the water at the weir, and took a sample of it, and had every reason to congratulate the company on the result. Another great benefit to a large and populous town was that it required such an extremely small extent of ground on which to work. In reply to the Chairman, he admitted that he thought £1,500 a-year high.

Mr. Adam Scott understood that the quantity of water in Coventry was very large. Was not that in some way connected with the river flowing into the sewers?

Mr. Melliss said there was a large amount of leakage of sub-soil water into the sewers.

Mr. Adam Scott thought in that case it was not a fair example of what the system would be in another town.

Mr. Melliss said there were great difficulties to contend with in Coventry. In fact, no single town could be taken as a type of another. Each one must be dealt with on its own merits, according to the character of the sewage and of the soil, &c. He said the sewage was purified successfully, and at a cheaper rate than many large sewage farms had been enabled to effect.

Dr. Jacob (Medical Officer of Health for Reigate) asked if the company were prepared to state how much land they would require for the purification of sewage of a town of say 10,000 inhabitants by this process; secondly, if they could give any estimate of the cost per head of the population? There were many towns within his knowledge which had experienced extreme difficulty in acquiring land for irrigation purposes, owing to the hostile feeling of the landowners, and he should be very glad if any precipitation process could be proved to be successful.

Mr. Melliss said the answer to the question would depend on the standard of purity required in the effluent water. At Southampton, for instance, where the sewage was discharged into a tidal river or into the sea, so high a standard was not required as would be needed at Richmond, and the quantity of land would depend on the standard of purity required. But taking a town of 10,000 inhabitants, and supposing a not very high standard, one acre would be enough. If great purity were required it would take three or four acres. The cost varied very much according to the quality of the sewage. That of Coventry was as black as ink, but he should think about 1s. per head of the population would be a fair price. He believed the company would be willing to undertake it at that rate, including works providing chemicals, disposing of the sludge, and so forth.

Mr. Towle thought there must be a large quantity of chemicals used in the process, as he had witnessed the water flowing from the sewage works at Coventry, and it was his opinion that certain chemicals not only destroyed the manure but destroyed the land upon which it fell.

Mr. Payne asked if Mr. Melliss could give any particulars as to the cost of drying the sludge.

Mr. T. Lemon (Southampton) asked what was the value of the sludge at Coventry? It was stated that the chemical value was 35s. to 40s. a ton, but his experience was that no farmer would give anything like that price for it. The value of sewage manure was much overstated by chemists, and farmers wanted it in a more concentrated form. They would rather give £12 or £14 a ton for high class manures than 3s. for this, and he should like to know what was the actual price obtained for it.

Mr. Melliss replied that the drying was now done by machines; some of the sludge had been stored in tanks, but that was being done away with. It was disposed of in various ways. Some of it was fortified with other ingredients, some sold in its natural state, and a great deal was sold in a semi-dry state. The cost he had mentioned, 1s. per head, would cover every expense of dealing with the sewage, including the cost of getting rid of the sludge.

Mr. Payne asked if he could not give the approximate price per ton for drying? The information given was so much mixed up, that it hardly answered his question.

Mr. Melliss said he could hardly give an exact answer. The cost of dry manure was probably about £2, including chemicals, labour, interest on plant, &c.

Mr. Payne said that was more than the value of it.

Mr. Melliss said that was so.

The Chairman asked if the process were likely to continue?

Mr. Melliss replied in the affirmative.

The Chairman said apparently they put in more than they got out; in other words, it cost £2, and they did not get £2 for it.

Mr. Melliss said it cost rather more than it realised, and towns must eventually pay to get rid of sewage.

The Chairman said it was one thing to pay for washing one's hands and another thing to pay something more for scented soap. They seemed to be making at a large price something which would not realise its cost. Could not the additional cost be dispensed with? Was there any need to trouble yourself with the sludge at all?

Mr. Payne thought it would be better to throw the sludge away than to pay £2 to make it into something only worth £1.

Mr. Melliss said they must get the sludge out of the way. Hitherto it had been too much the idea to expect to get valuable products out of sewage, but he looked at it from the other point of view. The first thing was to get the water pure and then see how you could diminish the cost by selling the sludge. The value he had quoted for the manure was from Dr. Vöelcker.

Mr. Lemon asked what the farmers would give for the sludge?

Mr. Melliss said they had given £3 a ton for it not long ago.

Mr. Alderman Tatham asked whether that was pure and simple, or fortified?

Mr. Melliss said pure. When it was fortified they would give £6, £7, £8, or £10 a ton for it.

The Chairman asked if it were part of the system to make this manure?

Mr. Melliss said yes, the company got a profit by fortifying it and selling it as a manure worth from £6 to £10 a ton.

Mr. Boulton (Aberdeen), asked what was the relative proportion between the solid matter and the whole of the sewage?

Mr. Melliss said about $4\frac{1}{2}$ tons of dry precipitate was obtained from $2\frac{1}{4}$ million gallons.

Mr. W. Boulton said it was stated in the printed paper that the sludge contained 85 per cent of moisture; did that mean that there was 15 per cent. of solid matter?

Mr. Melliss said there was 25 tons of that sludge from $2\frac{1}{4}$ million gallons of sewage.

Mr. James Wyld said it appeared to him the sludge was only made valuable as a manure by the addition of various elements to it. Some six years ago he was consulted as to whether this precipitating process was applicable under all circumstances, and he wished to ask how far Mr. Melliss had been successful at Nuneaton. He had seen samples of the Nuneaton sewage which was poured into the river Anker, the stench from which was fearful.

Mr. Walford (Nuneaton) said the sewage of that town was managed by the same process as at Coventry. The sewage was of a very remarkable character; the first experiments made by Dr. Anderson were made with the sewage of that town. He himself and a number of scientific men were deputed to go down and see them. He had no interest pecuniarily in Dr. Anderson's process, but he could say it was entirely succssful, and everyone who witnessed the experiments came to the same conclusion. The sewage was extremely bad, and therefore, afforded one of the best tests which could be applied to any precipitating system. Several questions had been asked as to how far this process was a paying one, and he thought Mr. Melliss had answered with a great deal of wisdom in saying they were trying to find a system which should operate successfully, and when they had done that they would try by all means in their power to reduce the cost. It appeared to him there were three classes of towns to be dealt with with reference to drainage. One class, those near the sea, which had the advantage of draining directly into it; the second those near on rivers, and had the advantage to themselves, but the disadvantage to others, of draining into the rivers, this process had now been stopped, and so irrigation systems came into vogue. This, he admitted, where the soil was suitable, and the gradients such as they had at Cheltenham and some other places, might be successful. But there was another class of towns, inland towns, which had no facilities for irrigation, and where they must adopt some system of precipitation. There were many towns in which a large tract of land could not be obtained at any reasonable cost, and in those cases such a system as Dr. Anderson's, General Scott's, or others, enabled the sewage to be precipitated with a very small quantity of land indeed. If the effluent water was required to be of a very perfect character, a few acres of land in addition to those required for the tanks would purify it almost entirely. For some years past he had investigated these points, and he unhesitatingly said no man could form a true opinion on the question unless he gave Dr. Anderson's process a fair and impartial investigation. In comparing the cost, it was necessary to include interest on capital invested in irrigation schemes, the purchase of land, the erection of works, pumping engines, &c., and in most cases these items were omitted in giving the cost of irrigation schemes. It was often said that no rent was paid for the land, but then they must reckon the interest on the money sunk in buying the farm.

Mr. Charles Jones (Ealing) feared that ratepayers would think a charge of 1s. per head rather a large sum to pay, seeing that it would come to £500 a year in a town of 10,000 inhabitants. He had charge of both irrigation and precipitation works, and he should like to ask whether the cost of the tanks and the works and the engineering was comprised in the 1s. per head, and also the cost of the land. The remarks made at that Conference would tend to guide other towns in their choice, therefore they must be most guarded in trying to elicit all the points in connection with any particular system. Irrigation was no particular system, because no man or company was interested in promoting it; it was a general principle, and one which was looked upon as likely to solve the difficulty. No doubt precipitation in connection with it would tend much to assist it, but when they referred to particular company's processes, he must say, having had to deal with a good many of them during the last twelve years, that he had not found one yet which could stand on its own bottom.

Mr. Melliss first replied to the first question whether the sewage of Nuneaton was satisfactorily purified. At this moment it was being successfully purified by the same process as that in use at Coventry; it had satisfied the Court of Chancery, which was not an easy matter. With regard to the 1s. per head, he did not name that as applicable to all towns, because he could not name a price until he had carefully investigated the circumstances. But it was meant to include interest on the cost of works, tanks, and everything else. One gentleman seemed to think this a large charge, but it would not be found so on comparison. According to the published returns, the cost at Tunbridge Wells was 5s. 3d. per head per annum. With regard to the various large sewage farms now in existence, no information at all had been supplied to this Conference. He had been carefully collecting public returns lately, and he found, taking an average of three years' working, at Tunbridge Wells the purification of sewage cost what he had mentioned. At Eton, it was 5s. 1½d. If these figures were wrong, he should be glad to be put right.

Mr. Jones thought those figures did not give credit for the produce of the farm.

Mr. Melliss said they did; the figures were taken from the published returns of the local board.

Mr. Eyton Jones (Mayor of Wrexham) said they had 84 acres at £5 an acre, which they sublet to Col. Jones, who paid them a profit rent of £30 a year, and yet he made £300 a year profit by it, besides setting aside a sinking fund annually to recoup himself on his capital account.

Mr. Lemon thought it would be very desirable for the Society to obtain correct returns of the comparative cost of the various systems. Mr. Melliss made the same statements at the Society of Civil Engineers, when they were directly contradicted by Mr. Rawlinson and others, and he believed they were totally inaccurate.

Mr. Jones, referring to the statement that a large amount of subsoil water got into the sewers at Coventry, asked if that would not be in favour of the effluent. They knew that at Merthyr Tydvil, a short distance below the surface, there was a clear and beautiful spring which poured 300 per cent. of pure water into the sewage and thus greatly improved the quality of the effluent.

Mr. Melliss said he really did not know what the water supply of Coventry was, but he believed the borough engineer was in the room. He did not think that the water which mixed with the sewage was so large in quantity as to materially affect the effluent.

Mr. Jones said he believed about 40 gallons of pure water per head went into the sewage at Coventry.

Mr. Baldwin Latham, C.E. said there was a great difference between the sewage and the effluent. At Coventry there was a deal of subsoil water added to the sewage, which made it more expensive to treat, because it contained a smaller amount of manurial matter. He had seen the works at Coventry, and considered them about the most successful in the country. Last week, Mr. Keate, of the Metropolitan Board of Works, told him that he considered the Coventry experiment one of the most successful anywhere, and that it might be introduced into many towns with advantage. Being concerned with a large number of these undertakings, he might say he found it every day more difficult to get a sewage scheme carried out. The opposition the towns had to contend with was enormous. It required first a number of inquiries before the Local

Government Board, and then two others in the Houses of Parliament; thus it became so expensive that towns really did not like to face such undertakings. If, therefore, it could be shown that there were systems by which these expenses could be avoided, they were deserving of the gravest consideration by those interested. There were many towns the rivers of which would be materially improved even if they could only begin by carrying out some crude process for even mechanical separation, and as they progressed and got them to a high standard, so they might improve the character of the effluent. He considered it absolute waste of money to talk about perfect standards in the effluent when it was to be turned into rivers, which were a long way below the standard of impurity of the sewage itself. Compared with such rivers as the Bradford Beck or the Calder, the sewage of many towns might be called clean, and for such places to go to large expense for purifying sewage at the present moment, was almost as absurd as to stand on the brink and throw sovereigns into the water. You must go by steps and raise the standard from time to time, as the condition of rivers improved. In conclusion, he might say that his experience taught him that there was hardly any one system which would be universally applicable.

The Conference was then adjourned till eleven o'clock the next day.

CORRESPONDENCE.

HEALTH AND SEWAGE OF TOWNS.

Sir,—In the paper which Mr. William White Fereday read before the Sanitary Conference, held under the auspices of the Society, he dwells chiefly on the treatment of human excreta of towns, by the process of the Town Manure Company, which consists in evaporating and drying the night soil, so as to produce a portable manure. He does not at all invite discussion on the chemical treatment of the material which he considers perfect, and has patented. But his closing remark appeals rather to the outside public, for after admitting that the process has been banished from West Bromwich as a nuisance, he remarks that the vapours and gases are now subjected to a process which ensures their "total destruction.."

Now, this is really where the hitch is, for of what avail is it to produce the best possible manure, and to relieve the Township Boards of their most perplexing difficulty, if the whole surrounding population is deprived of health, comfort, and happiness?

Or why should Sanitary Boards be debarred from running their night soil into the streams, and yet permitted to evolve the noxious exhalations which arise from them (intensified by empyreuma) into the air which we breathe, or (which is perhaps much worse) to collect the pestiferous matter, and store it up in their yard, perhaps in hundreds of tons, till they are able to manufacture it?

I am well acquainted with the locality in which one of Mr. Fereday's improved plants is erected, and have means of knowing to some extent the state of matters in it. I must bear my testimony to the facts that, whatever the improvements in it may be, the atmosphere in the line of the wind from the chimney of those works is totally unfit for human respiration; and that, in the simple interests of humanity, such a process ought not to be allowed near human dwellings. It is to be hoped that the Society of Arts, of which I have the honour to be a member, will be found using its influence to discourage this deleterious system. At one comfortable family residence, near these works, no window can be opened for weeks together, whilst the wind blows in the direction from them to it.

One wealthy firm, who have extensive manufactories near them, have received notice from their workmen that they must leave their employment if this nuisance continues, for they are often sick to vomiting when these filthy vapours blow towards their works; and they say that the stench from them is usually much worse in the night than in the day. And it is a fact that, at the present moment, the Local Government Board have before them a memorial from the locality referred to, which is signed by the principals of every adjacent firm, by several hundreds of workmen, and a number of medical men, clergy, J.P.'s, and influential people, praying that these works may be immediately removed. It is therefore much to be desired that a system so fraught with mischief and discomfiture to all near-lying people, will not gain the position of a recognised plan for the adoption of Sanitary Boards.

Allow me to remark in closing, that there is one expedient (though of limited applicability) for the deodorising of night soil, which I have seen applied with very marked success, although I believe it has not received any public notice.

Where ammoniacal salts are manufactured from gas liquor, there is generally a waste fluid produced, which contains a variety of the homologues of carbolic acid. Sometimes these are allowed to pass into the atmosphere as a vapour, and become an annoyance to the neighbourhood; I have always been in the habit of condensing them. In the present state of that industry a very large quantity of that (at present useless) deodorant might be collected, and if mixed with the night soil, under proper regulations, it would, to some considerable extent, aid in mitigating this great difficulty in most large manufacturing towns.

Apologising for trespassing so far on your valuable space,—I am, &c.,

Alfred Payne, F.C.S., F.S.A., &c.

Wolverhampton, May 27, 1876.

MEETINGS FOR THE ENSUING WEEK.

Tues. ...Royal Institution, Albemarle-street, W., 3 p.m. Prof. W. G. Adams, "Some of Wheatstone's Discoveries and Inventions." (Lecture III.)
Biblical Archæology, 9, Conduit-street, W., 8½ p.m.
Zoological, 11, Hanover-square, W., 8½ p.m.

Wed. ...Aeronautical (at the House of the Society of Arts), 8 p.m.
Entomological, 11, Chandos-street, W., 7 p.m.
Geological, Somerset House, W.C., 8 p.m.
Microscopical, King's College, W.C., 8 p.m.
Archæological Association, 32, Sackville-street, W., 8 p.m.
Obstetrical, 53, Berners-street, Oxford-street, W., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.

Thurs...Royal Historical, 11, Chandos-street, Cavendish-square, W., 8 p.m. 1. Mr. James Heywood, "The Establishment of Swiss Freedom and the Scandinavian Origin of the Legend of William Tell." 2. Mr. William Pilcher, "Lamoral, Count of Egmont."
South London Photographic (at the House of the Society of Arts), 8 p.m.
Inventors' Institute, 4, St. Martin's-place, W., 8 p.m.
Royal Institution, Albemarle-street, W., 3 p.m. Professor Tyndall, "Voltaic Electricity" (Lecture VII.)
Mathematical, 22, Albemarle-street, W., 8 p.m.

Fri.......Junior Philosophical, 6a, Victoria-street, S.W., 7.30 p.m. Mr. F. Clarkson, "Antiquity of Man."
Royal United Service Institution, Whitehall-yard, 3 p.m. Major Lonsdale Hall, "The Study of Modern Military History by the Regimental Officers of the Army."
Royal Institution, Albemarle-street, W., 8 p.m., Weekly Meeting. 9 p.m. Professor Tyndall, "The Parallel Roads of Glen Roy." (Close of the Season.)
Royal Botanic, Inner Circle, Regent's-park, N.W. 4 p.m. Professor Bentley, "Organs of Nutrition in Plants." (Lecture V.)
Astronomical, Somerset House, W.C., 8 p.m.
Quekett Club, University College, W.C., 8 p.m.

Sat.......Royal Institution, Albemarle-street, W., 3 p.m. Prof. Morley, "King Arthur's place in English Literature." (Lecture III.)
Physical Science Schools, South Kensington, S.W. 3 p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.

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All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

ANNUAL EDUCATIONAL CONFERENCE.

The twenty-fifth annual Conference will take place on Friday, the 23rd June, at 11 o'clock. The chair will be taken by Sir Henry Cole, K.C.B.

With the view of giving special interest to the Conference this year, the Council have decided that the subject of Adult Education, especially in reference to Technical Instruction and its promotion by the action of the Government, shall form the principal subject for discussion, and all persons interested therein will be invited to attend.

The discussion will take place under the following heads:—

1. Adult education as now conducted in literary and mechanics' institutes, workmen's colleges, clubs, &c., night classes, public elementary schools, &c.
2. Aid to adult education given by the Education Department.
3. Aid to adult education given by the Science and Art Department.
4. Aid given by the Universities of Oxford, Cambridge, London, &c., in examinations, lectures, and otherwise.
5. Aid obtainable from the surplus of the Exhibition of 1851, held by the Commissioners.
6. Subjects which it is especially desirable to promote in adult education, such as laws of health and cleanliness, household economy, food, music, &c.
7. Annual report on the Union of Institutions, and suggestions for improving the examinations of the Society of Arts.

Each speaker will be restricted to ten minutes on each separate division.

Intending speakers, under each head, are requested to fill up a form, giving name and address; and they will be called upon by the Chairman.

Special papers, which have been prepared at the request of the Council, will be printed and circulated at the Conference. The writers will be allowed five minutes for stating the substance of them, in addition to any speech.

The meeting will adjourn at 1.30 p.m. for half an hour, and continue not later than 4 p.m. It can be resumed if necessary on the following day.

After the Conference the Society will issue a report on its results, and on the several returns and documents which have been prepared.

SURPLUS OF THE GREAT EXHIBITION OF 1851.

Her Majesty's Commissioners have lately announced their intention of realising from their land possessions at South Kensington a considerable sum—it is said about £350,000—and applying it to those objects which promote Science and Art, as soon as the funds can be obtained. What aid the Commissioners may properly be asked to give to Adult Education will be one of the subjects discussed at the annual Conference on the 23rd June. The *Times* had an article on this subject, which is reprinted in the *Journal* (p. 737).

CONVERSAZIONE.

The Society's Conversazione will be held on Friday, June 23rd, at South Kensington Museum, by permission of the Lords of the Council on Education. Cards are now in course of issue.

NATIONAL TRAINING SCHOOL FOR MUSIC.

A second Scholarship has now been completed by subscriptions from the members of the Society. This has been awarded to Monimia Twist, the next on the list of candidates recommended for Scholarships at the Society's examination.

Of the eight recommended candidates, five have now obtained Scholarships:—Walter G. Alcock, Monimia Twist, Marion Westmacott, Frederick S. Dove, and Florence M. Warman. The three still remaining are Helen Akroyd, Percy H. Mull, and Emilie P. Brickwell.

The following are the subscribers to this Scholarship:—

	Annual for 5 years. £	s.	d.
Warren De la Rue, F.R.S.	20	0	0
Major Carpenter	8	0	0
Wm. Atkinson	5	0	0
Wm. Hawes, F.G.S.	2	0	0
Thos. Twining	2	0	0
Edward N. Clifton	2	0	0
John Ball	1	0	0

GENEVAN SOCIETY OF ARTS.

The Council have received from the Genevan Society of Arts a medal, struck to commemorate the centenary of that society. The medal has on its obverse a group of figures with various emblems of art and industry, and the legend, "Société des Arts de Geneve," "Fondée en MDCCLXXVI.;" on the reverse is "Centième anniversaire,

MDCCCLXXVI.," within a wreath twisted with a ribbon bearing the words "Artibus Promovendis."

HEALTH AND SEWAGE OF TOWNS.*

Wednesday, May 10th, 1876. The chair was taken at eleven o'clock by the Right Hon. James Stansfeld, M.P. The discussion on Water-carried Sewage was resumed.

HERTFORD.

Mr. W. Keith (Secretary to the Phosphate Sewage Company) desired to be permitted to read a paper he had prepared,† describing the system of purification adopted by the company with which he was connected at Hertford.

The Chairman said it was no part of the object of the Conference to discuss the schemes of companies having patented or other processes for dealing with sewage. If that were done these Conferences would be endless and useless, and would simply resolve themselves into a strife of contending interests. What they wanted to know with regard to Hertford was the practical effects of the method employed there, its success, and its operation on the death or sick-rate and the health of the population. They were not primarily concerned with the profit or loss which might accrue to a company or town as the result of the operations.

Mr. T. W. Grindle (Engineer to the Corporation of Hertford) said he noticed in the return from Hertford that the cost of the present process was put at £200 as against £450 expended under the lime process. It should be £400. Captain Flower, in his paper, representing the Lee Conservancy, stated that the lime process was abandoned, but the better word would be discontinued, the change being made simply because the Corporation derived a benefit of £200 a year by taking up tho phosphate sewage process. Prior to that process being introduced, he had an analysis of the lime effluent by Dr. Letheby, which he would hand in.‡ Captain Flower also stated that the nuisance from the lime sludge was intolerable, but this was a great exaggeration. From necessity not from choice he had lived for the last 19 years within 50 yards of the sewage tanks, during 17 of which the lime process was carried on, and it was not so offensive as described, though the present plan certainly diminished the smell, and the analysis made tended to show that a pure effluent could be obtained from it. Complaint was made by a sanitary authority below Hertford, where the effluent was turned into the Lee, that it was unfit to pass into the river, and Captain Flower, instructed by the Lee Conservancy Board, obtained samples of the water and submitted them to Dr. Keate, and his report also he would hand in. He stated, however, that both the waters were extraordinarily pure, so much so that he thought the sewage must be of an extraordinary character.

The Chairman asked if the sewage of Hertford was very much diluted before it was treated with this process?

Mr. Grindle said it was.

The Chairman said he gathered that such was the fact from Dr. Keate's report, a passage of which he read. That fact considerably modified the impression that might be entertained of the results of the process employed.

Mr. Papillon (Mayor of Colchester) wished to ask the meaning of the statement that the New River Company allowed the Corporation £600 a year, while the annual outlay for maintenance was only £200; was it that the Corporation made a profit of £400 a year?

Mr. Grindle said they did on the sewage works, which went towards the rates and to cleansing and repairing the sewers.

Mr. Papillon said it was also stated that middens and ash-pits were not allowed. Was that under the bye-laws?

Mr. Grindle said they insisted on all sewage being turned into the sewers. Sewers were provided, and they insisted on people draining into them.

Mr. Papillon—Was that under a bye-law, or under the general law as a nuisance?

Mr. Grindle—There was no bye-law. They treated them as nuisances.

The Chairman asked if the Corporation themselves applied the process, or the company?

Mr. Grindle said the Phosphate Sewage Company agreed to treat the sewage of Hertford for £300 a year, but they paid the Corporation £100 a year for the use of works.

The Chairman—Therefore, but for the contribution of the New River Company, they would be at a cost of £200 a year?

Mr. Grindle said that was so.

Captain Douglas Galton, C.B., asked if all middens were abolished in the town; were there not some cottages in the vicinity which still had them?

Mr. Grindle said every cottage had a water-closet and water supply. There were about four earth-closets in the whole town. There were no cess-pits of any sort in the borough, unless there were one or two unknown to the Corporation.

Captain Galton asked if any difficulty was found in keeping the closets in order in the small cottages?

Mr. Grindle said there was no difficulty whatever, because a pail of water would always clear a closet.

Mr. Councillor Walker (Leeds) asked if an analysis had been made of the sewage previous to treatment?

Mr. Grindle said that from an analysis made when the lime process was in operation, showing the character of the sewage before and after treatment, it appeared that the character of the sewage was the same now, or if anything slightly stronger.

Dr. Yeld (Sunderland) asked what was done with the town refuse if they had no middens?

Mr. Grindle said there were ash-pits; that is, the ashes were thrown down in the yard without being enclosed, so that they might be frequently removed. The average water supply was about 40 gallons per head daily.

Mr. Cook (Ware) asked what system was adopted with tho effluent after it left Hertford Sewage Works before it entered the Lee? He wanted to know if there was not a system of stops, and whether steps were not taken to remove a good deal of the scum from the water.

Mr. Grindle said the effluent after leaving the works did not undergo any treatment whatever, but there were skim boards put down to take off that low confervoid growth spoken of in Dr. Letheby's report, and to prevent it flowing into the Lee. Every morning a man went down with a net, and wherever he found this flocculent matter he skimmed it off and put it in a receptacle on the bank.

The Chairman asked the distance from the point where the sewage left the works to that where it entered the Lee.

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* The report of the discussion will be continued in subsequent numbers of the *Journal*. For the convenience of those wishing to have the account of the proceedings in a more compact form, the same will also be published as a pamphlet, which can be had in a few days on application at the Society's House. Price 2s. 6d.

† See *Journal* for May 19th, page 631.

‡ See Analyses of Hertford effluent water, page 734.

Mr. Grindle said about 1,400 yards.

Mr. Cook said you could see the effects of decomposition in the Lee below the inlet of the Hertford sewage. The water was not fit for drinking purposes. There were hundreds of tons of deposit taken out of the ditch.

General Scott asked if the confervoid growth spoken of was of the nature of sewage fungus?

Mr. Grindle said it was called sewage fungus by some persons; but Dr. Letheby called it confervoid growth, and he adopted the name on his authority.

Leeds.

Mr. Alderman Tatham (Leeds), after stating briefly the substance of his paper on Leeds*, said that they had succeeded perfectly in the ventilation of sewers, going on the principle that fresh running sewage through clean drains evolves no deleterious gases, and where it did come up it was from some fault in the drain or subsidence, or some slack place which caused it to decompose; and they considered that if there were deleterious gases they were better outside the house than inside. He had seen Latham's charcoal baskets, and also the direct openings in London, and came to the conclusion that openings were the right thing. At the time of the Prince of Wales's illness there was a great panic about sewage gas, and the Town Council voted £5,000 for the ventilation of the sewers. One of the committee suggested that they should erect direct openings in the middle of the streets at the cost of £4 each, but they thought it better to have a large number of small ones than a small number of large ones, and, therefore, eventually the method of simply tapping the dip stone of the openings of the gullies was adopted, and there are now about 13,000 or 14,000 gullies open. The advantage and benefit was very marked in the air of the sewers, and whereas the large openings would have cost £4 each, the alteration of the gulley holes only cost about 6½d. At the same time in any new streets they put a large ventilating shaft in at the intersection, and at every dead end put in a pipe or shaft connected with some chimney shaft. As the gullies were opened they were carefully examined to see if any smell came up, and if so, means were taken to ascertain the cause and rectify it. Many persons naturally had endeavoured to discover defects, but complaints were always investigated immediately, and were generally found to arise from the gulley boxes being filled with foul matter, and when they were cleaned out the nuisance ceased. One of the Corporation on one occasion complained of a great smell in a gully hole, but on visiting the place it was found that though the smell did exist it evidently came from the gas works in the immediate neighbourhood. The action of the air in the sewers is not constant. Sometimes the gases are heavy, sometimes light, so that the draught is sometimes up and sometimes down, but by having these numerous openings all difficulty is avoided. The medical officer of health was at first entirely opposed to this method, but he eventually came round to their view, and agreed that it was the best system. He also after the completion of the openings reported that the town was now free from all preventible disease.

Mr. Marsden (Bolton) said Mr. Tatham had not given any distinct judgment in favour of one system over another.

Mr. Humphris asked the rate of inclination of the sewers, and also as to their general freedom from deposit?

Mr. Tatham said in some parts there was a very satisfactory fall, but in others the sewers were very flat. Some required cleaning out occasionally, and flushing was useful too, but they had no particular difficulty.

Mr. Marsden asked if they had not given up one process because they were infringing on a patent right?

* For paper, see *Journal* for May 19th, page 632.

Mr. Tatham said they had nothing to do with patent rights. If any man came to them with a better system they would try it, and leave him to fight the question of patents.

Mr. Shelford asked firstly, if all the sludge was dried; secondly, if the £1 per ton included the cost of chemical manipulation and drying; and thirdly, whether the £1 per ton for manure referred to manure thoroughly dried, or what percentage of moisture it contained?

Mr. Tatham said the price included drying, chemicals, labour, and interest on capital, and the manure was dried sufficiently to be drilled.

Mr. Monson (Acton) inquired the value of the raw night soil at Leeds, and what was added to this deposit to make it more valuable than the night soil itself; also whether the precipitant used was any advantage to the water supply or the rivers?

Mr. Tatham said with regard to the precipitant a pure water must be an advantage to the river. The ingredients were disposed of, so that the effluent became comparatively pure.

Mr. Walker said the night soil deposit was mixed with ashes, which was difficult to sell, and they only got about 1s. 6d. a ton for it. They did not sell any pure.

Captain Galton asked if there were any arrangements for drying the sludge, and if so, how long they had been at work?

Mr. Tatham said they had been going on in the most economical manner they could, and putting off expenditure as long as they could. Hitherto they had been drying in the open air; but recently they had got a pair of drying cylinders at work. They were drying about a ton and a quarter a day at a cost of not more that 5s. per ton.

The Chairman said he understood they had had drying cylinders at work for some years.

Mr. Tatham said that was the company, not the Corporation. He could not say what their results had been.

General Scott said he was not one of those who thought there was no value in the deposit from sewage. It would be a great pity to adopt the idea of the Rivers' Pollution Commissioners, who estimated the value of the A B C manure at 32s. per ton.

Mr. Tatham said the Blue Book said so.

General Scott said the matter required a little more explanation. They estimated one sample at £1 14s. 9d., but added that according to Messrs. Lewis and Gilbert's opinions it was not worth one-third of the sum, and there were no better judges in the country of the value of manure. He should like to know if the process was carried on continually night and day. A great difficulty arose when towns had to deal with a great quantity of this sludge. He should also like to know the nature of the Hanson process, if it consisted largely of soda-waste the precipitating power was due to the use of lime, and of course that would add very materially to the bulk of the deposit, and diminish its value. Were the dyes actually taken out so as to make the water perfectly colourless? He might mention on this point that with the exception of a very few dyes they were not injurious to health. Some contained arsenic, and those ought to be kept out of the sewers, but as a general rule they were not injurious, and the Bill proposed to be brought into the House of Lords the year before last would have done away altogether with the test of colour. He also wished to know the composition of the material now used at Leeds as the A B C precipitant, and particularly whether the amount of lime had not been largely increased so as to make a wide difference between the process now in use and that employed three or four years

ago. He believed lime to be the cheapest possible precipitant, but the effluent would be improved by the addition either of sulphate of alumina or sulphate of iron. The question was whether it was worth applying it.

Mr. Tatham said the process was worked night and day, and there was no Sunday closing. The dyes had not been taken out by any process equal to the A B C. They had operated on the dye waters, and there were samples in the Town-hall of various dye waters, the colour of which had been extracted by the A B C process. Hanson's also took them out, but at an additional cost.

General Scott said the question was hardly answered in such a way as to enable the Conference to understand it.

Mr. Tatham said in January, 1876, the lime used by the A B C was 8 tons 13 cwt., as against 7 tons 2 cwt., showing that the relative proportion of lime had been increased.

Mr. Crookes said he attended the Conference in two capacities; in one, namely, as the Chairman of the Native Guano Company, he did not wish to say anything; but in the other, that of an independent man of science who had studied the subject of sewage purification for many years, and knew as much as most persons of the practical working of all the processes, he might be able to give some useful information. There were one or two points connected with the effluent from precipitation processes which ought to be borne in mind. In the first place, you must not have an alkaline effluent, because wherever there was alkalinity there was a tendendency to putrefaction, as had been proved over and over again. Where you could keep the effluent acid, you were safe, and if it were neutral the carbonic acid of the atmosphere would make it safe. The amount of lime which might be used could be increased to a considerable extent, but it would be unsafe to exceed the quantity necessary to neutralise the acid in the sulphate of alumina. Any chemist would understand that so long as the lime was kept in less proportion than sufficient to neutralise the acid in the sulphate of alumina, the effluent would remain acid; but if they overstepped that amount, the effluent became alkaline, and tended to cause putrefaction in the river and to kill the fish. The amount of lime put in at first was at Leeds *nil*, and the action of the A B C materials then depended on the natural alkali in the sewage owing to the decomposition of the urea into carbonate of ammonia, which made the sewage alkaline. That alkali precipitated some of the alumina from the sulphate of alumina and this acted as a mordant, carrying down much of the albuminoid substance present. A great deal of the sulphate of alumina put in was sometimes wasted because there was not alkali enough, and therefore, adding lime would give a better action. The lime was added first to the sewage, and was well mixed with it, and the sulphate of alumina put in afterwards. His instructions were positive never to add sufficient lime to make the effluent alkaline. Another point, proved many years ago by Professor Heisch, was this, that you must not have phosphoric acid in the effluent, or there would be a great tendency to produce the low confervoid growth commonly called sewage fungus. That was a great difficulty with any process which had any phosphate in it. He did not recollect seeing more than once or twice any such fungus in the effluent from the A B C process, and he attributed that freedom to its acid character and the absence of phosphates. The process carried on at Leeds by the Native Guano Company could scarcely be called an experiment, since they had treated about 5,000 million gallons, and, during the whole of the time the effluent had been in a fit state to go into any river in the kingdom. The value of the manure was a moot point. Some chemists put it at 30 shillings per ton, and at that price it would not be worth carrying to any great distance; but the great test was what would it fetch in the market. The Native Guano Company had sold over 4,000 tons of their product, which had brought in about £14,000 in hard cash, or about £3 10s. a ton; and no doubt the whole of the native guano at Leeds could have been sold, if the managers in London had wished to sell it. But the reputation of the native guano which brought in that £14,000, was made from guano prepared from a residential town well water-closeted, where there were no manufactories, and as in a town like Leeds there was comparatively little night soil and an immense quantity of refuse from all kinds of factories, it was not considered safe to injure the reputation of the native guano by selling the Leeds product under that name.

The Chairman felt bound to say that in his opinion Mr. Crookes had kept well within the limits he had assigned to himself, and certainly had not indulged in any speculations as to the merits of rival systems.

Mr. Grindle wished to know if Mr. Crookes was of opinion that the value of manure as given by chemical analyses bore no proposition whatever to its value as reckoned by the farmer; in other words, was the analysis worth the paper it was written upon?

Mr. Crookes said, although he was a chemist, he had very little faith in chemical analysis when you had simply a row of figures given to you. The analysis of water, such as was ordinarily given without comment or explanation, was of no value whatever. He attached little importance to a chemical analysis of manure, when it simply said so much per cent. nitrogen, and so much per cent. phosphoric acid. The nitrogen, the chemist said, he would calculate as ammonia, not saying whether it really was in a form that would destroy a plant or nourish it, and the phosphoric acid he would calculate as bone-ash, not saying whether it was in a form which the plant could take up, or whether in the form of phosphate of alumina, which had little, if any, manurial value.

Mr. Grindle said he understood that manure stated by the analyst to be worth only about 30s., was found by the farmer to be worth £3 10s.

The Chairman asked if that referred to the same samples. He understood that the manure at Leeds would be of less value than that from a residential town.

Mr. Crookes said he took it for granted that the refuse from Leeds was principally manufacturing, and could not have so much value as from a town well water-closeted, and with no factories in it. The analyses he spoke of were the general analyses they had always had of manure from a residential town.

Mr. W. C. Sillar wished to ask a question of Mr. Crookes for the satisfaction of the meeting, viz., if before he was connected with the Native Guano Company, or had any interest in that or any other, he had personally visited any districts where the farmers had treated their crops with the manure known as native guano, knowing what the chemical analysis of it was as given by Dr. Frankland. Also whether he himself saw any farmers or persons in whose judgment he had confidence from whom he received information regarding its agricultural value.

Mr. Crookes, in reply, stated that before he had any connection with the native guano, while pursuing his inquiries on the general subject of sewage purification, he visited the neighbourhood of Leamington, amongst other places, and knowing the Native Guano Company had works there, and were selling manure, he made a point of visiting every farmer in the neighbourhood whom he could hear of who was using it, and asking his opinion. He also went to the agent for the sale of it, and an inspection of the books showed that a farmer would perhaps have half a ton given him one

year, the next year he would order five or ten tons, and in the third year 50. There were several instances of that kind of thing. That was conclusive to his mind that the farmers found something in the manure which the chemical analysis did not detect. There were a great many substances which chemical analysis would show to be almost worthless, which yet were very valuable indeed. He could see chemical reasons why the native guano should be a good manure, but they were not reasons generally recognised by science as yet; they required more working out.

General Scott wished to ask the effect of alkaline matters in promoting decomposition. Undoubtedly they did so in many cases, but the inference he should have gathered from Mr. Crookes' remarks, if entirely ignorant of the matter, would be, that putting alkaline water on the land would be injurious to the soil. But still lime was largely used for agricultural purposes. He wished to ask whether as long as it remained alkaline it did not tend to prevent putrefaction rather than to encourage it? At the same time he agreed that it would be far better if they could do so, to place sewer water in rivers in a slightly acid condition. The whole question was, whether it was worth the cost of doing so. A remark was made about fish living in the water, but they must not be misled by that, for he had seen sewage water strongly limed at Ealing in which fish would live for a month at a time.

Mr. Crookes said there might be cases in which it would be very advantageous to put lime on the land where the land was said to be of an acid tendency. There might be decomposition going on in the land which tended to develop something of an acid quality, for which the lime proved a corrective. It was only useful under certain conditions where it would be neutralised by the carbonic acid in the land or the atmosphere, and become carbonate of lime. It was generally recognised that alkalinity promoted putrefaction. He remembered a case in some irrigation fields at Edinburgh where the sewage was put on the land, and the effluent was either neutral or slightly alkaline; there was an immense quantity of insect life in the land. A change was then made, and McDougall's disinfectant, or something of the kind containing carbolic acid, was used, and the result was the whole of these small animals were destroyed, and the crops were made perfectly clean. In chemical experiments also it was known that if you wanted to promote putrefaction you must keep the matter alkaline. Some fish would live in anything, and near the outfall of sewage you might find plenty of fish. Some, however, were particularly delicate, the gudgeon for instance, the slightest taint of sewage would kill it. In the effluent from the native guano works erected in Paris some years ago they had many of those fish living, and this was considered by the authorities there the best proof of the purity of the water. However, he thought it a mistake to look at the purity of the effluent water from too chemical a point of view. He would not, of course, say anything against chemistry, but the common sense point of view should prevail. If water was clean to look at, had no smell, did not form a deposit on standing, and a person who did not know where it came from pronounced it good water to the taste, and if fish would live and thrive in it, he saw no harm in putting it into a river such as the Aire at Leeds which was worse than ordinary sewage, or into any river at all even if it contained more organic nitrogen and organic carbon, and more salts in solution than chemical analysis said it ought to. The common sense way of looking at it was this, that any effluent should be better than the water of the river into which it was put. If that process were adopted universally it would tend to purify the river naturally. The manufactories at the top of the river would of course have the highest standard of purity to work up to, those lower down would for some years have the standard very low, but it would go on increasing as they found the means of purifying the water they threw in. In that way, by making the river itself the standard of purity, the thing would work itself round; until at last you came to this point, that nobody could put any thing into the river, because from one end to the other it was as pure as the mountain stream which gave it birth. Then would come the time for chemical analysis.

Mr. Alderman Taylor (Rochdale) thought Mr. Crookes had enunciated a fallacy which he wished, if possible, to correct. He said a residential town would have stronger manure than a manufacturing town where closets were not in use.

Mr. Crookes said that was not quite so. What he said, or meant to say was, that the sewage from a town like Leamington, well water-closeted and containing no manufactories would be likely to make better manure than that from Leeds, which not only did not contain much night soil, but was full of manufacturing refuse, dye waters, and things of that sort. He attached much more importance to the dye waters than the presence or absence of night soil. The principal value of the excrement was the urine, not the night soil.

Mr. Taylor said that was precisely the point he wished to refer to. In Halifax, Bradford, or any woollen town in Yorkshire there must be a vast deal more urine in proportion than in a residential town, and not only urine but nitrogen in other forms. Leeds no doubt collected a vast amount of urine for manufacturing purposes, and so did every woollen town. The sewage of a town like Leeds must be much stronger than that of any residential town.

Mr. Walker asked if Mr. Taylor meant to say that if the urine was taken out of the sewage and put into the river, that therefore the sewage would be better.

Mr. Taylor said that if a town were well water-closeted the manure was much more diluted than if it were not, because there was a great deal more water used.

Mr. Crookes asked if it was not the fact that the urine at Leeds was collected in separate receptacles, and sold to manufacturers on account of the ammonia and other properties it contained. He knew that was the case in many towns, especially on the Continent.

Mr. Tatham said the urine was largely collected in Leeds for manufacturing purposes, and was for that reason kept out of the sewers, and this reduced the value of the sewage.

Mr. Taylor asked if the equivalent of the urine did not come back to the sewers again?

Mr. Tatham said no, it went into the river.

Mr. Taylor said it ought to go into the sewers.

Dr. Wright asked how it was that the A B C process was abandoned at Leamington if it was successful?

The Chairman thought that was a question rather outside the scope of the Conference.

Mr. Botly said that lime, though used by farmers, was not used as a manure. It was used where land was strong, to correct the acidity.

General Scott admitted that lime could not properly be called a manure. The first point was whether the small quantity of lime in excess left in sewage water after precipitation by the lime process was not neutralised by the carbonic acid when it got into a river of moderate size. The next was regarding the word putrefaction and the action of alkaline matters. Did Mr. Crookes mean to assert that by mixing lime with a sewage deposit you actually promoted decomposition and made it stinking? He should be ready to prove that the presence of lime preserved it.

Mr. Crookes said that when water contained a small

excess of lime, it would be practically destroyed as soon as exposed to the air, by carbonic acid. As regarded the tendency of alkalis to produce decomposition or putrefaction, he did not use the word putrefaction to include a great many decompositions, of which little was known, but in the ordinary sense which everybody understood. Sewage matter contained a large quantity of a substance very much allied to albumen, and the most horrible smell which could be imagined was produced by the action of alkali on albumen. He had detected that smell in a great deal of sewage sludge, but only when it was slightly alkaline. It could always be prevented, either in the laboratory or on a large scale, by slightly acidifying the solution. The question whether alkalies tended to decomposition or not was a question rather too chemical to discuss at that meeting. Chloride of lime was totally different to lime itself.

Mr. Towle said there was a great sensation in the country three or four years ago on hearing that Leeds was trying experiments with several plots of land, to prove which was the best manure, and he should like to know if the process was still going on, because he understood it proved that native guano came next to Peruvian.

Mr. Tatham said the experiments were carried on for two consecutive years, and then they preferred referring to practical agriculturists for their reports.

Mr. Towle said he was an old practical farmer, and had had a thorough experience of these manures for many years. His experience was that you might well manure a field with farmyard manure, or any other, and then if you gave it a good liming process, the lime neutralised the manure, and you might just as well have done nothing at all.

Mr. C. N. Cresswell wished to ask Mr. Tatham if the question of water supply for manufacturing purposes was not, in the north of England, the most vital question of the day, and whether the effluent produced by the A B C, or any other precipitating process, would not be pure enough for such purposes. Had the Corporation considered that important question?

Mr. Tatham said there was no doubt the value of pure water for manufacturing purposes was very great, and manufacturers would enjoy their full share of the benefit of purifying the rivers; but the pressure had come upon them from the landowners below, who found the pollution destructive to the fish, and from other reasons. They had considered that if the effluent were returned to Leeds, it would be useful for many purposes for watering the streets, and for domestic purposes other than drinking, and eventually he expected they would utilise it in that way.

Mr. Hanson said he should have risen earlier to give the particulars of the process he employed, but for the statement of the Chairman that the Conference was not intended to hear particular processes explained, but as inquiries had been made he would state the materials he used. They were black ash, a refuse from the alkali works in large quantities, mixed with sulphuric acid. Lime cost 14s. 6d. per ton, and black ash, 8s., and by the addition of two tons of this, the sludge was precipitated and neutralised much better than by lime alone, while it was more economical. The quantity he used was 10 tons per day less than that of the A B C process, being 24 tons against 34. The great advantage was that it reduced the quantity of residuum. He must entirely repudiate the idea that he was infringing any other patent. There was a patent for salts of iron, but that was too vague, as there were many salts of iron, and would be more.

Mr. Taylor asked what was meant by black ash?

Mr. Hanson said it was the refuse produced from alkali works. No use had hitherto been found for it, and it was thrown aside and stored in large quantities, when it became dangerous, because it had such an affinity for oxygen that it readily heated, and would take fire unless precautions were taken. It was the very thing which was wanted to neutralise the lime.

Mr. Crookes said that what Mr. Hanson used was not black ash, but soda or tank waste, consisting essentially of the sulphides of calcium and sodium.

Leicester.

Mr. James Thompson next described what had been done at Leicester. For the last 30 years he had watched the proceedings taken for the disposal of sewage in that town. About 20 years ago a plan was adopted, drawn up by Mr. Wicksteed, for dealing with it by the lime process, when a private company was formed, who attempted to produce a valuable residuum, and at first it was imagined that £5 per ton would be realised. Lime water was injected, and the sewage then passed into large tanks, where the solid deposit was precipitated. It was soon found that the product had to be given away, and even then the farmers hardly cared to have it. Other experiments were made, and a few years ago the A B C process was tried, but no one felt inclined to take it up. The loss on the sewage works last year was £2,000, and it averaged from £1,400 to £2,000. The local boards of the surrounding districts now proposed to connect their sewerage systems with the borough of Leicester, and it was decided that if any mutually advantageous terms could be arranged, some comprehensive plan should be adopted for dealing with the sewage of the whole district. Similar proceedings were going on at Nottingham, where the officer of the Board of Health had drawn up a scheme for disposing of the sewage by irrigation, and they hoped to adopt the same course, for he believed the authorities had come to the conclusion that the proper way of dealing with sewage was to put it on the land. The published returns were wrong in two particulars, the population being 115,000 instead of 95,000, Leicester having made the most rapid progress in population of any of the large towns between 1861 and 1871; and secondly, with regard to the pail system, the expense stated only referred to that incurred by the Town Council, omitting that which fell on the householders themselves, which was an important item.

The Chairman having announced that any remarks on the general subject of precipitation would now be received,

Mr. Shelford, C.E., said he did not represent any town or district, or advocate any particular process, but as an engineer he had had to construct works for various precipitation processes, and having thus had to consider the whole subject, he had published in the *Engineer* what he conceived to be the main conclusions which had been fairly established. In the first place it seemed clear that those precipitation processes would not pay commercially, which required a large quantity of chemical ingredients; next it had been proved that the cost of drying sewage sludge was £1 per ton, and that the total cost of manipulation, including everything except chemicals, was 30s. per ton or £6 8s. 6d. per million gallons, and that this was about the same in all processes. It followed therefore, that the cost per million gallons of sewage depended on the quantity of chemicals employed. If four tons of manure were obtained, four times 30s., or £6, repaid the cost of dealing with the million gallons. If owing to the large quantity of chemicals employed you obtained eight tons of dry manure, then the cost would be doubled. If the cost of drying by machinery was saved, the minimum cost of manipulation would be one-third, or £2 2s. 10d. per million gallons; but according to the statements made, that minimum had not yet been reached, nor did he think it was likely to be reached at present. Mr. Rawson and Mr. Alderman Tatham had given the cost of materials at 37s. per million gallons; and adding that to the cost of manipulation £2 2s. 10d.,

it appeared that the cost at Leeds was £4 per million gallons, without drying, and without crediting anything for the value of the manure. Precipitation processes might be divided broadly into two; cheap methods, and recuperative methods. By the former you ought to remove and dry the sludge in the cheapest possible manner, of which the lime process was an example, by the latter, to recover the outlay by the sale of dry manure. But no solid return could be expected from any recuperative process until chemists and agriculturists were agreed as to the value of these manures, and meanwhile precipitation must be conducted at the expense of tho towns requiring it. In conclusion he thought the representatives of the various towns might go home with this conviction, that before they could conduct efficient precipitation they must pay £3 per million gallons of sewage.

Mr. Walker asked if the £1 per ton expense for drying appliod to any particular machine?

Mr. Shelford said it was the result of drying partly in the open air and partly by Milburn's machine.

Mr. Walker said the highest estimate they had heard given of the amount of moisture in the sludge was 80 per cent., or 1,792 lbs. of water per ton. Now, it would be a very poor machine indeed which would not evaporate 4 lbs. of water for every lb. of coal consumed, and therefore 4 cwt. of coal would evaporate the water in a ton of sludge. As they paid 5s. per ton for coal in Leeds, the expense for fuel would be just 1s. per ton. The machinery they used was Borwick's cylinder, which required very little power; a portable engine of 15 or 20 horse-power worked the whole machinery, and about five men were employed. If he had known this question was coming up he would have been better prepared, but the cost of drying the sludge had already been given by Mr. Tatham at 5s. per ton, and the figures he had now mentioned showed pretty clearly that that estimate was within the mark. He had not read the paper in the *Engineer*, but he thought this instance was enough to induce gentlemen to trust rather to their own experience than to those who made calculations for them.

Mr. Rock (Hastings) said he had tried the sewage manure on half an acre of land, which he had broken up for the purpose. He gave it 4 cwt. of dry sewage manure for four years, and grew the same crop, mangel wurzel. The crops were very good throughout, but the last was probably tho best. It was never less than 30 tons to the acre, and in one case 40.

Mr. Robert Rawlinson, C.B., said he had been engaged in collecting the most recent information with regard to the several modes of dealing with town sewage, and a preliminary report was now before the President of the Local Government Board, in which all the facts were given. He might, however, say broadly that, in his opinion, the question of dealing with sewage ought not at the outset to be one of profit to the town, but of getting rid of that which was injurious to human health in the cheapest and readiest way. There were many places in Lancashire and Yorkshire where irrigation was impracticable for two reasons; one, the difficulty of obtaining land, and another, the great objection to depriving the district of its water. The manufacturing districts were so thickly planted that they must have water, dirty or clean; and there were many purposes for which dirty water could very well be used, though they would much rather have clean. How the rivers were to be cleansed was the great problem to be solved, as it was evident that the manufacturing industries could not be very much extended if the present rate of pollution went on. This pollution took place in various ways, and any one who read the reports of the Rivers' Pollution Commission, and would look carefully at the deductions drawn from them, would see that proper regulations might very largely reduce the present evils. He should certainly tremble, however for the trade of this country, if at first rigid chemical standards were set up and enforced, simply because they would be absolutely impractical. He held that nothing could be more injurious for a State than to enact a law which could not be obeyed. Certain restrictions might however be very stringent if they were confined to special things. For instance, the rivers were abused in many ways, by casting in solids as well as fluids, but the former was so gross and palpable an abuse that it hardly needed one word of argument to convince reasonable men that it ought not to be practised. There were millions of tons of solids thrown recklessly into the rivers each year, which were washed down, and so raised the beds and banks of the streams, that when a heavier fall of rain than usual occurred hundreds of thousands of pounds worth of property was destroyed by the inundation. Another form of abuse, which some might perhaps defend, was this. Many mills or streams in the manufacturing districts took water in from the river into lodges, and it was usual to stop the mill for a period and flush the mud back again into the river. This he thought ought not to be allowed in the interest of all. It might be said that the mud came from the river and might fairly be sent back again; but the injurious effects were there. Those on the upper part of the stream got the water in its purest state, and used it, and accumulated this mud in goits and small dams, and then flushed it out into the river, say on a Saturday afternoon or Sunday, and it went down to some unsuspecting manufacturer, who was not prepared for it, and he had known instances where hundreds of pounds worth of pieces were destroyed by this kind of thing. If the mud was taken out by hand it would cost perhaps 2s. a ton, and the river would be so far purified. To come back to the several modes of dealing with sewage, towns should look not to profit but to the cheapest mode of dealing with it. After investigating all the best methods, he knew of none by which a town would be benefited commercially by dealing with its sewage; not even by irrigation when all expenses were charged; but he believed the least loss arose where irrigation was carried on in a proper manner. He also thought the outcry made against irrigation and sewage farming was quite groundless. The assertion that sewage farms were swamps need not be true, or even that they bred disease; and it was certainly not true that the produce was unwholesome. Assuming a sewage farm of 100 acres, there need at no time be more than 5 acres under sewage, and for any special purpose not more than one acre; and it must be obvious that there could not be much of a swamp where only one acre was under sewage. Experience had also solved the question of wet seasons and frost; there was really no difficulty whatever. Col. Jones would tell them that a wet season, so far from being adverse to sewage farming, was absolutely beneficial to it; the only drawback being that it gave the adjoining farmers an advantage which reduced the value of his crop, though it did not reduce its amount; he might also have a little more difficulty in getting his crop off the ground and disposing of it. As to the quality of the produce grown, there was experienco enough to silence any objection; the grass did not purge the cattle or create any form of disease, and if the season was favourable, it would make fine wholesome hay. The only difficulty was that the grass was so abundant and succulent that it took a long time to dry; but if it could be thoroughly dried, it made very good hay, which tho cattle liked, and did well on. These things being so, the result was, that precipitation, where you could not possibly get land for irrigation, was the best process, not to make profitable manure, for in his opinion profit was not to be made out of the matter deposited from sewage; at all events, he knew of no process that came within any range of profit. He had analyses from Dr. Voelcker, of samples of sewage mud taken from several towns, and in no instance did he give the value with the chemical ingredients, as far as he recollected, at £1 per ton; and it must be remembered that he made his analyses by drying the manures which he had tested to an

extent much greater than was ever done in practice. Whether farmers would give that sum, 20s. per ton, he was not prepared to say, but there was this one great fact staring one in the face, that whatever the value of the manure might be, it did not find a ready sale. When he was at Rochdale, he saw thousands of tons which the farmers would not take away. It was evident, therefore, that whatever the value might be, at the present time the price asked did not offer sufficient inducement for farmers to buy it. Towns, therefore, must be content to clarify their sewage at the expense of the rates.

At this period of the proceedings the Conference adjourned for luncheon.

On re-assembling, the chair was taken by **Captain Douglas Galton, C.B.**

Mr. Adam Scott said it was important to consider the state of legislation in connection with this question. They seemed preparing the way for some measure in connection with river pollution, and with regard to this problem, public opinion seemed divided into two general schools. One looked at the question in an æsthetic view, and wanted to restore the rivers to their original clear appearance, whilst the other looked upon the sanitary question as the most important, and considered that it was not in any way answered by simply purifying the sewage just before it went into the river. Irrigation and precipitation, good as they were at the outfall, did not interfere with the diseases which might be caused by the sewers in the town itself. If the whole sanitary force of the Government, therefore, were to be directed to one point, it should be to that one which would have the greatest effect on the health of the country. It should not legislate simply for the fish in rivers, whilst leaving typhoid patients and others untouched. According to the Registrar-General's returns, there were 15,000 deaths and 150,000 cases of sickness from typhoid fever in one year, and taking the average length of life at 40 years, it would appear that one in every five of the population who reached that age had suffered in some way or other from typhoid. He would, therefore, beg to propose a resolution to the Conference, affirming a general principle with regard to the proper mode of dealing with town sewage from a sanitary point of view.

The Chairman said it would be premature to propose any resolutions until the close of the discussion.

Mr. Richard Monson asked Mr. Scott if he considered it a better plan to store sewage at every dwelling than to remove it directly by means of water-carriage.

Mr. Scott said this was a very important question, and he thought it would be very well if the Government appointed a committee to inquire into it. It was impossible at the present moment to say whether the old prevailing system in this country was better or worse than the water-carriage system.

DISPOSAL OF SLUDGE.

Major-Gen. Scott, C.B., said the whole question of dealing with sludge was simply how to get rid of it in the least expensive manner. In proportion as you put in a larger quantity of precipitating material you rendered the manure of less value, unless the added material itself had a value. The principal plans proposed had been the method by lime, by that in conjunction with sulphate of alumina or of iron, and in conjunction with phosphoric acid in some soluble form. If the resulting manure had no particular value, the cheapest plan, of course, would be to use the cheapest precipitating material. The deposit by lime had a theoretical manurial value of £1 10s. per ton, but really it would not sell for 2s. 6d., in fact it was often difficult to get it taken away. In the phosphate sewage process you got a certain amount of phosphate of alumina in the deposit, and according to his own experience it had a theoretical value of from £3 to £4 per ton. What the practical value was he could not say, and it could only be found out by trial on an extended scale. Dr. Voelcker considered that phosphate of alumina in the precipitated form was almost as valuable as precipitated phosphate of lime, which he put at £15 or £16 per ton. Precipitated phosphate of iron he put at something like the same value. If this were true, the process of precipitation by phosphoric acid had something promising about it, but the great defect was, you put in a material having a certain value, and brought it out in a deteriorated condition. It would be interesting to ascertain more nearly than had yet been done the amount of sludge to be disposed of by the different processes. In the lime process the amount was very considerable; at least 50 per cent. was added to it, and if it was an expense to get rid of, you would be better off with a smaller amount. In that respect Mr. Crookes' remarks were very valuable, namely, that in proportion as you put acid into the water you carried away the lime in solution, and therefore increased the value of the deposit. He thought the A B C process would be improved by omitting the shaly matter. Mr. Hanson, he understood, used the refuse from alkali works. This might be valuable in taking out colour from dye waters, but here again you had a large admixture of inert matter introduced. With this sludge there was a small quantity of lime, with a large quantity of carbonate and sulphide of calcium, which was a defect in the process. He did not quite understand the different statements made as to the quantity of lime used in the A B C process; Mr. Hanson said it was 34 tons per day, and that he, by his process, used only 24 tons; but in either case a very large quantity of sulphuric acid must be used, or there would be a large amount of carbonate of lime present. These matters might appear technical and tedious, but they were very important. The amount of organic matter would not vary much in the different processes.

Mr. Tatham said he had it in Mr. Hanson's own handwriting, that 34 tons was the total amount of material used by the A B C process.

Gen. Scott asked the total quantity of material now used *per diem* at Leeds?

Mr. Tatham said they were now using lime only, and it took 14 or 15 tons. This did not remove the colour from the dye waters, and next week the A B C were going to make another trial and see if they could reduce the cost.

Gen. Scott asked the amount of lime used by the A B C.

Mr. Tatham said eight tons, the total cost of the precipitants was then 18s. 3¾d.

Gen. Scott remarked that in that case the cost of the eight tons of lime alone would be £6 per day, and as every 28 lbs. of lime used would require 50 lbs. of good commercial acid to neutralise it, besides that required to neutralise the alkalinity of the sewage itself; fourteen tons of sulphuric acid would therefore be required, which bad cost £3 10s. per ton, and it did not need much calculation to show that the total cost of the precipitating material must be something like £53 8s. a day, which multiplied by 365, gave £20,075 per annum. He did not know what Mr. Hanson meant by saying that whereas he used 24 tons of lime, the A B C required 34 tons.

Mr. Hanson said his statement was that the quantity of materials of all kinds was 24 tons, against 34 tons of all kinds used by the A B C Company.

Col. Jones said the question of sludge disposal was a very important one, and he looked upon Gen. Scott as the first authority upon it. It was important in the first place to arrive at some data as to the quantities of sludge thrown down by various precipitants, and the quantities that

could be got out by subsidence, also the quantity necessary to be removed before the sewage had been put upon the land. For his own part he regarded the sludge as a nuisance which he would rather be without; he took it out in straining tanks, to the amount of 600 tons per annum, which he disposed of when he could to neighbouring farmers at about 1s. 6d. per ton. In larger places it was an immense trouble; at Birmingham for instance, where it amounted to 400 or 500 tons a day, and had to be dug into the ground. The greater part of that arose from the lime which was used, so that where subsidence alone could be resorted to, it caused much less difficulty. The water and mud were in such a state of combination that he did not think it was simply a question of evaporating so many pounds of water as Mr. Walker had described. He used air drying upon a filter composed of gravel and coke, by which about 35 per cent. of the water was removed in 24 hours, and it was then in a fit state to be dried by such a machine as Mr. Howard Kidd had invented, and which was certainly a great desideratum. It was very difficult to dry the sludge sufficiently for the use of farmers in three weeks, and in damp weather it took much longer. One of the greatest evils was the amount of road *detritus*, which was mixed with it, and which would be prevented by the separate system of sewers.

Mr. Howard Kidd was about to explain his drying machine, of which a diagram was exhibited; but, as he stated that it had not at present been used otherwise than experimentally, the Chairman ruled that it did not come within the scope of their proceedings.

Mr. C. Jones (Surveyor, Ealing) asked if anything had been done in the way of burning the sludge. For some years past there had been a great deal of difficulty with the sludge at Ealing, and every attempt seemed to be almost a failure, if not quite so. He had lately experimented on burning it like ballast, and found it could be accomplished without causing any offensive effluvia. The bulk considerably decreased, and his impression was that the residuum would be valuable for grass lands. It could be carried out anywhere where the neighbourhood was not crowded, and expensive machinery for drying an almost worthless material would be unnecessary.

General Scott thought this plan would be an infringement on a process of his own. Referring to his previous calculation with regard to the lime and sulphuric acid required for the A B C process at Leeds, he could not understand in Mr. Tatham's paper how it would cost £8,048 to apply that process. He had simply taken the statement that eight tons per diem were used, and that the effluent was sent away acid. Would not the proportions he had named be required, viz., 14 tons of sulphuric acid to the eight tons of lime?

Mr. Peter Spence said some slight corrections ought to be made in the statement, though there was a good deal in it. In the first place the lime was not pure (even if it was not slaked before it was put in), beyond 70 or 80 per cent., and this would make a considerable deduction. Besides, it appeared to him that the quantity mentioned was very much in excess of what was requisite to effect the object Mr. Crookes had in view. They used five tons of sulphate of alumina, which did not contain half its weight of sulphuric acid, so that if they used eight tons of lime, it was much more than was required to saturate all the sulphuric acid, and would leave the sewage in an alkaline condition.

Mr. C. Tucker (Mayor of Bridport) asked whether the sludge itself was perfectly harmless when it was being dried and prepared, or whether it would be likely to disseminate the seeds of infection or disease in the neighbourhood?

The Chairman remarked that the question of health would be discussed later on.

SEWAGE DISCHARGED INTO THE SEA.

Brighton.

Mr. Gilbert Redgrave said the main outfall sewer had been recently completed at Brighton, under Sir John Hawkshaw. Here was an interesting example of the drainage of a sea-side town, completed under great difficulty, and a town which stood foremost perhaps of all in this country as presenting peculiarities to be grappled with. The area was about 1,800 acres, and the rateable value £453,368; the average rates being during the last four years 5s. 2d. in the pound. Before the passing of the Act of 1870, for the Brighton main outfall sewer, the sewage was discharged by eight outfalls into the sea immediately in front of the town, but as this caused a very disagreeable state of things, the sewage being seen occasionally floating in the sea and on the beach, it was resolved to take it to a considerable distance. The length of the outfall carried out under Sir John Hawkshaw was about eight miles, the point of discharge was Portobello; the sewers beginning at Hove-street were 21 feet above the discharge at Portobello; the sewer discharged on the beach at dead low-water mark, the fall throughout was only three feet per mile, and during the last portion only one foot per mile. There were three storm overflows in its length utilising the old out-falls in front of the town, and the total cost had been £100,000. Owing to the discharge being at low-water during a great part of the day, the sewage could not pass into the sea but was dammed back into the sewer, the result of this was, that great complaints had been made in the town about the gases generated from this long section, which rose through the houses, and also through the street gullies. In cold frosty weather it had been stated that visitors had seen steam and warm gases rising from the sewer in the principal parade, and had also smelt it. In order to overcome this difficulty, they had constructed an artificial system of ventilating this sewer, the area of which was so considerable. A ventilating tower had been constructed about one mile to the eastward of the town to extricate the foul gases by means of furnaces constantly burning at the base, and, if necessary, they could supplement it by the action of fans driven by machinery. The fire-grate area was 20 square feet, and the height of the chimney 100 feet. It was found on blocking off the latter part of the sewer by a trap, that a considerable amelioration was experienced in the upper part, but it was rather questioned whether the position of the tower was the best for the purpose, since foul gases were also generated in the higher part of the sewer, and would have a tendency to rise through the gully holes in the town. However, it was impossible to secure a site further to the westward. Efforts had also been made in the town itself to obtain means of ventilating the sewer. As a similar case might arise in other towns, he thought the Brighton experience might be useful in pointing out that ample means should be provided of ventilating such a sewer.

Mr. Adam Scott said when decayed organic matter was discharged into fresh water, decomposition went rapidly, by reason of the oxygen in the water, and putrefaction set in. But in salt water it was different; the salt acted as a kind of pickle, and thus those matters were found floating about for a long time, as had been stated. The result was that the atmosphere became charged with unhealthy gases, much in the same way as with gunpowder, ready to burst out on the slightest contact with a spark of disease. At Rio Janeiro, he understood that the sewage in former times was emptied into the sea, and seventy years ago that place was used as a sanatorium for the United States, but in consequence of this practice fever became so prevalent that ships refused to touch there if they could help it, and ten or twelve years ago the Rio Janeiro Improve-

ment Company effected a deodorising of all the houses, at a cost of £6 10s. per annum for each house. This reduced the yellow fever, and since then they had adopted water-carriage sewers, but unfortunately these emptied into the harbour, and the result was something exceedingly disgusting, and the effect on health very bad. In Naples the sewage was discharged some distance from the town, and the same result took place. There was a most beautiful extent of sea-shore, which had become quite a scene of death; no one could reside there, and many noble villas were falling into utter ruin. Again, at Marseilles, for hundreds of years they had discharged the sewage into the sea, and the epidemics there were well known; in fact it had passed into a proverb in France that pilots could go into the harbour in the thickest fog, being guided by the smell alone.

Dr. Yeld (Medical Officer of Health for Sunderland), as representing a seaport town, thought Mr. Scott's remarks would have rather a depressing effect if they were assumed to be literally true. According to him seaports discharging sewage into the sea would be veritable plague spots, but that could not have been the case in this country. In Sunderland, with a population of 180,000, the whole of the sewage was discharged into the sea at low-water mark, and into the tidal river, but for many years they had been a most healthy town, last year standing second on the list of large towns.

Mr. Adam Scott asked how many years they had so discharged the sewage?

Dr. Yeld said for 40 or 50.

Lord Alfred Churchill remarked that in the Mediterranean there was no tide to take the sewage away.

Dr. Yeld said, with reference to the ventilation of sewers, there was a difficulty, because at certain times during the day the same gases got back. They had adopted open ventilation as being the most approved plan, with a ventilating shaft which only drew its supply of air from the first opening next the chimney. They had from 700 to 1,000 small ventilators placed at a distance of about 40 feet along the sewers, so that when the tide came in the gases were discharged into the open air and so rendered innocuous. This was a point of much importance affecting the health of seaport towns. He had never heard of or seen any of the deposits from the sewers thrown on the beach and left there as referred to at Brighton, and was quite certain that so far there had been no evil results. The bed of the river was dredged from time to time, and the deposit left near the discharge of the sewer was removed. No doubt the power of salt water to prevent decomposition was very great.

Mr. Whitley (Leeds) thought on this question of sewer gases the vitality and health of the population depended, and he could not express the amount of grief he felt at the difference of opinion which existed between Mr. Alderman Tatham and himself on this point. The Chairman, in opening the proceedings, had spoken of them as insidious gases, and nothing to his mind was so certain as that sewer gas, whether concentrated or not, was injurious. It was only a question of degree, whether you let it out diluted into the great reservoir of nature, or let it out in a small stream to destroy the persons close to it. He held that, like champagne in bottles, it should be hermetically sealed up until it was required, and then disposed of. The sewers and traps should be hermetically sealed, and there should be a large fire of a gaseous nature at the bottom of the shaft at a temperature of 200 or 400 degrees, through which the gases should be drawn, and thus they would be annihilated.

Mr. Tatham said he was only opposed to the speculations of his friend Mr. Whitley, on account of the logic of facts. In 1868 there was a great drought, and the effect was to untrap all the gullies in the town. In that year the death-rate fell to 21, or lower than it had been for many years. A year ago they again untrapped all the gullies, and the medical officer declared the town to be free from all preventable disease.

Mr. Spencer said he brought forward a great scheme some years ago, for ventilating towns by one great shaft, conveying all the smoke and all the gases from the sewers. That plan was never carried out, but in connection with it he suggested connecting sewers with chimneys, and by that means relieving the pressure upon the sewers, so that there should be no creation of gases. Another important thing was this: the various openings in the sewer no doubt, to a certain degree, did away with the evils, but still there were cases in particular winds when the nuisance would arise. To guard against this the sewers should be closed, and by placing a tower, as at Brighton, with a strong draught, the gases might be carried off. In his own house he had prevented any nuisance from sewer gas by simply carrying a pipe from the drain to the kitchen chimney, and, as the fire was nearly always alight, there was a constant draught, and no inconvenience was ever perceived.

Mr. Tucker (Mayor of Bridport) said in Bridport, which was a mile from the sea, this question of draining direct would be very important when the time came that they should be obliged to drain. Taking the mortality per 1,000, the average of the returns would be something over 20, but of those towns which drained direct into the sea, the 13 principal ones showed a less average, namely, Devonport, 18; Eastbourne, 16; East Stonehouse, 28·37, and that included the hospital, otherwise it would be only 22; Folkestone, 19; Hastings, 17; Penzance, 21; Plymouth, 20·62; Portsmouth, 19·5; Ryde, 14; Scarborough, 19·51; Southampton, 19·84; St. Mary's Church, 15·8; Sunderland, 22·4. From Brighton there was no return at all.

Mr. Walker said, with regard to the scheme adopted at Brighton, he understood the sewage accumulated in the main sewer, and the gases were driven back by the tide into the sewage system, to remedy which a chimney had been erected, at the base of which a fire was kept burning. This plan was not new, but he was surprised to hear it was effective. In the first place, if the sewer was hermetically sealed how could they produce the draught or admit air into the sewer to displace the gases drawn off by the chimney, whilst if openings were made for ventilating it, unquestionably the air to displace the gases removed by the furnace would rush down the opening nearest the furnace itself, leaving the more distant parts quite unaffected. Again, if the lower portion of the main sewer communicating with the sea at low water was composed of a material incapable of resisting internal pressure, he feared before long the inhabitants of Brighton would see the sewage oozing through the sand over the line of the sewer. It was much the best to allow sewers to communicate freely with the open air, leaving the process of ventilation to be carried on by the descent of the atmospheric air in a natural way.

Mr. Adam Scott said he understood that this shaft was not so much to ventilate the sewers in Brighton, as for that portion of it nearest the sea where the gases were generated.

Mr. Redgrave said the last part of this large outfall, 7 feet in diameter, had but a fall of one foot in the last mile and a quarter, so that it was nearly on a level; the total fall was only 21 feet 6 inches, and the rise of the tide was 15 feet, so that during the greater part of each tide the pressure of the sea water was greater than the pressure of the sewage, which was thus dammed back. The result of this was that something like 250,000 superficial feet of sewage was dammed up, and was giving off, to a certain extent, foul gases. The attempt at ventilation had been to prevent these gases in the lower part of the sewer being driven up into the town by the rising tide, and for that purpose a tidal valve had been put in at a point intermediate between the outfall and the town, whilst the ventilating tower was one mile

to the eastward of the town, so placed to extract the foul gases from the lower part of the sewer, not to ventilate the town itself. The effect was said to be very great, but it had not been at work very long, and it was impossible at present to say whether it would effect the purpose for which it was made. The ventilators in this main outfall were placed at a great distance apart, namely, from 1,000 to 1,500 feet, on account of the sewer being at such a depth below the surface of the soil. The greater part of it was in a tunnel through the chalk, so that ventilators could only be made with great difficulty and at great expense. There was no provision made for closing the ventilator while suction was at work, but the tendency would be to suck the light gases from the sewer itself, rather than to draw down the cold atmospheric air 100 feet above the level.

Dr. Syson (Medical Officer for the Peterborough United District) said he felt the great importance of the Brighton case, but Mr. Redgrave had hardly explained the evils correctly. It seemed to him that in a certain state of the tide the sewage was kept in the sewer, and, therefore, it was not so much the gas given off from the sewage as the pressure which tho sewage exercised, owing to the displacement of air or gas normal in the sewer, so that during the hour the tides were exercising this adverse influence, they were really forcing the gaseous contents of the sewer into the houses. As far as the chimney went he thought its influence would be *nil*, and that it would be better to disperse the gas by means of frequent openings, foul gas being quite inert for mischief when thoroughly diluted. These artificial means of ventilation were very expensive, but there was no doubt that the good effects would merely extend to the first weak place in the sewer, where air from the outside could rush in.

Mr. Humphreys (Mayor of Carnarvon) said the sewage in their neighbourhood was thrown into the estuary of the harbour, and they found a great deal of the sludge was left at corners on the beach where it was thrown by the current. They were very desirous of adopting some plan to get rid of it, and some time ago they were on the point of adopting the A B C process, but they found so much was said against it that they hesitated until it was further discussed.

Dr. Taylor said Liverpool, which he represented, was somewhat similarly situated to Brighton with regard to the retention of the sewage in the sewers at high tide, because the sewers had to be carried under the docks by means of a syphon, and when the tide rose to a certain height it was kept back. In order to prevent the tide coming into the town, tidal valves were placed so that they had a long length of sewer filled with sewage and sea water. The plan adopted for ventilation was to have iron pipes carried up the sides of the warehouses with Archimedean screws placed at the top, and by means of these a large amount of air from the sewers above the valves was extracted. There were also openings in the streets, so that there was every facility for removing the gas. They had had no complaints, and little or no smell was perceived. With regard to the sewage matter being thrown into the tidal water of the Mersey, they had had no complaints whatever. There were some imaginary ones, but they only referred to Waterloo, a little place with a sandy beach, which was very fashionable both for residents and visitors, where, if any deposit were carried down, it would be thrown upon the shore, and produce injurious effects. Instead of that, the Waterloo district was remarkably healthy, the death-rate being not more than 14.

The Chairman asked if the Archimedean screws were worked by steam power.

Dr. Taylor said no, merely by the current of air. Dr. Burdon Sanderson and Mr. Parkes, when in Liverpool, had examined the operation of these ventilators, and they found in some places there was an upward current, and in others a downward, so that though they assisted in keeping up the circulation, they were practically valueless. Some of the Corporation were anxious to have large chimneys with furnaces erected, but in order to test how far that would act upon the air in the sewers, they had a careful examination made of the traps in the various houses, and found there was scarcely a house which had a trap perfect, so that if any chimney had been erected it would simply have drawn the air out of the houses, and would have had no effect on the sewers.

Mr. Alderman Burgess (Warrington) said in his town they had adopted the system of ventilating from the street. The system carried out was to have loose covers over the manholes into the sewers, with a grid in in it, and they found it work exceedingly well. If the object was to prevent the gas being driven into the houses there was another much more simple system by which it could be avoided, and that was to have no communication between the house and the sewer. That was what they relied upon. They did not allow a house to be built in Warrington, except where there was a water-closet which they could not prevent, which should have a communication with the sewer, but the sewage was carried to the outside and fell into a box or trough, whence it passed away, so that it was entirely disconnected. That was the most efficient way of preventing mischief arising from the sewage gases.

The Chairman said the death-rate at Warrington was 26 per 1,000.

Mr. Alderman Burgess said that the average death-rate for eight years previous to 1872 was 30·14. These changes were introduced in 1871, and in 1872 the death-rate was 23·3; in 1873, 23·19; and in 1874, 23·38. In 1875 it rose again, as it did throughout the country, in consequence of the severity of the weather, to 26; but it had now got down again, and at the present time they had as low a death-rate as had been yet attained.

Mr. James White said some 37 years ago the Government directed an investigation into the causes of bad health on the West Coast of Africa and the injury to the copper sheathing of vessels, with the remedies which might be suggested. The report showed that when any animal or vegetable matter came into contact, not with sea-water itself, but with the sulphates contained in it, sulphuretted hydrogen was produced in an enormous quantity, and it was calculated that an area of 12,000 square miles on the West Coast of Africa was thus rendered unfit for Europeans to live in. With regard to throwing the sewage into the sea, it should be remembered that for two-thirds of the year a south-west wind was pretty general on the whole of the south coast, and as long as that blew there was no offence, but with an east wind, at Hastings, for instance, the stench from the outfall sewer nearly half a mile or a mile distant was something fearful. That was also the case at Margate, and all those who had resided in Margate knew that when an east or north-east wind blew the stench from the sewer gas was very bad, consisting of sulpuretted hydrogen to a large extent. It was the same at Ipswich, and even as far as Edinburgh, where the nuisance was very bad with an east wind. Some sixteen years ago, he visited Campbelltown, where a friend of his was principal medical man, and he then drew his attention to the sanitary condition of the place. At that time there was not a single water-closet, but the whole of the ordure was thrown into the street, and swept into the large beautiful bay, and there it remained, a portion passing away at each tide. Two years afterwards that fine town was nearly decimated by disease. This showed that unless you had a swift and free discharge, the throwing of sewage into sea-water was dangerous. When at Leeds, he had taken a deal of trouble to investigate the subject of their sewage, and he must say he never found any place where the sewer

gases were so free from sulphuretted hydrogen as at Leeds, and he might add that he was himself as good a test as could be applied, for he never went into any sea-port town where this gas was given off without having an attack of diarrhœa within a very short time.

TOWNS UNDER NO SPECIAL TREATMENT.

Mr. Brewer (Richmond) gave the substance of his paper on Richmond.*

(Lord Alfred Churchill here took the chair.)

Mr. Cresswell (Member of the Heston and Isleworth Sanitary Authority) said he had listened to the harrowing tale of Mr. Brewer with the sympathy of a fellow victim. But Mr. Brewer omitted to state one very important event which had occurred within the last two months. Most members of the Conference would be aware that there had been with regard to the Thames valley drainage, which was a very complex question indeed, a very elaborate inquiry conducted by Colonel Ponsonby Cox, an eminent officer of the Government, with reference to the scheme propounded by the Surbiton Improvement Commission, for dealing with the whole sewage of the valley of the Thames on a very colossal scale, namely, the construction of a sewer, which according to his computation would have rivalled the *cloaca maxima* of Rome. All the parishes in the district waited with great anxiety for the result of this important inquiry, for the Conservators of the Thames, and, he believed, the Local Government Board, agreed to do nothing until it was issued. It was drawn up by Col. P. Cox some time since, and he had reason to believe it remained under the consideration of the Local Government Board and their medical officers some time before it was published, thereby giving to the document the greatest possible authority, when they deliberately ratified and approved it. This most exhaustive report dealt with the condition of the Thames, and had been read with satisfaction by all the authorities within the district. In his opinion, if he might be allowed to give one, it was a most satisfactory solution of a very difficult question; and if Mr. Brewer, who had detailed the calamitous condition in which Richmond found itself, would take the trouble to read the latter portion of that most important document, he would find that, with the sanction of the Government, and the sanction of the Conservators of the Thames, and he believed he might say with the sanction of every professional man, Col. Cox had provided a remedy for the whole difficulty. He thought the great difficulty was not to find the means, but to find the will to deal with the question.

EDINBURGH.

Mr. Adam Scott then read a paper on the Edinburgh and Glasgow water-flushing systems.†

Dr. Yeld inquired whether Mr. Scott attributed the prevalence of typhoid fever in Edinburgh to the intermittent water supply?

Mr. Adam Scott said the water supplied to those who had typhoid fever and those who had not was the same.

Dr. Vacher (Medical Officer of Health for Birkenhead) thought it was not true that typhoid fever was unknown years ago; it used to be entered as gastritis, enteritis, inflammation of the bowels, and very often as gastric fever. Cholera, diarrhœa, and dysentery might also have been described under some of those names. He would remind Mr. Scott, that when he was speaking the previous day on the subject of typhoid or enteric fever, he said their knowledge was not becoming greater about this disease, and therefore he must admit it would be difficult to tell whether deaths from typhoid fever were entered under other names.

* See *Journal* for May 26th, page 654.
† See *Journal* for May 26th, page 664.

Mr. Adam Scott said that his statement was made upon the authority of the report of Mr. Simon, in which it was stated that they were merely on the threshold of the subject; and also upon the authority of an eminent Glasgow physician, whom he noticed was in the room, and whom he hoped would address the meeting.

Dr. Stewart (Glasgow) said he could speak with some authority upon the point. He recollected a number of very bad cases of typhoid fever occurring at a particularly healthy place about ten miles from Glasgow, and from 1836 to 1838, when typhus fever raged in Glasgow, there were many cases from the same place, but none in Glasgow. In 1840, he applied to Dr. John Reed upon the matter, when that gentleman pronounced the cases to be those of typhoid fever, and it was now a common disease; and, according to Dr. Murchison, since the flushing by water system had been adopted in Glasgow and Edinburgh, the prevalence of typhoid fever had become much greater. He had no doubt much of the misunderstanding upon the subject had arisen from the fact that up to a few years ago the whole of the cases were termed typhus indiscriminately.

Dr. Wilson said that in Dr. Murchison's celebrated book it was stated that since the more general use of animal food, typhoid fever had been more prevalent, and it was proverbial that thirty-five years ago, especially among the poorer classes, animal food was very little used. The reason for the increase of typhoid fever might be from the decomposition of animal food in the bowels, although Dr. Fergus proved that in Glasgow it arose from the badly-constructed water system.

Dr. Yeld did not think his question had been answered. In the paper Mr. Scott stated that, "In the new and closeted town of Edinburgh, typhoid and diphtheria are never entirely absent, and are frequently epidemic, and it has been noticed that the ravages of these diseases have been the greatest in the best houses;" and his question was whether that was not due to the intermittent water supply. The answer given was that the supply of water was the same to all parts of the town, which he did not think was a satisfactory answer. The paper was written especially with regard to the water-closet system, and in Edinburgh, with an intermittent water supply, they could not avoid a large escape of gas into the houses, to which might be attributed in a great measure the source of disease.

Dr. Wright thought the confusion made between typhoid and typhus was very considerable; in Cheltenham he never saw but one genuine case of typhus fever, and that was an imported case. He had attended many cases of typhoid fever, and upon investigation found they were all produced from imperfect drains. The construction of these works was generally left in the hands of jobbing men, who did not care how it was done; and he had himself seen men put down the pipes without attempting to make good the joints, thus allowing a leakage from the house drainage and causing illness. In one instance he was called in to attend three children suffering from diphtheria, and on examining the place, he found there was a tube communicating with their bedroom which opened into the sink below close by the drain, which tube acted as a vent to bring up the effluvia into the bedroom. Do not let them blame the water-carriage system because there were defects in it, for all these defects could be cured.

Mr. Adam Scott said he was not aware that the intermittent water supply was the cause of typhoid fever in Edinburgh. A great many cases had arisen from imperfect drains, but not from the intermittent water supply, though, no doubt, that might be an additional cause.

Dr. Sanders said that at Ely the death-rate had been reduced 42 per cent. since the water-carriage system had been in force, and if typhoid fever had increased they must look to the number of lives saved from other diseases by such introduction, and it was no reproach to

the system itself to say that typhoid had increased. If they went into the best houses in London they would find sewer gas coming up every sink, and he did not think that was a reproach to the system itself, but rather to the engineers and others who had had the responsibility of putting down the drains. He considered that point could not be too strongly urged, and great harm would be done if they were to simply consider the method of dealing with sewer gases as they found them; their efforts should rather be directed to preventing having them at all.

Sir Henry Cole, K.C.B., wished to offer a few remarks upon the construction of drain pipes. There was no doubt that owing to our constitutional system of independence of Government, and our not wishing to poke our noses into other people's houses, we in our ignorance were subjected to great annoyance from imperfect drains. Vestries looked after the drains to a certain extent, and in some localities the large sewers were made pretty fairly as they ought to be, but in London they were entirely at the mercy of he did not know who. In the *Times* of that day there was an account of how the Government allowed its public offices to be built; after spending many thousands of pounds upon the building, it seemed that the drainage had been left to take care of itself. He himself went into a house which was certified to be in thorough repair, and perfectly fit for habitation: but he had not been there three weeks before he detected bad odours from the drains, and it took him six weeks to reform the whole of the internal drains. His neighbour not 200 yards off took a house, and after he had been there a short time, he found out the bad odours, and on sending for a responsible person to look into the matter, it was found that the drains, which were very good in themselves, had been imperfectly laid, the joints being put together with earth instead of cement. On asking the clerk of the works who came to examine them, what he thought was saved by using earth instead of proper cement, he was informed that the saving would be 2s. a house. The clerk being asked whether he thought it worth while for the sake of 2s. to spoil a house which had cost £2,000 or £3,000, said "Consider the saving on a thousand houses." What a specimen of morality! The conclusion he drew from that was that they ought to insist in their various localities upon some certificate being given that the internal drains of the house were in proper order; for if a poor and ignorant man like himself took a house on the faith of what it ought to be and got typhoid fever or diphtheria from imperfect drains he had no redress. They ought to be able to go to the Vestry and see a plan of the drains, to see whether they were properly connected with the main drain, when he would be able to judge whether the thing was likely to be right or not. On the Continent that was insisted upon, though their constitutional Government was not so perfect. He hoped one effect of the Conference would be to point out—to the Prime Minister if needs be, whose cry had been *sanitas sanitatum*—the importance of this subject.

Mr. William Boulton (City Surveyor for Aberdeen) said, with reference to house drains, they found much the same state of things in Aberdeen. In examining many of the house drains he had found them very badly constructed, the pipes laid with very wrong levels, bad joints, and bad connections, and in some cases he had found the pipes entirely disconnected from each other, whilst in other cases they were not connected at all to the main sewer. Under the several Police Acts for the borough, the surveyor has entire control over the construction and proper maintenance of house drains, sinks, water-closets, &c., and in the erection of new houses these have all to be fitted up and ventilated to his satisfaction. In cases where existing drains are found to be in bad repair, or to be improperly constructed, the surveyor has power to repair, or if necessary, altogether to reconstruct them; and to fit up other necessary sanitary appliances, and charge the cost of the work to the proprietor of the house.

Mr. Hall (Canterbury) said, having had considerable experience in Canterbury and elsewhere, he found one difficulty was in properly connecting the drain-pipe at the bottom, and also the improper plumber's work which was carried on. He attributed the failures which took place, to the old-fashioned pan closet and also to the imperfect connection of the sink-pipe with the drain. He did not care how the drains were ventilated as long as they were ventilated, for he had proved that all water-closet traps would get out of order in from six to twelve years.

Mr. Rogers Field thought the difficulty with reference to the water-carriage system arose from the fact that very little attention had been paid to the method in which house drains were connected with the sewers. Engineering skill had been employed on the construction of sewers, but the town generally considered when it had got sewers properly constructed and ventilated, that the duty of the sanitary authorities ceased. Sometimes they made regulations that holes in the sewers should only be cut under their supervision, to prevent the sewer being damaged, but in very few cases did they trouble themselves further with what took place. The true solution of the question was, that the sanitary authorities should make certain regulations under the best advice as to the proper method of connecting or disconnecting the drains with the sewers.

Dr. Yeld agreed with what he considered to be now the almost universal opinion, that the defects arising in a sanitary point of view from the water-carriage system arose entirely from the shocking manner in which the house drainage was constructed. In Sunderland, they had brought the question before the Local Government Board, believing that no amount of regulations would secure the object. They considered that the house drainage should be constructed by the local authorities, and looked upon house drains as having a relative connection to the sewers, in the same way that gas and water-pipes had to the mains of the gas and water companies. What would be the effect if persons were allowed to put in their own services for gas and water? It would be as unbearable in that respect as it now was with the sewers, and the escape would be something frightful. He did not believe the escape of sewage gases from the bad manner in which drains were constructed would be remedied until the Legislature took the matter up and put them in at the cost of the owners.

Dr. Syson thought they wanted a minimum amount of uniformity in building and in the connections. He had had considerable experience of sewer gas, and believed that he was the first man in England to frame a clause, which had now become law, preventing connection between gully traps and the houses. He thought the Society should urge upon the Government the importance of taking the matter up, as the sanitary authorities were powerless in the matter by reason of their powers being limited by Act of Parliament. He did hope that the practical result of that meeting would be to go with a strong voice and ask the Government to take up the matter.

Mr. Elcock (Manchester) said there was one bearing of the question which no one had touched upon, viz., the permeation of sewer gas from the water in the trap of the water-closet. Dr. Fergus had demonstrated, at a meeting of the Social Science Association in 1874, by experiments which could not be confuted, that, however well the soil-pipe of a water-closet might be ventilated, the gas found its way through the water in the trap; therefore, they should not only look to the bad junctions, but to the traps themselves. He was within the mark in saying that in some of the experiments performed by Dr. Fergus at that meeting, the

chemical put on one side of the trap showed itself on the other side in five minutes, proving how subtle was the fluid which passed through the water. Dr. Fergus had been hammering away at the question for years, but it was only at the meeting in 1874 that he was able to bring the matter so palpably before the audience, that they were compelled to admit that what he said was a fact, that sewer gas might pass through the water in the trap, however well it was ventilated.

The Conference was then adjourned until 11 o'clock next day.

ANALYSES OF HERTFORD EFFLUENT WATER.

(*Furnished by Mr. T. W. Grindle, Town Surveyor.*)

	Parts per Million.		Grains per Gallon.	
	Free ammonia.	Albumenoid ammonia.	Total Alkalinity as caustic soda.	Solid residue.
1875.				
April 19th	2·244	1·175	16·2	28·7
May 23rd	2·05	1·225	15·4	29·2
July 2nd........	2·335	1·175	15·4	27·3
August 20th	3·35	1·225	14·0	26·8
September 23rd..	3·35	1·15	13·3	27·9
October 18th	3·75	1·1	15·4	28·3
1876.				
May 10th	4·05	1·75	15·4	29·4

In no case did the effluent water contain "suspended matter." In all cases the effluent had a very slight taste of lime, but had no perceptible odour.

MISCELLANEOUS.

SURPLUS OF THE GREAT EXHIBITION OF 1851.

The "Great Exhibition" of 1851, which raised so many hopes foredoomed to disappointment, and which was the object of so much both of misapplied eulogy and of undeserved satire, left behind it, as our readers are aware, a legacy of practical work. A Royal Commission was empowered to purchase, out of the surplus realised by the Knightsbridge enterprise, the Kensington Gore Estate, and to administer a large property "in the interests of Science and Art." The Commissioners started with a clear capital of £186,000, and by a judicious use of this they have already bestowed substantial benefits on the objects of their trust. They have bestowed on the South Kensington Museum, and the Schools of Science and Art connected with it, some valuable land, buildings, and fittings. They sold to the Government for a sum computed not to exceed half the value of the property a site for the Natural History Collections, which, during many years, had been buried out of sight in the British Museum. It must be added that the Commissioners embarked in a more doubtful project in connection with the Albert Hall, and that their relations with the Royal Horticultural Society, who are the tenants of the central garden, have been, in a pecuniary sense, very far from satisfactory. But, at any rate, the time has now come when the Commissioners must take stock of their means and come to a decision as to their policy. They held a meeting on Wednesday at Marlborough House, under the presidency of the Prince of Wales, and came, as we understand, to some important conclusions. The Commissioners discharge a high public trust, and it is desirable that the objects they have in view, as well as the methods by which they hope to carry them out, should be justly appreciated by the country.

In the first place, the financial position of the Commissioners has to be considered. The property in their hands is extensive and valuable, but the amount that would be immediately available for educational or kindred purposes depends on the scheme selected for disposing of the surplus lands. Five projects have been suggested and discussed. The first of these would involve the sale of the East and West Galleries, the French and Belgian Courts, and the arcades and offices of the Horticultural Society, and the land attached, leaving only a central square of 10 or 12 acres—about half the area of the present Gardens. This plan would give the Commissioners a million sterling in hand, but it would so largely reduce the space intended from the beginning for public uses that its rejection will probably be generally approved. The second proposal—that the Government should purchase from the Commissioners for science and art purposes, at half the present value, the Horticultural Gardens and Exhibition Buildings, relieving the Commissioners, at the same time, of the liabilities incurred through their connection with the Horticultural Society—is not likely, it may be feared, to recommend itself at this time to a Ministry lately arraigned on the score of its reckless expenditure. Probably, then, the idea of realising three-quarters of a million, or thereabouts, in this way may be dismissed. The suspension of selling and leasing land, which has been suggested as a third course, would, however, under the most favourable conditions, leave only £150,000 for future work. The sale of the ante-garden of the Central Square and the Annexes—a modification of the first proposal and open to similar objection—would, it is calculated, realise half a million. But the plan on which the Commissioners are inclined to look most favourably is the sale simply, for private building, of the ground outside the arcades, leaving the Horticultural Gardens and the Exhibition Buildings still in the Commissioners' possession, and securing an immediately available capital of £350,000, after clearing off all actual and possible liabilities. The land thus sold would not exceed six acres out of thirty, it is neither useful nor ornamental, and if handsomely built over it would rather enhance than diminish the value of the remainder of the estate.

But, in whatever manner the Commissioners may determine to turn some further portion of their estates into ready money, they are resolved to go on with the work of extending and strengthening the machinery for education in Science and Art, which in this country owes its origin, it may almost be said, to the Exhibition of 1851. There are many ways in which the Commissioners, with from £300,000 to £500,000 at their disposal, would be able to promote movements which have been standing still or been slackened for want of funds. There are schemes for founding scholarships liberally endowed in connection with the Schools of Science and Art already established or being established in the chief seats of manufacturing industry, where the need for technical training has been felt; also for bringing the more promising pupils from such provincial schools into contact with the highest experimental and theoretical teaching at South Kensington; for helping local museums with grants for buildings and collections; for assisting in the organisation of International Exhibitions, and many other similar projects. There is one, however, of larger dimensions and more definite character than the rest, on which the Commissioners, as it appears, have determined to expend a large sum. On Wednesday they agreed to offer the Government to provide a building for a Library of Science and for other kindred purposes, to be erected on the Commissioners' estate, partly on the ground now occupied by the entrance

to the Horticultural Gardens and the French Annexe, and partly on Government land adjoining. The estimated cost of the erection would not exceed £100,000, and the Commissioners could expend this sum while retaining a considerable balance for work in other directions. Such is the new undertaking which it is proposed to connect with the traditions and motives of the Exhibition of 1851, and with the object to which the Prince Consort devoted the best energies of his life.

The case which has been made out for the foundation of a Science Library is unquestionably a strong one. The South Kensington Museum, with all its ramifications, was set at work originally by the Commissioners, and received material aid from their funds. Its success is now assured, for the public have learnt to appreciate thoroughly the great educational advantages of the establishment. But the demands upon the space available have thus grown excessive. In the Art Library and the Educational Library students congregate in far too great numbers for health, not to speak of comfort. Room for examination work is also wanting. It is less generally understood, perhaps, that many valuable local collections of Art objects cannot be received and exhibited, and two most valuable bequests of literary and artistic treasures—the collections of Mr. Dyce and Mr. Forster—have been hitherto excluded simply because no space could be found for their accommodation. In many other respects the South Kensington Museum is injured by overcrowding, and the Government has lately resolved to postpone for the present any further extension of the buildings. It has, therefore, been urged that the Commissioners could not make a more appropriate use of the revenues which they hold in trust for the advancement of Science and Art than by relieving the Department at South Kensington of some portion of this pressure. The proposed library buildings might give immediate relief to the thronged Art and Educational Reading-Rooms of the Museum, and at the same time, might supply accommodation for the collection of physical and mechanical instruments, to which the Loan Exhibition will bring, it is hoped, some highly-prized contributions. The Dyce and Forster libraries, at present comparatively useless because almost inaccessible, would naturally find a place, for a time at least, in the new building. There, also, rooms for examinations and similar business would be provided. The concessions which the Commissioners seek in return for the offer of this library include, we believe, either the purchase of the gardens and galleries or the restoration to the Commissioners of so much of their original estate as would be equivalent to the site of the new building. It is probable, as we have said, that the first alternative, at least, would not, in its full proportions be acceptable to the Treasury; but it ought not to be difficult to devise a reasonable compromise.—*Times.*

In 1875, the western States of America, California, Nevada, and the gold districts added to the gold in circulation 49,214,087 dollars. The production of silver in Nevada, California, Utah, Colorado, &c., amounted to 31,574,950 dollars. It is calculated that in 1876 Nevada alone will produce at least fifty millions of dollars.

The consumption of gas has immensely increased in Paris during the last twenty years. Thus in 1855, the consumption did not exceed 40,747,400 cubic metres; in 1875, it had risen to 175,938,244 cubic metres. The number of private gas consumers in Paris in 1875 was 111,221. The French capital possessed 33,000 public lamps last year; it had also 1,041 miles of gas pipes.

The aggregate receipts of the Brussels Tramway Company in the first four months of this year amounted to £21,539, as compared with £19,935, in the corresponding period of 1875, showing an increase of £1,604 this year. The number of cars in use upon the company's lines this year has been 67, as compared with 65 in the corresponding period of 1875.

CORRESPONDENCE.

NEWSPAPER POST.

Sir,—Referring to the correspondence between the Postmaster-General and the Secretary of the Society, published in a recent number of the *Journal*, I shall feel obliged if you will allow me to point out that there are even greater anomalies in connection with the newspaper post than the constitution which forbids a newspaper to be stitched under the penalty of losing the newspaper privilege.

As an illustration, I do not think I can do better than place before your readers my own case, which briefly is that I am the publisher of a monthly trade journal of a large circulation amongst the classes it represents. It is not stitched; in appearance, size, and weight it is similar to the *Builder*, the *Architect*, and several other weekly papers, whilst it is not much more than half the size, and certainly not more than half the weight, of the *Engineer*, or the *Field*, neither has it a cover, like the *Graphic* or *Engineering*, yet, because the arbitrary law laid down by the Post-office authorities is, that no publication is a newspaper "if issued at intervals of more than seven days," I am compelled to pay 2d. postage on every copy as against 0½d. by the journals above named. It would be exactly the same published fortnightly.

What is still more singular is that for foreign transmission my journal is registered at the Post-office as a newspaper, and is forwarded accordingly, being placed on the same footing as all other newspapers. The effect of this is that I actually post it to all parts of Europe, India, America, and the Colonies for the same price as if I sent it through the post into the next street. The absurdity of this needs no comment.

As my case is but a correct representation of the tax under which a good many other somewhat similar publications are also labouring, I think the time has arrived when some action should be taken with a view to the abolition of such a hard and fast line as that laid down by the present regulations, and I would add that the Society for the Encouragement of Arts, Manufactures and Commerce would be doing much towards the spread of technical education—about which there is so much talk in some circles just now—if the Council of the Society took the initiative in this matter.—I am, &c.,

W. T. Emmott.

Office of the *Textile Manufacturer*, 15, Market-street, Manchester, May 29, 1876.

NOTES ON BOOKS.

A Manual of Qualitative Chemical Analysis.—By Professor W. Dittmar. Edinburgh: Edmonston and Douglas. 1876.

Professor Dittmar's book is intended for use by advanced students, or at least those who have got somewhat beyond the mere rudiments of chemistry. The arrangement of the work is as follows. It is divided into four sections, the first of which gives a series of exercises intended to familiarise the student with the necessary operations required in the execution of ordinary chemical analyses. These, beginning with the simplest experiments, proceed gradually to those of greater difficulty and delicacy. Section II. deals with the principal metals and their reactions, those of the rarer metals being also given in a smaller type at the end of the six groups (the copper, arsenic, iron, barium, magnesium, and potassium groups) under which the metals are classed. "From these reactions is

deduced a method for the qualitative analysis of a mixture of metals, supposing them to be given in the shape of salts of certain acids." The third part deals with the non-metals, and in the author's words, it develops methods; (1) for the examination of a substance for its non-metallic elements; (2) for the discrimination of all the more important inorganic, and of a few of the more common organic acids; and (3) for the separation from one another, and from metallic bases, of certain groups of these acids. The fourth and last section of the book is concerned with the analysis of substances of unknown nature, and in it the applications of the methods given in parts II. and III. to unknown substances are further explained. This section refers also to various methods of analysis not treated at length in the previous part of the book, including analysis by the spectroscope, and dwells at some length on the "Film tests" of Bunsen.

The Amateur House Carpenter.—By Ellis A. Davidson. London: Chapman and Hall. 1875.

There are perhaps very few to whom some knowledge of the subject treated in this book would not be useful. It is not to be supposed that an amateur, except those few who make a hobby of some mechanical pursuit, can ever absolutely dispense with the assistance of those who have not merely devoted their idle half hours to the acquirement of an art. In the best of cases amateur work is but a poor substitute for that turned out by the skilled handicraftsman. But that is no reason why the amateur should not acquire sufficient knowledge to enable him to supervise and direct his workmen, or sufficient practical dexterity to supply their place when the need arises. It is not too much to say that we should all be taught a certain familiarity with the use of tools; wherever we live, in town or country, we are certain to find plenty of occasions when such knowledge will be valuable. How frequently does it occur that those engaged in scientific work, either research or teaching, require some fresh piece of apparatus which a little ingenuity would enable them to construct for themselves, but whose absence, if they have not the skill required, causes considerable inconvenience. Even with all the necessary facilities, scientific men and lecturers often find it hard to get made exactly what they require, and in practice they are often obliged to make it themselves.

It is the information required by such classes as these that Mr. Davidson has set himself to supply. He begins with an account of the tools employed and their uses. Then comes a description of the method of constructing and fitting the most simple articles, a tool-rack, a shelf, a box. Then proceeding a little further, we get instructions for the construction of a cupboard, a wardrobe, a table, &c.; and in describing these, the various methods of uniting timber, mortising, dovetailing, mitreing, &c., are all given. Going out of doors, we are taught how to build a garden-house, an arbour, a chicken-house, and this leads up to some chapters on building construction generally, including one on building in brick and stone. Chapters on plan drawing, and geometrical drawing generally, conclude the book.

It should be added, that the book is amply illustrated throughout, the engravings being by Dalziel, from drawings by the author.

A few days ago a fly-wheel three tons weight, 9 ft. diameter, cast in one piece, having worked for years as part of a steam engine, was laid horizontally on two balks of timber in the yard of the West Hartlepool Cement Works; the wheel was left perfect at night, and was found next morning fractured in several pieces, no person having touched it. The day previous the sun's rays had heated the rim considerably, and the night being cold, the arms having retained but little heat contracted too rapidly, snapping from he boss and rim of the wheel.—*Engineer*.

GENERAL NOTES.

Continuous Brakes.—A correspondent of *Iron*, who describes himself as "one who has passed his best days on the foot-plate," takes exception to some of Mr. Bramwell's remarks on continuous brakes in his recent lecture on railway safety appliances. One chief point raised is that a continuous brake does not "skid" the wheels, and so does not wear off portions of the wheels and render them polygonal instead of round. A continuous brake, says "Foot-plate," will bring the train up with all its wheels revolving. Another point is that if a continuous brake is only to be used in cases of emergency (as suggested by Mr. Bramwell), the driver does not acquire the habit of using it, and so may neglect to employ the power in his hands when the necessity arises.

Inspection of Lightning Conductors in Paris.—The Prefect of the Seine has organised a special staff of officials to inspect the lightning conductors at least twice a year, and to ascertain their working condition by means of the most approved appliances. Lightning conductors of various forms are also to be erected at different points in Paris, for the purpose of comparative study; and observations are to be made and recorded as to the state of the storm-clouds passing over the capital, and any special phenomena which may occur.

MEETINGS FOR THE ENSUING WEEK.

Mon.....Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Henry Davey, "The Underground Pumping Machinery at the Erin Colliery, Westphalia."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m. 1. Mr. E. D. Young, "Journey to the Northern End of Lake Nyassa." 2. Mr. T. P. B. Wither, "Valley of the Tibagy, South Brazil."
British Architects, 9, Conduit-street, W. General Conference of Architects, and during the week.

Tues....Association of Gas Managers (at the House of the Society of Arts), 11 a.m.
Photographic, 5 Pall-mall East, S.W., 8 p.m. 1. Col. Stuart Wortley, "The Preparation of Sensitive Dry Pellicle from Collodion, and from Gelatine." 2. Mr. W. Brooks, "Note on a Dry Plate Exposed and Developed Fifteen Years after its Preparation."
Anthropological Institute, 4, St Martin's-place, W.C.
Royal Colonial, 15, Strand, W.C., 8 p.m. Lieut. V. Lovett Cameron, "The Colonisation of Central Africa."

Wed....Association of Gas Managers (at the House of the Society of Arts), 11 a.m.
Royal Literary Fund, 10, John-street, Adelphi, W.C., 3 p.m.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m.

Thurs...Royal, Burlington House, W., 8½ p.m.
Antiquaries, Burlington House, W., 8½ p.m.
Linnean, Burlington-house, W., 8 p.m. 1. Professor Rolleston, "Pre-historic Pig of Britain." 2. Major-Gen. Nelson and Prof. Duncan, "Structure of Coral-lines." 3. Dr. Masters, "Superposed Arrangement parts of Flower." 4. Mr. B. R. B. Sharpe, "Birds from New Guinea." 5. Mr. E. J. Miers, "Crustaceans."
Chemical, Burlington House, W., 8 p.m. 1. Professor Dewar, "Chemical Studies." 2. Dr. Armstrong and Mr. Ackworth, "Researches on the Reduction of Nitric Acid, and on the Oxides of Nitrogen." Part I. "The gases Evolved by the Action of Metals on Nitric Acid." 3. Mr. Ringzett, "The Composition and Formula of an Alkaloid from Jaborandi." 4. Prof. Gladstone and Mr. Tribe, "The Simultaneous Action of Iodine and Aluminium on Ether and Compound Ethers." 5 Mr. W. Carleton Williams, "Compounds of Antimony Pentachloride with Alcohols and with Ethers." 6. Prof. Mallett, "The Volatility of Barium, Strontium, and Calcium." Dr. Russell and Mr. Lapraik, "Note on the Action of Potassium Pyrogallate on Nitric Oxide."
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Mr. R. Phené Spiers, "Egyptian Architecture."
Civil and Mechanical Engineers, 7, Westminster-chambers, 7 p.m. Annual Meeting.
Zoological, 11, Hanover-square, W., 4 p.m.
Numismatic, 13, Gate-street, W.C., 7 p.m. Anniversary Meeting.
Philosophical Club, Willis's Rooms, St. James's, S.W., 6 p.m.
Association of Gas Managers (at the House of the Society of Arts), 11 a.m.

Fri.......Philological, University College, W.C., 8 p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W. 4 p.m. Professor Bentley, "Organs of Nutrition in Plants." (Lecture VI.)

JOURNAL OF THE SOCIETY OF ARTS.

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FRIDAY, JUNE 16, 1876.

All communications for the Society should be addressed to the Secretary John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

REPORT ON THE RESULTS OF THE CONFERENCE ON HEALTH AND SEWAGE OF TOWNS.

The Chairman of the Conference and the Executive Committee, after having carefully considered the information furnished from the various localities, as well as the facts brought forward during the Conference, have to submit the following as the conclusions to which such information appears to lead :—

1. In certain localities, where land at a reasonable price can be procured, with favourable natural gradients, with soil of a suitable quality, and in sufficient quantity, a sewage farm, if properly conducted, is apparently the best method of disposing of water-carried sewage. It is essential, however, to bear in mind that a profit should not be looked for by the locality establishing the sewage farm and only a moderate one by the farmer.

2. With regard to the various processes based upon subsidence, precipitation, or filtration, it is evident that by some of them a sufficiently purified effluent can be produced for discharge, without injurious result, into water-courses and rivers of sufficient magnitude for its considerable dilution; and that for many towns, where land is not readily obtained at a moderate price, those particular processes afford the most suitable means of disposing of water-carried sewage. It appears, further, that the sludge in a manurial point of view is of low and uncertain commercial value; that the cost of its conversion into a valuable manure will preclude the attainment of any adequate return on the outlay and working expenses connected therewith, and that means must therefore be used for getting rid of it without reference to possible profit.

3. In towns where a water-carried system is employed, a rapid flow, thorough ventilation, a proper connection of the house drains and pipes with the sewers, and their arrangement and maintenance in an efficient condition, are absolutely essential as regards health; hitherto sufficient precautions have rarely been taken for efficiently ensuring all the foregoing conditions.

4. With regard to the various dry systems, where collection at short intervals is properly carried out, the result appears to be satisfactory, but no really profitable application of any one of them appears as yet to have been accomplished.

5. The old midden or privy system, in populous districts, should be discontinued, and prohibited by law.

6. Sufficient information was not brought forward at the Conference to enable the Committee to express an opinion in regard to any of the foreign systems.

7. It was conclusively shown that no one system for disposing of sewage could be adopted for universal use; that different localities require different methods, to suit their special peculiarities, and also that, as a rule, no profit can be derived at present from sewage utilisation.

8. For health's sake, without consideration of commercial profit, sewage and excreta must be got rid of at any cost.

The Executive Committee, whilst abstaining from submitting any extensive measures, have no hesitation in recommending that the prevention of dangerous effects from sewage gases should receive the immediate attention of the Legislature, and they submit the following resolutions as the basis of petitions to Parliament:—

1. That the protection of public health from typhoid and other diseases, demands that an amending Act of Parliament be passed, as soon as possible, to secure that all house drains connected with public sewers in the metropolis, and towns having an urban authority, should be placed under the inspection and control of local sanitary authorities, who shall be bound to see to the effective construction and due maintenance of all such house drains, pipes, and connections. Provisions having this object in view already exist in the Act constituting the Commissioners of Sewers in the City of London, in the Metropolis Local Management Act, 1855, and in the Public Health Act, 1875, but practically they seem scarcely sufficient for the purpose.

2. That plans of such drains and connections be deposited in the charge of the respective local authorities, who shall be bound to exhibit them and supply copies of them to the public on payment of a moderate fee.

3. That the owners of houses be compelled by law to send to the respective local authorities, within a specified time after the passing of the Act, plans of all house drains on an appointed scale.

Signed by

The Right Hon. James Stansfeld, M.P., Chairman of the Conference.

Members of the Executive Committee.
- Lord Alfred S. Churchill, Chairman of the Council.
- F. A. Abel, F.R.S., President of the Chemical Society.
- Sir Henry Cole, K.C.B.
- Capt. Douglas Galton, R.E., C.B., F.R.S.
- Lieut.-Colonel E. F. Du Cane, R.E., C.B., Surveyor-General of Prisons.

ANNUAL EDUCATIONAL CONFERENCE.

The twenty-fifth annual Conference will take place on Friday, the 23rd June, at 11 o'clock. The chair will be taken by Sir Henry Cole, K.C.B.

With the view of giving special interest to the Conference this year, the Council have decided that the subject of Adult Education, especially in reference to Technical Instruction and its promotion by the action of the Government, shall form the principal subject for discussion, and all persons interested therein will be invited to attend.

The discussion will take place under the following heads:—

1. Adult education as now conducted in literary and mechanics' institutes, workmen's colleges, clubs, &c., night classes, public elementary schools, &c.
2. Aid to adult education given by the Education Department.
3. Aid to adult education given by the Science and Art Department.
4. Aid given by the Universities of Oxford, Cambridge, London, &c., in examinations, lectures, and otherwise.
5. Aid obtainable from the surplus of the Exhibition of 1851, held by the Commissioners.
6. Subjects which it is especially desirable to promote in adult education, such as laws of health and cleanliness, household economy, food, music, &c.
7. Annual report on the Union of Institutions, and suggestions for improving the examinations of the Society of Arts.

Each speaker will be restricted to ten minutes on each separate division.

Intending speakers, under each head, are requested to fill up a form, giving name and address; and they will be called upon by the Chairman.

Special papers, which have been prepared at the request of the Council, will be printed and circulated at the Conference. The writers will be allowed five minutes for stating the substance of them, in addition to any speech.

The meeting will adjourn at 1.30 p.m. for half an hour, and continue not later than 4 p.m. It can be resumed if necessary on the following day.

After the Conference the Society will issue a report on its results, and on the several returns and documents which have been prepared.

CONVERSAZIONE.

The Society's Conversazione will be held on Friday next, June 23rd, at South Kensington Museum, by permission of the Lords of the Council on Education. Cards have been issued to the Members.

FOOD COMMITTEE.

A meeting of this Committee was held on the 12th June. Present—Benjamin Shaw (in the chair), Lord Alfred S. Churchill, Dr. Pitman, E. C. Tufnell, and J. A. Youl.

EDUCATION COMMITTEE.

A meeting of this Committee was held on the 12th June. Present—Lord Alfred S. Churchill (in the chair), Edwin Chadwick, C.B., Sir H. Cole, K.C.B., and Major-General F. Eardley-Wilmot, R.A., F.R.S.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The Scholarships founded by Sir Titus Salt, Bart., and the town of Bradford, have been awarded to Mr. Frederick Cliffe and Mr. C. Marshall. There were six candidates.

A competition for three Scholarships, founded by A. D. Sassoon, Esq., Barclay Field, Esq., and the Past and Present Masters of the Skinners' Company, was held at the National Training School for Music on Saturday, the 10th inst. There were thirteen candidates, and the Examiners were Dr. Sullivan, Dr. Stainer, Ernst Pauer, Esq., and Alberto Visetti, Esq. Mr. Sassoon's Scholarship was awarded to Miss Brickwell, one of the candidates recommended at the Society's examination; Mr. Field's to Miss Thompson; and the Past and Present Masters of the Skinners to Miss Strange.

The school has received valuable presents of furniture from Mrs. Freake; of music from Messrs. Augener and Co., Messrs. Ashdown and Parry, Mr. Pauer, Mr. Visetti, Mr. Welch, and Miss Ferrari; of books on music from Sir Henry Cole, K.C.B., and John Hullah, Esq.

EXAMINATIONS, 1876.

PRIZES AND CERTIFICATES AWARDED TO CANDIDATES

PRIZES.

His Royal Highness the Prince Consort's Prize of Twenty-five Guineas to

No. 892—Paul Juste Descours, aged 19, of the Birkbeck Literary and Scientific Institution, in the Civil Service, who has passed in the First-class in the following subjects during the specified period :—

1874. French, with the First Prize of £5.
„ Arithmetic.
„ English History.
1875. Commercial Geography and History.
1876. Political Economy, with the additional Prize of £2.
„ English.
„ Book-keeping, with the Second Prize of £3.

The Council Prize (for Female Candidates) of Ten Guineas to

No. 213—Mary Lattimer, aged 17, of the Carlisle Mechanics' Institution (no occupation stated), who has passed in the First-class in the following subjects during the specified period :—

1875. Arithmetic, with the Prize of £2 for Females.
1876. English, with the Prize of £2 for Females.
„ Book-keeping, with the Prize of £2 for Females.

COMMERCIAL EXAMINATIONS.

Arithmetic	1st Prize	£5	To No. 930—Clarke, Thomas R., 24, Birkbeck Lit. and Sci. Inst. accountant.
	2nd Prize	3	„ 1120—Turnbull, William J., 20, Quebec Inst., Civil Service clerk.
			No Prize for Females awarded.
Book-keeping	1st Prize	5	„ 881—Wright, Charles, 18, Birkbeck Lit. and Sci. Inst., clerk.
	2nd Prize	3	„ 892—Descours, Paul J., 19, Birkbeck Lit. and Sci. Inst., in Civil Service.
	Females' Prize	2	„ 213—Lattimer, Mary, 17, Carlisle Mech. Inst. (no occupation stated).
Commercial Geography and History	....	..	*No Prizes were awarded in this subject.*
English	1st Prize	5	„ 930—Clarke, Thomas R., 24, Birkbeck Lit. and Sci. Inst., accountant.
	2nd Prize	3	„ 587—Houghton, John W., 19, Liverpool Inst., clerk.
	Females' Prize	2	„ 213—Lattimer, Mary, 17, Carlisle Mech. Inst. (no occupation stated).
French	1st Prize	5	„ 893—Butcher, Frederick J.. 18, Birkbeck Lit. and Sci. Inst., clerk.
	2nd Prize	3	„ 903—Arnold, Frederick J., 21, Birkbeck Lit. and Sci. Inst., clerk.
	Females' Prize	2	„ 18—Brebner, Mary, 17, Aberdeen Mech. Inst. (no occupation stated).

German	1st Prize	5	„ 123—Phillips, Arthur, 22, Birmingham and Midland Inst., clerk.
	2nd Prize	3	„ 956—Burke, Charles, 26, City of London College, clerk. *No Prize for Females awarded.*
Italian	1st Prize	5	„ 108—Davies, Walter W., 20, Birmingham and Midland Inst., clerk. *No Second Prize awarded. No Prize for Females awarded.*
Political Economy	1st Prize	5	„ 1104*—Irons, George W., 27, St. Stephen's Evening Classes, Westminster, Civil Service writer.
	2nd Prize	3	„ 960—Casson, William A., 22, City of London College, clerk.
Shorthand	1st Prize	5	„ 602—Butterworth, James, 24, Manchester Mech. Inst., clerk.
	2nd Prize	3	„ 611—Davies, T. W., 22, Manchester Mech. Inst., clerk.
Spanish		..	*No Prizes awarded in this subject.*

ADDITIONAL PRIZES.

The additional Prizes in Political Economy, offered by Mrs. Harry Chester, have been awarded as follows:—

Additional Prize of	£2 to No.	892—Descours, Paul J., 19, Birkbeck Lit. and Sci. Inst.. in Civil Service.
Prize of Books to the value of £1	„	901—Jaquet, Robert G., 19, Birkbeck Lit. and Sci. Inst., in Civil Service.
„ „ „	„	958—Carson, John, 23, City of London College, clerk.
„ „ „	„	1040—Wright, William H., 21, City of London College, clerk.

The Prizes offered by the Council for Writing from Dictation have been awarded as follows:—

1st Prize of	£3	to No.	621—Ingham, John, 25, Manchester Mech. Inst., clerk.
2nd „	2	„	353—Stevenson, George, 17, Glasgow Ath., clerk.
3rd „	1	„	882—Thorn, Arthur G., 21, Birkbeck Lit. and Sci. Inst., clerk.

The Prizes offered by the Council for Handwriting have been awarded as follows:—

1st Prize of	£5	to No.	865—Hooke, George A., 19, Birkbeck Lit. and Sci. Inst., clerk.
2nd „	3	„	1120—Turnbull, William J., 20, Quebec Inst., Civil Service clerk.
3rd „	2	„	621—Ingham, John, 25, Manchester Mech. Inst., clerk.
4th „	1	„	902—Carter. Alfred, 24, Birkbeck Lit. and Sci. Inst., Civil Service clerk.

The Prizes offered by the Council for Writing and Manuscript Printing have been awarded as follows:—

1st Prize of	£3	to No.	621—Ingham, John, 25, Manchester Mech. Inst., clerk.
2nd „	2	„	1092—Hughes, George C., 21, Royal Polytechnic Inst., clerk.
3rd „	1	„	1120—Turnbull, William J., 20, Quebec Inst., Civil Service clerk.

Each of the above Candidates has obtained a Certificate in Commercial Knowledge.

DOMESTIC ECONOMY EXAMINATIONS.

Clothing	1st Prize	£5	To No. 920—Dickes, Emma, 27, Birkbeck Lit. and Sci. Inst. (no occupation stated).
	2nd Prize	3	„ 595—Thwaites, Isabella, 35, Liverpool Inst., teacher of cookery.
Cookery	1st Prize	5	„ 777—London, Thomas, 35, Leeds Young Men's Christ. Assoc., teacher.
	2nd Prize	3	„ 1085—Walker, Louisa, 23, Kentish-town Literary Institute, teacher.
Health	1st Prize	5	„ 777—London, Thomas, 35, Leeds Young Men's Christ. Assoc., teacher. *No Second Prize awarded.*
Housekeeping and Thrift	1st Prize	5	„ 595—Thwaites, Isabella, 35, Liverpool Inst., teacher of cookery.
	2nd Prize	3	„ 656—Ashworth, James E., 20, Manchester Mech. Inst., in cotton trade.

The following is an Alphabetical List of the Candidates who have passed the examinations.

The number following the name gives the age of the Candidate.

The asterisk (*) *before* a number signifies that the Candidate has gained a Commercial Certificate.

(1st) after a subject signifies First-class.
(2d) „ „ Second-class.

The occupations stated are either present or proposed.

476—Abey, Thomas W., 24, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (2d)
812—Adams, Henry, 18, Sheffield Ch. of Eng. Inst., teacher—Arith. (1st)
230—Aitken, John, 33, Dundee Y.M. Chr. Assoc., in H.M. Customs—Eng. (2d)
946—Allsop, Peter J., 21, City of London Coll., in a warehouse—Bkpg. (2d)
628—Almgill, Arthur, 17, Manchester M.I., clerk—Bkpg. (2d)
947—Althans, George A., 17, City of London Coll., clerk—French (2d)
347—Ambrose, Frederick G., 16, Glasgow Ath., clerk—Eng. (2d)
615—Amos, Thomas, 14, Manchester M.I., at school—Arith. (2d); Eng. (2d)
451—Anderson, Fred, 18, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (1st)
252—Andrew, Walter, 19, Freetown W.M. Inst., clerk—Arith. (2d)
489—Andrews, Annie, 19, Hull Y.P. Chr. and Lit. Inst. (no occupation stated)—Eng. (2d)
375—Annan, John, 19, Glasgow Ath., clerk—Bkpg. (1st)
148—Arden, Richard P., 18, Bolton Ch. Inst., corn merchant's assistant—Arith. (1st)
*903—Arnold, Frederick J., 21, Birkbeck Lit. and Sci. Inst., clerk—Arith. (1st); Eng. (1st); French (1st), with the Second Prize of £3; Bkpg. (1st)
31—Asher, Alexander, 18, Aberdeen M.I., stonecutter—Arith. (2d); Eng. (2d)
656—Ashworth, James E., 20, Manchester M.I., in cotton trade—Arith. (1st); Eng. (2d); and a Domestic Economy certificate in Housekeeping and Thrift (1st), with the Second Prize of £3.

806—Badger, Harriet, 17, Sheffield Ch. of Eng. Inst., teacher—Eng. (2d)
361—Bailey, George, 21, Birkbeck Lit. and Sci. Inst., clerk—Bkpg. (2d)
475—Bailey, William, 19, Hull Y.P. Chr. and Lit. Inst., printer—Eng. (2d)
875—Bain, Andrew W., 18, Birkbeck Lit. and Sci. Inst., clerk—Bkpg. (2d)
154—Balshaw, James, 19, Bolton M.I., book keeper—Eng. (2d); Shorthand (2d)
638—Banning, Adim, 23, Manchester M.I., cabinet maker—Bkpg. (2d)
671—Barber, Elijah, 20, Manchester M.I., clerk—Shorthand (1st)
950—Barclay, William, 18, City of London Coll., clerk—Bkpg. (2d)
182—Barnes, John, 19, Burnley M.I., weaver—Bkpg. (2d)
687—Baron, Walter, 14, Manchester M.I., at school—Arith. (2d); Eng. (2d)
880—Barrett, Thomas G., 24, Birkbeck Lit. and Sci. Inst., clerk—Bkpg. (2d)
575—Barrow, Samuel, 16, Liverpool Inst., clerk—Arith. (2d)
470—Battarbee, Robert H., 17, Hull Y.P. Chr. and Lit. Inst., shop assistant—Bkpg. (1st)
1108—Baverstock, Alice J., 16, St. Stephen's (Westminster) Ev. Classes, teacher—Eng. (2d)
149—Baylis, Edward S., 17, Bolton Ch. Inst., surveyor's clerk—Eng. (2d)
859—Beaton, Lachlan, 25, Birkbeck Lit. and Sci. Inst., clerk—Bkpg. (2d)
652—Bedford, William, 26, Manchester M.I., foreman blacksmith—Arith. (1st)
203—Bell, Edward F., 14, Carlisle M.I., student—Arith. (1st)
809—Bell, Robert, 20, Sheffield Ch. of Eng. Inst., teacher—Arith. (1st)
951—Benn, William R., 21, City of London Coll., clerk—German (1st)
952—Bennett, Horatio H., 22, City of London Coll., clerk—German (1st)
944—Bennett, Richard W., 23, Birkbeck Lit. and Sci. Inst., clerk—Bkpg. (2d)
2—Bennett, W. P., 30, Aberdeen M.I., clerk—Eng. (2d)
807—Benoy, James, 14, Sheffield Ch. of Eng. Inst., at school—Arith. (2d); Eng. (2d)
682—Beswick, Frederick A., 15, Manchester M.I., at school—Eng. (2d)
870—Beves, Henry C., 22, Birkbeck Lit. and Sci. Inst., collector—Bkpg. (2d); Arith. (2d)
953—Biggs, George H., 21, City of London Coll., foreman—Bkpg. (2d)
71—Bilton, Thomas H., 16, Ashford M.I., clerk—Arith. (2d); Bkpg. (2d)
155—Birchby, William N., 23, Bolton M.I., correspondent—Bkpg. (1st)
802—Bisbey, John, 22, Sheffield Ch. of Eng. Inst., teacher—Eng. (2d)
852—Bishop, Walter W., 23, Birkbeck Lit. and Sci. Inst., commercial traveller—Eng. (2d)
509—Blair, William, 17, Ipswich W.M. Coll., clerk—Bkpg. (2d)
616—Blakeley, Frederick, 14, Manchester M.I., at school—Eng. (2d)
810—Booth, Emily, 18, Sheffield Ch. of Eng. Inst., teacher—Eng. (2d)
686—Bostock, Arthur L., 14, Manchester M.I., at school—Arith. (2d)
75—Boston, Emily J., 17, Ashford M.I., pupil-teacher—Arith. (2d)
225—Bott, William A., 15, Dudley M.I., pupil-teacher—Arith. (2d); (Eng. (2d)
211—Bowes, Thomas, 18, Carlisle M.I., student—Arith. (2d)
101—Boyle, Samuel, 26, Belfast W.M. Inst., clerk—Eng. (2d)
955—Boylin, Henry, 18, City of London Coll., clerk—Bkpg. (1st)
664—Bradshaw, John, 20, Manchester M.I., clerk—Arith. (2d); Bkpg. (1st)
231—Braik, George, 20, Dundee Y.M. Chr. Assoc., warehouseman—Eng. (2d)
1118*-Bramley, Joseph, 16, Walworth Lit. and Sci. Inst., clerk—Shorthand (2d)
756—Brassington, Edward, 17, Salford W.M. Coll., in warehouse—Bkpg. (2d)
46—Brebner, Jane, 19, Aberdeen M.I. (no occupation stated)—French (2d)
*18—Brebner, Mary, 17, Aberdeen M.I. (no occupation stated)—Eng. (1st); French (1st), with the prize of £2 for females; Arith. (2d)
1053—Bridel, Alfred J., 18, Islington Youths' Inst., joiner—Arith. (2d)
576—Briscoe, Joseph T., 19, Liverpool Inst., architect's assistant—Arith. (1st); Eng. (2d)
*662—Brockbank, James, 17, Manchester M.I., clerk—Arith. (1st); Eng. (2d); Bkpg. (1st)
746—Broderick, Henry, 15, Salford W.M. Coll., architect—Arith. (2d)
577—Brodie, William, 22, Liverpool Inst., draughtsman—Arith. (1st)
*941—Brook, Frederick H., 21, Birkbeck Lit. and Sci. Inst., clerk—Arith. (1st); Eng. (2d)

390—Brown, Donald C., 15, Glasgow M.I., warehouseman—Bkpg. (2d)
515—Brown, James, 28, King's Lynn Ath., clerk—Bkpg. (1st)
370—Brown, Robert, 17, Glasgow Ath., clerk—Bkpg. (2d)
333—Buchanan, Walter, 19, Glasgow Anderson's Univ. Pop. Evg. Classes, clerk—Spanish (1st)
402—Buchanan, Walter, 19, Glasgow Y.M. Soc., clerk—Arith. (2d); Eng. (2d)
937—Buckbarrow, John E., 23, Birkbeck Lit. and Sci. Inst., warehouseman—Arith. (2d); Com. Geog. and Hist. (2d)
*956—**Burke, Charles**, 26, City of London Coll., clerk—Eng. (2d); French (2d); German (1st), with the Second Prize of £3.
684—Burman, Frederick, 15, Manchester M.I., at school—Arith. (2d); Eng. (2d)
*893—**Butcher, Frederick J.**, 18, Birkbeck Lit. and Sci. Inst., clerk—Arith. (1st); Eng. (1st); French (1st), with the First Prize of £5; Bkpg. (1st)
*602—**Butterworth, James**, 24, Manchester M.I., clerk—Arith. (1st); Eng. (2d); Shorthand (1st), with the First Prize of £5.
62—Butterworth, William E., 19, Aldershot and Farnham district, soldier—Arith. (2d)

*576—**Caird, John**, 20, Liverpool Inst., clerk—Arith. (2d); Eng. (2d); Bkpg. (2d)
*1111—**Canti, Natale**, 18, St. Stephen's (Westminster) Ev. Classes (no occupation stated)—Arith. (1st); Eng. (2d); Spanish (2d); German (2d)
19—Cardno, William, 19, Aberdeen M.I., banker's clerk—Arith. (1st); Eng. (2d)
957—Carr, William, 26, City of London Coll., clerk—Bkpg. (2d)
*958—**Carson, John**, 23, City of London Coll., clerk—Pol. Econ. (1st), with a prize of books to the value of £1; Eng. (2d); Bkpg. (1st)
*902.—**Carter, Alfred**, 24, Birkbeck Lit. and Sci. Inst., Civil Service clerk—Arith. (1st); Eng. (1st); French (2d.); Bkpg. (1st); and the Fourth Prize of £1 for Handwriting.
*960—**Casson, William A.**, 22, City of London Coll., clerk—Pol. Econ. (1st), with the Second Prize of £3; Eng. (2d.); Bkpg. (1st)
444—Caukwell, Thomas B., 15, Hull Y.P. Chr. and Lit. Inst., clerk—Arith. (2d)
473—Charlton, Leonard H., 20, Hull Y.P. Chr. and Lit. Inst., clerk—Arith. (1st); Shorthand (2d); Bkpg. (1st)
220—Cherrington, John E., 15, Dudley M.I., teacher—Eng. (2d); Arith. (2d)
465—Christie, Alexander, 15, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (2d)
351—Christie, John E., 16, Glasgow Ath., clerk—Arith. (1st)
961—Clark, Frank M., 20, City of London Coll., clerk—Shorthand (2d)
*930—**Clarke, Thomas R.**, 24, Birkbeck Lit. and Sci. Inst., accountant—Arith. (1st) with First Prize of £5; Eng. (1st) with the First Prize of £5
803—Clarkson, William, 19, Sheffield Ch. of Eng. Inst., teacher—Arith. (2d); Eng. (2d)
581—Clayton, John, 15, Liverpool Inst., shipwright—Arith. (2d)
312—Cleland, John, 20, Gartsherrie Academy, engineer—Arith. (2d)
21—Clouston, John, 32, Aberdeen M.I., custom-house officer—Arith. (2d); Eng. (2d)
683—Cobb, John, 16, Manchester M.I., at school—Arith. (2d); Eng. (2d)
34—Collie, John W., 20, Aberdeen M.I., clerk—Eng. (2d)
854—Collison, Mary S., 28, Birkbeck Lit. and Sci. Inst., teacher—Arith. (2d)
331—Colquhoun, John, 18, Glasgow Anderson's Univ. Pop.Evg.Classes, warehouseman—Bkpg. (2d)
359—Connor, Frederick, 27, Glasgow Ath., teacher—Arith. (1st); Eng. (1st)
868—Cookes, Harriet A., 26, Birkbeck Lit. and Sci. Inst., governess—Eng. (2d); French (2d)
1104—Coombs, Henry R., 17, St. Stephen's (Westminster) Evg. Classes, teacher—Arith. (2d); Eng. (2d)
29—Cooper, Frank, 20, Aberdeen M.I., engineer's apprentice—Shorthand (1st); Arith. (2d)
*368—**Cooper, John**, 20, Glasgow Ath., clerk—Arith. (2d); Eng. (2d); French (2d)
582—Cooper, William L., 20, Liverpool Inst., clerk—Bkpg. (1st)
107—Cornish, Elizabeth M., 21, Birmingham and Mid. Inst., teacher—Eng. (2d)
1112—Court, George, 17, St. Stephen's (Westminster) Ev. Classes, teacher, Eng. (2d)
52*-Coutts, John, 18, Aberdeen M.I. (no occupation)—Arith. (2d)
811—Cowley, Joseph, 17, Sheffield Ch. of Eng. Inst., teacher—Arith. (2d); Eng. (2d)
1069—Cowper, Arthur, 19, Islington Youths' Inst., clerk—Arith. (2d)
377—Cox, Benjamin C., 22, Glasgow Ath., warehouseman—French (2d)
963—Cox, John W., 22, City of London Coll., clerk—Bkpg. (2d)
309—Cranston, Archibald, 22, Gartsherrie Academy, clerk—Arith. (2d.)
415—Crosland, Joe, 31, Huddersfield M.I., salesman French (2d)
*447—**Crowther, Frederick J.**, 17, Hull Y.P. Chr. and Lit. Inst., teacher—Arith. (2d); Eng. (2d); Bkpg. (2d)
47—Cruickshank, William, 22, Aberdeen M.I., engineer—Arith. (1st)
59—Cunningham, Frederick G., 15, Aldershot and Farnham district, soldier—Arith. (2d)
964—Cuthbertson, Robert A., 18, City of London Coll., clerk—Arith. (1st); Eng. (2d)

655—Daniels, Frederick W., 17, Manchester M.I., clerk—Bkpg. (2d)
965—Daubney, Charles, 19, City of London Coll., clerk—Eng. (2d)
729—Davenport, Frank, 23, Salford W.M. Coll., draughtsman—Bkpg. (2d)
11—Davidson, David, 16, Aberdeen M.I., clerk—Eng. (2d)
*611—**Davies, T. W.**, 22, Manchester M.I., clerk—Arith. (2d); Eng. (2d); French (1st); Shorthand (1st), with the Second Prize of £3; German (2d)
*108—**Davies, Walter W.**, 20, Birmingham and Mid. Inst., clerk—Arith. (2d); Eng. (2d); Italian (1st), with the First Prize of £5.
610—Dawson, Charles, 24, Manchester M.I., book-keeper—Bkpg. (2d)
1114—Deacon, Sarah, 18, St. Stephen's (Westminster) Ev. Classes, teacher—Eng. (2d)
409—Deighton, John W., 16, Halifax M.I., box manufacturer—Arith. (1st)
921—Denton, John, 31, Birkbeck Lit. and Sci. Inst., clerk—French (2d)
*892—**Descours, Paul J.**, 19, Birkbeck Lit. and Sci. Inst., in Civil Service—Pol. Econ. (1st), with an additional prize of £2; Eng. (1st); Bkpg. (1st), with the Second Prize of £3; and the Prince Consort's prize of Twenty-Five Guineas.
303—Dick, John, 16, Gartsherrie Academy, student—Arith. (2d)

920—Dickes, Emma, 27, Birkbeck Lit. and Sci. Inst. (no occupation) Eng. (2d); French (2d); and a Domestic Economy certificate in Clothing (1st), with the First Prize of £5.
1142*-Dickson, James R., 21, Quebec Inst., clerk—Bkpg. (1st)
564—Dingley, Harry, 17, Leicester W.M. Coll., clerk—Shorthand (2d)
1077—Dixie, Alfred J., 20, Islington Youths' Inst., jewellery case maker—Arith. (1st)
442—Dixon, Edward, 18, Hull Y.P. Chr. and Lit. Inst., clerk—Arith. (1st); Shorthand (1st); Bkpg. (1st)
237—Dodds, John D., 21, Dundee Y.M. Chr. Assoc., Arith. (2d); Eng. (2d)
386—Downie, John S., 21, Glasgow M.I., teacher—Arith. (2d); Eng. (2d)
721—Doyle, Annie, 23, Penzance, schoolmistress—Eng. (2d)
454—Drasds, Paul, 18, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (2d)
549—Draycott, William F., 17, Leicester W.M. Coll., teacher—Arith. (2d); Eng. (2d)
583—Dugdale, William H., 16, Liverpool Inst., draughtsman—Arith. (2d)
*966—**Dumsday, William H.**, 21, City of London Coll., clerk—Arith. (1st); Eng. (1st); French (2d)
1075—Duncan, Alfred J., 16, Islington Youths' Inst., clerk—Eng. (2d)
44—Duncan, James, 18, Aberdeen M.I., stonecutter—Arith. (2d)
1141—Duncombe, Edward W., 25, Quebec Inst., stockbroker—French (1st)
53—Durant, Frederic P., 14, Aldershot and Farnham district, civil engineer—Arith. (2d); Eng. (2d)
967—Dyer, Louis, 20, City of London Coll., clerk—Bkpg. (1st)

1083—Earp, George F., 18, Kentish Town Literary Inst., clerk—Eng. (2d); Shorthand (1st)
832—Edmonds, James H., 16, Swindon M.I., teacher—Arith. (2d)
329—Elder, David, 24, Glasgow Anderson's Univ. Pop. Evg. Classes, clerk—Bkpg. (2d)
968—Elwin, James, 20, City of London Coll., clerk—Bkpg. (2d)
969—Elwood, Elisha, 16, City of London Coll., clerk—Arith. (1st); Eng. (2d)
774—Emmett, James W., 17, Leeds Y.M. Chr. Assoc., teacher—Arith. (2d); Eng. (2d)
*643—**Entwisle, Peter**, 19, Manchester M.I., warehouseman—Eng. (2d)
900—Esden, George A., 17, Birkbeck Lit. and Sci. Inst., clerk—Arith. (2d); Shorthand (2d.); Bkpg. (1st)
784—Evans, Annie A. M., 19, Rugby (no occupation stated)—Arith. (2d); Eng. (2d)
970—Evans, Edmund J., 22, City of London Coll., clerk—Bkpg. (2d)
72—Evans, William H., 17, Ashford M.I., clerk—Arith. (1st); Bkpg. (1st)
677—Evans, William J., 14, Manchester M.I., at school—Arith. (2d)
556—Exton, Henry, 21, Leicester W.M. Coll., clicker—Eng. (2d)

*649—**Farnworth, Robert A.**, 18, Manchester M.I., clerk—Arith. (1st); Eng. (2d); Shorthand (1st); Bkpg. (1st)
661—Faulkner, Charles F., 16, Manchester M.I., clerk—Bkpg. (2d)
1074—Fellgate, Herbert H., 15, Islington Youths' Inst., clerk—Arith. (1st)
505—Fenter, John W., 20, Ipswich W.M. Coll., carpenter—Arith. (2d); Eng. (2d)
253—Fielding, Charles T., 18, Freetown W.M. Inst., teacher—Arith. (2d); Eng. (2d)
728—Firby, William, 20, Salford W.M. Coll., clerk—Bkpg. (2d)
435—Fishwick, William, 23, Hull Chr. Inst., clerk—Bkpg. (2d)
1115—Fitzgerald, Eleanor A., 18, St. Stephen's (Westminster) Evg. Classes, teacher—Arith. (2d); Eng. (2d)
659—Fletcher, Henry, 17, Manchester M.I., clerk—Bkpg. (2d)
*898—**Ford, Joseph T.**, 21, Birkbeck Lit. and Sci. Inst., clerk—Arith. (2d); Eng. (2d); Bkpg. (1st)
332—Forrest, Robert, 17, Glasgow Anderson's Univ. Pop. Evg. Classes, clerk—Bkpg. (2d)
516—Forster, Walter C., 17, King's Lynn Ath., clerk—Bkpg. (2d)
813-**Foster, Frederick E.**, 19, Sheffield Ch. of Eng. Inst., accountant—Arith. (2d); Eng. (2d); Bkpg. (2d)
812*-Foster, Walter H., 16, Sheffield Ch. of Eng. Inst., accountant—Arith. (1st); Eng. (2d)
1113—Fox, Frederick W., 17, St. Stephen's (Westminster) Ev. Classes, teacher—Arith. (2d); Eng. (2d)
895—Fry, James, 26, Birkbeck Lit. and Sci. Inst., Civil Service writer—Bkpg. (2d)

897—Garche, Emile, 20, Birkbeck Lit. and Sci. Inst., clerk—Bkpg. (2d)
340—Gardner, Henry, 16, Glasgow Ath., clerk—French (2d)
749—Garner, William, 23, Salford W.M. Coll., maker up—Arith. (2d)
*510—**Garrod, Philander N.**, 20, Ipswich W.M. Coll., clerk—Arith. (2d); Eng. (2d); Bkpg. (2d)
1118—Garside, Florence C., 19, St. Stephen's (Westminster) Ev. Classes, teacher—Eng. (2d)
974—Garwood, Henry, 21, City of London Coll., clerk—Bkpg. (2d)
412—Gaunt, Joseph, 16, Halifax W.M. Coll., teacher—Eng. (2d)
28—Geddes, James L., 24, Aberdeen M.I., clerk—Eng. (2d)
*1091—**Gennari, Alexander C.**, 20, R. Polytechnic Inst., clerk—Arith. (2d); Eng. (2d); Bkpg. (2d)
866—George, William E., 21, Birkbeck Lit. and Sci. Inst., clerk—Arith. (1st)
238—Giffen, James, 23, Dundee Y.M. Chr. Assoc., hackle-pin grinder—Eng. (2d)
33—Gill, Thomas P., 17, Aberdeen M.I., clerk—Arith. (2d); Eng. (2d)
49—Glennie, Charles E., 16, Aberdeen M.I., pupil teacher—Arith. (1st); Eng. (2d)
22—Glennie, William, 18, Aberdeen M.I., clerk—Bkpg. (1st)
434—Glover, George H., 20, Hull Chr. Inst., clerk—Bkpg. (2d)
*860—**Godard, John G.**, 24, Birkbeck Lit. and Sci. Inst., clerk—Arith. (2d); Eng. (1st); French (2d); Shorthand (1st)
975—Goodall, Charles, 19, City of London Coll. (no occupation stated)—Arith. (2d); French (2d); German (1st)
110—Goode, Charles B., 18, Birmingham and Mid. Inst., clerk—French (2d)
207—Graham, John, 16, Carlisle M.I., clerk—Eng. (2d)
482—Grassby, William M., 20, Hull Y.P. Chr. and Lit. Inst., shopman—Eng. (2d)
56—Gray, Herbert, 15, Aldershot and Farnham district (no occupation stated)—Eng. (2d)
518—Green, Thomas C., 21, King's Lynn Ath., clothier's assistant—Bkpg. (1st)
156—Gregory, James, 21, Bolton M.I., cashier—Shorthand (2d)

*109—**Grew, Frederick W.**, 20, Birmingham and Mid. Inst., lithographer—Arith. (2d); Eng. (1st); Bkpg. (2d)
362—Grierson, Frederick W., 18, Glasgow Ath., clerk—Eng. (2d)
662—Grundy, John, 16, Manchester M.I., clerk—Arith. (2d); Bkpg. (2d.)
673—Guilmette, Robertson W., 21, Manchester M.I., clerk—Bkpg. (1st)

632—Haigh, John D., 21, Manchester M.I., clerk—Bkpg. (1st)
114—Hall, Alfred, 24, Birmingham Mid. Inst., clerk—French (1st)
113—Hall, Annie, 19, Birmingham and Mid. Inst., in warehouse—Eng. (2d)
151—Hall, David, 17, Bolton Ch. Inst., chemist—Arith. (2d); Eng. (2d)
35—Hall, Harriet J., 26, Aberdeen M.I., dressmaker—Eng. (2d)
13—Hall, James, 17, Aberdeen M.I., clerk—Arith. (2d); Eng. (2d)
979—Hamblin, William R., 19, City of London Coll., clerk—Arith. (1st)
200—Hamlet, Joseph, 18, Cardiff Free Library, accountant—Bkpg. (2d)
1057—Hammond, Alfred, 16, Islington Youths' Inst., clerk—Arith. (2d)
521—Harbage, Thomas H., 26. King's Lynn Ath., ironmonger's assistant—Bkpg. (1st)
506—Harding, Henry L., 21, Ipswich W.M. Coll., ironmonger—Arith. (2d.)
1081—Harding, Samuel W., 19, Kentish Town Literary Inst., in Civil Service—Arith. (1st); Bkpg. (2d)
841—Hardy, Anthony, 25, York Inst., warehouseman—Arith. (2d)
980—Harris, George, 23, City of London Coll., clerk—Shorthand (2d)
609—Harris, William, 19, Manchester M.I., apprentice—Com. Geog. and Hist. (2d)
441—Harrison, John W., 18, Hull Y.P. Chr. and Lit. Inst., clerk—Shorthand (1st)
666—Hartley, Henry, 27, Manchester M.I., cashier—Eng. (2d); French (2d); Bkpg. (2d)
723—Harvey, Harold, 14, Penzance, at school—Arith. (2d)
804—Haslam, William A., 18, Sheffield Ch. of Eng. Inst., teacher—Arith. (2d); Eng. (2d)
76—Haworth, James, 17, Bacup M.I., clerk—Arith. (1st)
1119—Haynes, Jane, 19, St. Stephen's (Westminster) Ev. Classes, teaoher—Arith. (2d); Eng. (2d)
620—Haynes, Walter H., 14, Manchester M.I., at school—Arith. (2d); Eng. (2d)
1099—Haywood, Julia A. M., 18, R. Polytechnic Inst., teacher—Eng. (2d)
672—Heathcote, Arthur, 22, Manchester M.I., warehouseman—Eng. (2d); Bkpg. (2d)
*821—**Heckford, Clarence R.**, 19, Stourbridge Assoc. Institutes, clerk—Arith. (2d); Eng. (2d); Bkpg. (2d)
383—Henderson, James, 19, Glasgow M.I., grocer's assistant—Arith. (1st)
380—Henderson, John, 24, Glasgow Ath., clerk—Shorthand (1st)
385—Henderson, Thomas, 23, Glasgow M.I., clerk—Eng. (2d)
782—Hepworth, Norris R., 19, Leeds Y.M. Chr. Assoc., clothier—Arith. (2d)
41—Hewit, William, 15, Aberdeen M.I., pupil teacher—Arith. (2d)
689—Heywood, Douglas M., 17, Manchester M.I., at school—Eng. (2d)
214—Heywood, John, 24, Carmarthen Lit. and Sci. Inst., draughtsman—Arith. (1st); Eng. (2d)
824—Higgins, Albert W., 17, Swindon M.I., clerk—Arith. (2d)
*839—**Hill, John H.**, 25, York Inst., book-keeper—Eng. (2d); Bkpg. (2d)
836—Hill, William O., 18, Swindon M.I., teacher—Arith. (1st); Eng. (2d)
751—Hindley, John, 17, Salford W.M. Coll., in a warehouse—Arith. (2d)
820—Hinds, William G., 17, Stourbridge Assoc. Institutes, clerk—Arith. (2d.)
1121—Hitchcock, Samuel, 32, Quebec Inst., porter—Eng. (2d); Bkpg. (2d)
906—Hodge, John H., 27, Birkbeck Lit. and Sci. Inst., teacher—Arith. (2d); Eng. (2d)
210—Hodgson, George, 19, Carlisle M.I., student—Arith. (1st)
209—Hodgson, Joseph, 18, Carlisle M.I., student—Arith. (1st)
111—Holland, Richard, 21, Birmingham and Mid. Inst., clerk—Arith. (2d)
585—Holt, James, 15, Liverpool Inst. (no occupation stated)—Arith. (1st)
89—Holt, Margaret J., 19, Bacup M.I., weaver—Domestic Economy Certificates in Housekeeping, &c. (2d); Cookery (2d)
87—Holt, Sarah A., 17, Bacup M.I., weaver—Domestic Economy Certificate in Cookery (2d)
*865—**Hooke, George A.**, 19, Birkbeck Lit. and Sci. Inst., clerk—Arith. (1st); Eng. (1st); Bkpg. (2d); and the First Prize of £5 for Handwriting.
983—Hopwood, Edwin E., 23, City of London Coll., clerk—Bkpg. (2d); Arith. (1st)
81—Horsfall, Thomas D., 16, Bacup M.I., clerk—Arith. (2d); Eng. (2d)
*586—**Houghton, John W.**, 19, Liverpool Inst., clerk—Eng. (1st), with the Second Prize of £3; Bkpg. (2d)
914—Howard, George, 26, Birkbeck Lit. and Sci. Inst., clerk—French (2d)
808—Howe, Richard, 36, Sheffield Ch. of England Inst., clerk—Eng. (2d); Shorthand (2d)
*587—**Hudson, William C.**, 21, Liverpool Inst., clerk—Eng. (1st); Bkpg. (2d)
*1092—**Hughes, George C.**, 21, R. Polytechnic Inst., clerk—Arith. (2d); Eng. (2d); Shorthand (2d); Bkpg. (2d); and the Second Prize of £2 for Writing and Manuscript Printing.
*1134—**Hughes, William J.**, 21, Quebec Inst., Civil Service clerk—Arith. (1st); Eng. (2d); Bkpg. (2d)
550—Hunt, George W., 35, Leicester W.M. Coll., warehouseman—Eng. (2d)
365—Hunter, James, 17, Glasgow Ath., clerk—Eng. (2d)
1—Hunter, John, 34, Aberdeen M.I., clerk—Arith. (2d); Eng. (2d)
1140—Hutchings, Henry W., 16, Quebec Inst., clerk—Arith. (2d)

814—Ibbotson, John, 17, Sheffield Ch. of Eng. Inst., teacher—Arith. (2d)
*621—**Ingham, John**, 25, Manchester M.I., clerk—Arith. (2d); Eng. (1st); Shorthand (1st); and the First Prize of £3 for Writing from Dictation; the Third Prize of £2 for Handwriting; and the First Prize of £3 for Writing and Manuscript Printing.
*1104—**Irons, George W.**, 27, St. Stephen's (Westminster) Ev. Classes, Civil Service writer—Pol. Econ. (1st), with the First Prize of £5; Eng. (2d)

985—Jackson, Ernest, 20, City of London Coll., clerk—Bkpg. (2d)
890—Jackson, John R., 22, Birkbeck Lit. and Sci. Inst., in Excise—Arith (1st)
891—Jacobs, James T., 20, Birkbeck Lit. and Sci. Inst., clerk—Shorthand (2d); Bkpg. (2d)

1086—Jago, Sidney J., 20, Kentish Town Literary Inst., Civil Service clerk—Shorthand (2d)
819—James, William L., 21, Stourbridge Assoc. Institutes, clerk—Arith. (2d); Bkpg. (2d)
45—Jamieson, James, 15, Aberdeen M.I., clerk—Arith. (2d)
372—Jamieson, James F., 34, Glasgow Ath., clerk—Bkpg. (2d)
24—Jamieson, John B., 19, Aberdeen M.I., clerk—Arith. (2d)
*901—Jaquet, Robert G., 19, Birkbeck Lit. and Sci. Inst., Civil Service clerk—Pol. Econ. (1st), with a Prize of Books to the valuo of £1; Eng. (1st); French (2d); Bkpg. (2d)
65—Jeffery, Charles R., 16, Aldershot and Farnham district (no occupation stated)—Arith. (1st); Eng. (2d)
718—Jenkin, Barnet N., 14, Penzance, at school—Arith. (2d)
986—Johnson, Edwin H., 18, City of London Coll., clerk—Arith. (1st); Bkpg. (2d)
940—Johnson, Elizabeth M., 25, Birkbeck Lit. and Sci. Inst., governess—Arith. (2d)
1097—Johnson, Henry J., 21, Royal Polytechnic Inst., dealer in works of art—Eng. (2d)
755—Johnson, Samuel A., 17, Salford W.M. Coll., clerk—Bkpg. (1st)
471—Johnston, George, 20, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (1st)
626—Johnston, William N., 18, Manchester M.I., clerk—Arith. (1st); Bkpg. (1st)
344—Johnstone, William, 16, Glasgow Ath., clerk—Eng. (2d)
150—Jones, Henry, 19, Bolton Ch. Inst., schoolmaster —Arith. (2d); Eng. (2d)
989—Jones, Henry R., 21, City of London Coll., clerk—German (1st)
1119*-Jones, James F., 16, Walworth Lit. and Sci. Inst., clerk—Shorthand (2d)
455—Jones, William H., 18, Hull Y.P. Chr. and Lit. Inst., joiner's apprentice—Arith. (2d)
815—Jordan, Leonard, 17, Stourbridge Assoc. Institutes, pupil teacher—Arith. (2d); Eng. (2d)

116—Keen, Alfred J., 22, Birmingham and Mid. Inst., clerk—Eng. (2d)
588—Keet, Charles H., 18, Liverpool Inst., broker's apprentice—Arith. (2d); Eng. (2d)
991—Kelley, John F., 20, City of London Coll., clerk —Bkpg. (2d)
709—Kenworthy, William H., 15, Oldham Lyceum, bookkeeper—Arith. (2d)
202—Ker, Hugh, 18, Carlisle M.I., student—Arith. (2d)
874—Kerr, Janet H., 19, Birkbeck Lit. and Sci. Inst. (no occupation stated)—Pol. Econ. (2d)
436—King, Walter, 17, Hull Ch. Inst., clerk—Bkpg. (1st)
767—Kirk, John W., 15, Leeds Y.M. Chr. Assoc., teacher—Eng. (2d)
938—Kitts, Frederick W., 21, Birkbeck Lit. and Sci. Inst., in woollen warehouse—Pol. Econ. (2d)
994—Knight, Richard E., 27, City of London Coll., clerk—Bkpg. (2d)

1139—Langston, Frederick W., 16, Quebec Inst., engraver—Arith. (1st); Eng. (2d)
623—Langtry, William R., 22, Manchester M.I., clerk —Bkpg. (2d)
1054—Lansdell, Henry, 20, Islington Youths' Inst., clerk—Arith. (2d)
916—Laslett, William H., 18, Birkbeck Lit. and Sci. Inst,, clerk—Shorthand (2d)
*213—Lattimer, Mary, 17, Carlisle M.I. (no occupation stated)—Eng. (1st), with a prize of £2 for females; Bkpg. (1st), with a prize of £2 for females, and the Council Prize of Ten Guineas for Females.
366—Law, Andrew B., 17, Glasgow Ath., clerk—Eng. (2d); French (2d)
*239—Leighton, David B., 26, Dundee Y.M. Chr. Assoc., clerk—Arith. (2d); Eng. (2d); French (2d)
427—Leitch, Neil A. R., 15, Hull Ch. Inst., clerk—Bkpg. (2d)
1105—Le Maitre, Charles E., 25, St. Stephen's (Westminster) Ev. Classes, tutor—Arith. (2d)
999—Lidwell, Louis I., 19, City of London Coll., clerk —Bkpg. (2d)
430—Limbach, Louisa. 26, Hull Ch. Inst., teacher—French (2d)
328—Limont, George J., 18, Glasgow Anderson's Univ. Pop. Evg. Classes, clerk—Arith. (2d)
1142—Linford, Herbert W., 27, Quebec Inst., in Civil Service—Eng. (2d); Bkpg. (2d)
*474—Linnell, William, 24, Hull Y.P. Chr. and Lit. Inst., clerk—Arith. (2d); Eng. (2d); Bkpg. (1st)
486—Linsley, John T., 15, Hull Y.P. Chr. and Lit. Inst., clerk—Arith. (2d); Bkpg. (2d)
*657—Linton, William H., 17, Manchester M.I., clerk —Arith. (2d); Eng. (2d.); Shorthand (1st); Bkpg. (1st)
*894—Loban, Robert A. T., 21, Birkbeck Lit. and Sci. Inst., private secretary—Arith. (2d); Eng. (2d); Shorthand (1st); Bkpg. (2d)
825—Lockyer, Joseph, 19, Swindon M.I., clerk—Arith. (2d)
*1000—Loly, Gustave, 18, City of London Coll., clerk—Eng. (2d); Spanish (2d)
777—London, Thomas, 35, Leeds Y.M. Chr. Assoc., teacher—Domestic Economy Certificates in Clothing (2d); Health (1st), with the First Prize of £5; Cookery (1st), with the First Prize of £5.
460—Lonsdale, John H., 21, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (2d)
1101—Lough, Ellen E., 20, St. Stephen's (Westminster) Ev. Classes, governess—Arith. (2d); Eng. (2d)

357—McCallum, Gavin R., 17, Glasgow Ath., plumber —Arith. (2d)
388—McColl, John, 15, Glasgow M.I. clerk—Bkpg. (2d)
120—McDonald, James A., 16, Birmingham and Mid. Inst., clerk—Arith. (1st); Eng. (2d)
369—McEwan, James H., 18, Glasgow Ath., manufacturer—Arith. (1st); Eng. (2d)
96—McGouvan, John, 22, Belfast W.M. Inst., clerk —Arith. (1st); Eng. (2d)
250—McIntosh, John G., 21, Edinburgh Watt Inst., Civil Service Writer—Pol. Econ. (2d); Eng. (1st)
*381—McIver, Roderick, 26, Glasgow M.I., clerk—Arith. (1st); Eng. (2d)
348—Mackenzie, Andrew S., 18, Glasgow Ath., clerk —Arith. (2d)
330—MacNicol, Peter, 17, Glasgow Anderson's Univ. Pop. Ev. Classes, clerk—Bkpg. (2d)
244—McNicoll, Charles, 18, Dundee Y.M. Chr. Assoc., clerk—Arith. (2d)
91—McRoy, Elizabeth, 18, Bacup M.I., weaver—Domestic Economy Certificates in Clothing (2d); Housekeeping, &c. (2d); Cookery (2d)
208—McVitie, William J., 14, Carlisle M.I., in a warehouse—Arith. (2d); Eng. (2d)
674—McWilliam, William H., 16, Manchester M.I., accountant—Arith. (2d); Bkpg. (1st)
43—Main, James, 20, Aberdeen M.I., clerk—Arith. (2d)
*336—Malcolm, Archibald W., 15, Glasgow Ath., merchant—Arith. (1st); Eng. (2d); German (2d)
240—Malcolm, William S., 21, Dundee Y.M. Chr. Assoc., clerk—French (2d)

701—Marcroft, John G., 15, Oldham Lyceum, clerk—Arith. (2d)
325—Martin, Andrew, 19, Glasgow Anderson's Univ. Pop. Evg. Classes, clerk—Bkpg. (2d)
41—Martin, John, 19, Dundee Y.M. Chr. Assoc., light porter—Eng. (2d)
54—Mason, Edwin A., 15, Aldershot and Farnham district, no occupation—Eng. (2d)
1135—Mason, Frederic, 52, Quebec Inst., clerk—Eng. (2d); French (1st)
201—Massy, Charles, 28, Cardiff Free Library, clerk—Pol. Econ. (1st); Shorthand (1st); Bkpg. (2d)
637—Mather, David, 21, Manchester M.I., clerk—Bkpg. (2d)
669—Matthews, Henry, 20, Manchester M.I., clerk—Arith. (2d)
742—Mayo, J., 15, Salford W.M. Coll., teacher—Arith. (2d)
242—Mearns, Robert, 19, Dundee Y.M. Chr. Assoc., clerk—Eng. (2d); Shorthand (1st)
450—Meggitt, Frederick W., 17, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (1st)
194—Metcalfe, Theodore G., 20, Burnley M.I., teacher—Arith. (2d); Com. Geog. and Hist. (2d)
118—Milbourn, Mary L., 18, Birmingham and Mid. Inst., teacher—Arith. (2d); Eng. (2d)
922—Mills, Alfred T., 21, Birkbeck Lit. and Sci. Inst., warehouseman—Arith. (2d); Eng. (2d)
1088—Mills, Henry, 22, R. Polytechnic Inst., clerk—Italian (2d)
555—Mills, Mark, 17, Leicester W.M. Coll., clerk—Eng. (2d)
1001—Milne, Robert, 27, City of London Coll., shorthand writer—Bkpg. (1st)
8—Mitchell, William T., 17, Aberdeen M.I., warehouseman—Eng. (2d)
469—Moore, Henry, 18, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (2d)
785—Moore, Louisa E., 19, Rugby (no occupation stated)—French (2d); and Domestic Economy Certificate in Cookery (1st)
432—Morris, Richard, 18, Hull Ch. Inst., clerk—Bkpg. (2d)
1133—Morris, Richard T., 17, Quebec Inst., architect's pupil—Eng. (2d); Arith. (1st)
206—Morton, William, 15, Carlisle M.I., student—Arith. (1st)
488—Moses, Portas, 19, Hull Y.P. Chr. and Lit. Inst., reporter—Eng. (2d); Shorthand (2d)
565—Moulds, Walter, 17, Leicester W. M. Coll., elastic weaver—Shorthand (2d)
291—Mowat, John W., 14, Gartsherrie Academy, student—Arith. (2d)
871—Mull, Alfred, 18, Birkbeck Lit. and Sci. Inst. (no occupation stated)—Eng. (2d); French (2d)
896—Mungeam, Mary S., 33, Birkbeck Lit. and Sci. Inst. (no occupation)—Eng. (1st); French (2d)
710—Murrie, James, 19, Paisley Artizans' Inst., clerk—Arith. (2d)
389—Mutrie, James, 19, Glasgow M.I., draughtsman—Arith. (2d); Eng. (2d)

245—Napier, James Y., 16, Dundee Y.M. Chr. Assoc., clerk—Eng. (2d)
1089—Narraway, Clara M., 27, R. Polytechnic Inst. (no occupation stated)—Arith. (2d); Eng. (2d)
122—Nason, John R. W. W., 20, Birmingham and Mid. Inst., clerk—Eng. (2d); Spanish (2d)
1005—Nathan, Philip, 19, City of London Coll., clerk—Eng. (2d)
1093—Naylor, James T., 19, R. Polytechnic Inst., clerk—Arith. (2d)
*1122—**Neale, Charles M.**, 20, Quebec Inst., in Civil Service—Eng. (2d)
707—Needham, Joseph E., 19, Oldham Lyceum, pattern maker—Arith. (2d)
70—Nesbit, Henry, 16, Ashford M.I., clerk—Arith. (2d); Bkpg. (1st)
66—Neville, Richard, 18, Aldershot and Farnham district, soldier—Arith. (1st)
363—Newlands, John, 17, Glasgow Ath., clerk—Eng. (2d)
431—Newton, John V., 18, Hull Ch. Inst., corn merchant's apprentice—Bkpg. (1st)
711—Niven, Robert, 25, Paisley Artizans' Inst., clerk—Arith. (2d)
904—Nolloy, Charles H., 17, Birkbeck Lit. and Sci. Inst., clerk—Arith. (1st)

933—O'Brien, John W., 17, Birkbeck Lit. and Sci. Inst., clerk—Bkpg. (2d)
633—Officer, William, 24, Manchester M.I., warehouseman—Arith. (2d)
*187—**O'Malley, Patrick C.**, 35, Burnley M.I., bookkeeper—Arith. (1st); Eng. (2d)
712—Orchardson, John, 20, Paisley Artizans' Inst., clerk—Arith. (2d)
158—Ormrod, Frederic W., 17, Bolton M.I., teacher—Shorthand (2d)

818—Pagett, Walter W., 19, Stourbridge Assoc. Institutes, clerk—Arith. (2d)
726—Pappin, George, 15, Penzance, teacher—Arith. (2d)
487—Parish, Jane C., 20, Hull Y.P. Chr. and Lit. Inst., teacher—Eng. (2d)
*367—**Park, James S.**, 21, Glasgow Ath., clerk—Arith. (1st); Eng. (2d); Bkpg. (1st)
887—Parker, Edwin, 28, Birkbeck Lit. and Sci. Inst., clerk—Shorthand (1st)
1007—Parker, William, 31, City of London Coll., clerk—Bkpg. (2d)
1008—Parkhurst, Robert J., 24, City of London Coll., warehouseman—Bkpg. (1st)
221—Partridge, Matilda I., 18, Dudley M.I., governess—Arith. (2d)
278—Pate, James C., 14, Gartsherrie Academy, student—Arith. (2d)
629—Pate, John, 23, Manchester M.I., clerk—Bkpg. (1st)
387—Paton, James, 40, Glasgow M.I., book-keeper—Arith. (2d)
1048—Peacey, William J., 15, Islington Youths' Inst., clerk—Arith. (1st); Eng. (2d)
713—Pellew, William H., 17, Penzance, accountant Com. Geog. and Hist. (2d)
480—Peters, Lucy A., 21, Hull Y.P. Chr. and Lit. Inst., music teacher—Eng. (2d)
*123—**Phillips, Arthur**, 22, Birmingham and Mid. Inst., clerk—Arith. (2d); Eng. (2d); French (1st); German (1st), with the First Prize of £5
1087—Pickering, Edward, 25, R. Polytechnic Inst., book-keeper—German (2d)
919—Pillar, Alfred C., 25, Birkbeck Lit. and Sci. Inst., joiner—Pol. Econ. (2d)
438—Plummer, John G., 20, Hull Y.P. Chr. and Lit. Inst., clerk—Shorthand (1st)
1009—Poole, Frank G. L., 18, City of London Coll., clerk—Bkpg. (2d)
*1138—**Poole, Herbert J.**, 16, Quebec Inst., Civil Service boy-writer—Arith. (2d); Eng. (2d); Bkpg. (2d)
862—Porter, Henry, 21, Birkbeck Lit. and Sci. Inst., upholsterer—French (2d)
676—Porter, William, 14, Manchester M.I., at school—Arith. (2d); Eng. (2d)
73—Prankerd, Alfred E., 17, Ashford M.I., clerk—Arith. (1st); Bkpg. (1st)
*864—**Pratt, William J.**, 27, Birkbeck Lit. and Sci. Inst., in Inland Revenue—Arith. (1st); Eng. (1st)

660—Pugh, Edward, 39, Manchester M.I., clerk—Bkpg. (2d)

591—Quiggin, Daniel A., 20, Liverpool Inst., engineer—Arith. (2d); Eng. (2d)

403—Rae, Francis, 15, Glasgow Y.M. Soc., clerk—Arith. (2d)
275—Rankin, Thomas, 20, Gartsherrie Academy, civil and mining engineer—Arith. (1st)
246—Rattray, Robert, 21, Dundee Y.M. Chr. Assoc., clerk—Eng. (2d); Spanish (1st)
508—Reeve, John B., 17, Ipswich W.M. Coll., clerk—Bkpg. (2d)
42—Reid, David, 17, Aberdeen M.I., printer—Eng. (2d)
25—Reid, Walter A., 16, Aberdeen M.I., clerk—Eng. (2d)
627—Restall, Ernest, 20, Manchester M.I., clerk—Arith. (2d); Bkpg. (1st)
125—Reynolds, Thomas, 31, Birmingham and Mid. Inst., clerk—Bkpg. (2d)
720—Richards, George A., 14, Penzance, at school—Arith. (2d)
924—Richards, Sydney, 20, Birkbeck Lit. and Sci. Inst., clerk—Arith. (2d); French (2d)
1117—Ridewood, Frank H., 16, St. Stephen's (Westminster) Ev. Classes, teacher—Eng. (2d)
197—Rigby, John, 16, Burnley M.I., printer—Arith. (2d); Eng. (2d)
*1012—**Riley, Edmond J.**, 17, City of London Coll., clerk—Eng. (2d)
92—Riley, Sarah E., 18, Bacup M.I., winder—Domestic Economy Certificate in Cookery (2d)
1013—Ringrose, Richard, 25, City of London Coll., clerk—Eng. (2d)
934—Riorden, George J. J., 25, Birkbeck Lit. and Sci. Inst., engraver—Arith. (2d)
1095—Robertson, Margaret J. M., 22, R. Polytechnic Inst., teacher—Italian (1st)
274—Robertson, Robert, 21, Gartsherrie Academy, miner—Arith. (2d)
*364—**Robertson, William**, 24, Glasgow Ath., clerk—Arith. (2d); Eng. (2d); French (2d)
1014—Robinson, Charles J., 16, City of London Coll., clerk—Bkpg. (2d)
360—Robinson, William, 33, Glasgow Ath., book-keeper—Eng. (1st); French (1st); German (2nd)
592—Roscoe, Harry, 16, Liverpool Inst., draughtsman—Arith. (1st)
*1015—**Rose, John H.**, 28, City of London Coll., clerk—Pol. Econ. (2d); Eng. (2d)
889—Rouse, Robert, 31, Birkbeck Lit. and Sci. Inst., clerk—Shorthand (2d)
184—Rushworth, William H., 21, Burnley M.I., weaver—Bkpg. (2d)
1151—Russell, George W., 20, Hitchin M.I., parchment maker—Shorthand (2d)
1016—Ruthen, James, 25, City of London Coll., clerk—Bkpg. (2d)
1017—Rymer, Edward D. F., 23, City of London Coll., law student—Eng. (1st); French (1st); German (1st)
459—Rymer, Ernest G., 16, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (1st)

878—Sadler, Geoffrey E., 15, Birkbeck Lit. and Sci. Inst., clerk—Bkpg. (2d)
717—Sampson, Arthur, 14, Penzance, at school—Arith. (2d)
630—Sanderson, Frederick W., 15, Manchester M.I., draughtsman—Arith. (1st); Eng. (2d)
936—Sanderson, Richard T., 28, Birkbeck Lit. and Sci. Inst., clerk—Pol. Econ. (2d); Shorthand (1st)
789—Saville, Laura J., 18, Rugby, pupil teacher—Arith. (2d); Eng. (2d)
794—Saville, Walter J., 15, Rugby, clerk—Arith. (2d)
23—Scott, James, 24, Aberdeen M.I., engraver—Arith. (2d)
461—Scott, William, 21, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (1st)
*869—**Sellar, George W.**, 19, Birkbeck Lit. and Sci. Inst., clerk—Eng. (2d); Shorthand (1st)
373—Shanks, John B., 21, Glasgow Ath., clerk—Spanish (2d)
*1019—**Sharp, John B.**, 17, City of London Coll., clerk—Arith. (2d); Eng. (2d); French (2d)
1064—Sharpe, Edward H., 16, Islington Youths' Inst., clerk—Arith. (1st); Eng. (2d)
873—Shaw, Arthur H., 19, Birkbeck Lit. and Sci. Inst., clerk—French (2d)
740—Shawcross, James J., 19, Salford W.M. Coll., clerk—Arith. (2d)
78—Shepherd, Edward, 16, Bacup M.I., weaver—Arith. (2d)
80—Shepherd, James, 19, Bacup M.I., clerk—Arith. (2d); Eng. (2d)
247—Short, Robert M., 20, Dundee Y.M. Chr. Assoc., draughtsman—Eng. (2d); Shorthand (2d)
855—Shipway, George, 29, Birkbeck Lit. and Sci. Inst., engineer—Arith. (2d)
600—Sidebottom, Alfred W., 18, Manchester M.I., apprentice—Arith. (2d); Eng. (2d)
1020—Simmons, William R., 26, City of London Coll., clerk—Bkpg. (2d)
*650—**Simons, Charles**, 18, Manchester M.I., clerk—Arith (2d); Eng. (2d)
170—Simpson, James, 17, Burnley M.I., weaver—Arith. (2d); Eng. (2d)
572—Smith, Harry B., 20, Leicester W.M. Coll., mechanic—Eng. (2d)
268—Smith, John, 17, Gartsherrie Academy, teacher—Arith. (1st)
68—Smith, John A., 15, Aldershot and Farnham district (no occupation stated)—Arith. (1st); Eng. (2d)
573—Smith, Thomas, 17, Leicester W.M. Coll., teacher—Arith. (2d); Eng. (2d)
593—Smith, William, 18, Liverpool Inst., clerk—Arith. (1st); Bkpg. (2d)
1022—Smyth, James, 32, City of London Coll., clerk—Bkpg. (1st)
74—Spencer, Walter J., 17, Ashford M.I., clerk—Arith. (1st); Bkpg. (1st)
733—Stainforth, Harry, 17, Salford W.M. Coll., pupil teacher—Eng. (2d)
82—Standring, Benjamin, 19, Bacup M.I., twister—Arith. (2d)
1024—Steel, William G., 23, City of London Coll., clerk—Bkpg. (1st)
1119*—Stevens, J. G., 18, St. Stephen's (Westminster) Ev. Classes, teacher—Eng. (2d)
*353—**Stevenson, George**, 17, Glasgow Ath., clerk—Arith. (2d); Eng. (1st); French (2d); and the Second Prize of £2 for Writing from Dictation.
266—Stevenson, Thomas G., 17, Gartsherrie Academy, draughtsman—Arith. (2d)
*823—**Stone, Samuel**, 31, Swindon M.I., clerk—Arith. (2d); Eng. (2d)
827—Stone, Sidney, 18, Swindon M.I., teacher—Arith. (1st); Eng. (2d)
1026—Stones, Edward J., 21, City of London Coll., assistant schoolmaster—Bkpg. (2d)
783—Stott, Susanna E., 22, Rugby (no occupation stated)—Domestic Economy Certificates in Clothing (1st); Housekeeping, &c. (2d); Cookery (1st)
12—Strachan, James, 15, Aberdeen M.I., clerk—Eng. (2d)
190—Sullivan, Alfred T., 21, Birkbeck Lit. and Sci. Inst., clerk—French (1st)

1027—Sutton, George, 19, City of London Coll., clerk —Bkpg. (1st)
622—Sutton, James B., 15, Manchester M.I., book-keeper—Arith. (2d); Eng. (2d)
413—Sutcliffe, Novello, 20, Halifax W.M. Coll., warp sizer—Eng. (2d)
52—Sutherland, David, 19, Aberdeen M.I., clerk—Eng. (2d); Bkpg. (2d)

685—Taylor, Albert L., 15, Manchester M.I., at school—Arith. (2d); Eng. (2d)
792—Taylor, Edith A., 15, Rugby (no occupation stated)—Arith, (2d); Eng. (2d)
624—Taylor, Edward, 17, Manchester M.I., clerk—Eng. (2d)
84—Taylor, Hugh, 18, Bacup M.I., pupil teacher—Arith. (2d)
1145—Taylor, John, 22, Quebec Inst., clerk—Eng. (2d)
88—Taylor, Margaret A., 17, Bacup M.I., weaver—Domestic Economy Certificate in Cookery (2d)
129—Taylor, Wilfred T. 20, Birmingham and Mid. Inst., clerk—Arith. (2d)
327—Taylor, William, 26, Glasgow Anderson's Univ. Pop. Evg. Classes, clerk—German (2d)
719—Teague, Thomas G., 17, Penzance, at school—Arith. (2d); Eng. (2d)
525—Teasel, William, 25, King's Lynn Ath., clerk—Bkpg. (2d)
1149—Tebbut, Arthur M., 34, Quebec Inst., merchant —Spanish (2d)
264—Tennent, Joseph, 14, Gartsherrie Academy, student—Arith. (2d.)
453—Tennyson, Edward, 23, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (2d)
492—Thompson, Edward H., 21, Hull Y.P. Chr. Lit. Inst., compositor—Eng. (2d)
*106—Thompson, James F., 18, Belfast W.M. Inst., clerk —Arith. (1st); Eng. (2d); Shorthand (1st)
828—Thompson, Thomas P., 20, Swindon M.I., clerk —Arith. (2d)
38—Thomson, Alec, 21, Aberdeen M.I., clerk—Arith. (1st)
688—Thomson, Lewis, 14, Manchester M.I., at school —Arith. (2d)
40—Thomson, James, 19, Aberdeen M.I., clerk—French (2d)
*882—Thorn, Arthur G., 21, Birkbeck Lit. and Sci. Inst., clerk—Arith. (1st); Eng. (2d); Bkpg. (2d); and the Third Prize of £1 for Writing from Dictation.
*191—Thornber, Sharp, 18, Burnley M.I., warehouseman—Eng. (2d); Bkpg. (2d)
571—Thorpe, John R., 26, Leicester W.M. Coll., book-keeper—Shorthand (2d)
401—Threshie, Daniel M., 16, Glasgow Y.M. Soc., clerk—Eng. (2d)
595—Thwaites, Isabella, 35, Liverpool Inst., teacher of cookery—Domestic Economy Certificates in Clothing (1st), with the Second Prize of £3, and Housekeeping and Thrift (1st), with the First of £5.
479—Tiplady, William, 16, Hull Y.P. Chr. and Lit. Inst., hatter's apprentice—Arith. (2d)
725—Toman, Richard, 14, Penzance, at school—Arith. (2d); Eng. (2d)
*1120—Turnbull, William J., 20, Quebec Inst., Civil Service clerk—Arith. (1st), with the Second Prize of £3; Eng. (2d); Bkpg. (2d); the Second Prize of £3 for Handwriting, and the Third Prize of £1 for Writing and Manuscript Printing.
596—Turner, Benjamin L., 17, Liverpool Inst., engineer—Arith. (2d)
597—Tyson, John, 20, Liverpool Inst., engineer's apprentice—Arith. (1st)

817—Vaughan, David, 19, Stourbridge Assoc. Institutes, clerk—Arith. (2d)

262—Waddell, William, 17, Gartsherrie Academy, clerk—Arith. (2d)
858—Walke, Andrew J., 23, Birkbeck Lit. and Sci. Inst., in Civil Service—Bkpg. (1st)
472—Walker, Fred, 22, Hull Y.P. Chr. and Lit. Inst., clerk—Bkpg. (2d)
439—Walker, James, 20, Hull Y.P. Chr. and Lit. Inst., clerk—Shorthand (1st)
1085—Walker, Louisa, 23, Kentish-town Literary Inst., teacher—Domestic Economy Certificate in Cookery (1st), with the Second Prize of £3.
939—Wallace, Robert, 25, Birkbeck Lit. and Sci. Inst., chemist—Pol. Econ. (2d)
715—Wallis, John N., 14, Penzance, at school—Arith. (2d)
1106—Walters, Henryetta V., 18, St. Stephen's (Westminster) Ev. Classes, teacher—Eng. (2d)
400—Wands, James, 18, Glasgow Y.M. Soc., architect's apprentice—Eng. (2d)
130—Ward, William G., 18, Birmingham and Mid. Inst., clerk—Arith. (2d)
433—Warden, John, 19, Hull Ch. Inst., clerk—Bkpg. (1st)
607—Wardle, Alfred, 14, Manchester M.I., at school—Eng. (2d)
605—Wardle, John, 24, Manchester M.I., buyer—Italian (2d)
943—Watkins, Herbert, 18, Birkbeck Lit. and Sci. Inst. (no occupation)—Bkpg. (2d)
183—Watson, Garibaldi, 15, Burnley M.I., clerk—Arith. (2d)
563—Watson, John H., 23, Leicester W.M. Coll., draper's assistant—Shorthand (2d)
641—Weatherill, Harry W. P., 20, Manchester M.I., clerk—Bkpg. (2d)
1033—Webb, Alfred J., 18, City of London Coll., clerk—French (2d)
651—Webster, John W., 19, Manchester M.I., clerk—Arith. (2d); Bkpg. (1st)
440—Weldon, Frederick W., 19, Hull Y.P. Chr. and Lit. Inst., clerk—Shorthand (1st)
69—Welsh, Samuel F., 17, Ashford M.I., clerk—Arith. (2d)
*598—Wertheimer, Julius, 16, Liverpool Inst., teacher —Arith. (2d); Eng. (2d); German (2d)
741—Whittaker, Joseph, 15, Salford W.M. Coll., teacher—Arith. (1st)
851—Whittingham, Joseph, 19, Birkbeck Lit. and Sci. Inst., clerk—Shorthand (1st)
131—Whittingham, Sarah P., 21, Birmingham and Mid. Inst., teacher—Arith. (2d); Eng. (2d)
483—Wigelsworth, Isaac E., 14, Hull Y.P. Chr. and Lit. Inst., clerk—Arith. (2d)
204—Wild, George, 18, Carlisle M.I., clerk—Arith. (2d); Eng. (2d)
30—Wildridge, Gilbert I., 20, Aberdeen M.I., clerk —Bkpg. (1st)
599—Wilkins, William H., 22, Liverpool Inst., teacher —Arith. (2d)
899—Wilkinson, Robert B., 23, Birkbeck Lit. and Sci. Inst., clerk—Bkpg. (2d)
1034—Wilks, John B., 18, City of London Coll., clerk —Eng. (2d); Bkpg. (2d)
1035—Willcocks, Walter H., 18, City of London Coll., clerk—Bkpg. (2d)
1036—Williams, Dundas J. R., 17, City of London Coll., (no occupation stated)—Arith. (1st); Eng. (2d)
414—Williams, Frederick L., 16, Halifax W.M. Coll., clerk—Eng. (2d)
754—Williams, John W., 24, Salford W.M. Coll., clerk—Arith. (2d); Bkpg. (2d)
639—Wilson, Julius, 19, Manchester M.I., clerk—Bkpg. (1st)
856—Winser, George F., 30, Birkbeck Lit. and Sci. Inst., clerk—German (1st)
90—Wood, Ellen, 17, Bacup M.I., weaver—Domestic Economy Certificate in Cookery (2d)

634—Wood, George R., 23, Manchester M.I., engraver —Bkpg. (2d)
*835—**Wood, John W.**, 17, Swindon M.I., teacher—Arith. (1st); Eng. (2d)
837—Wood, Joseph, 15, Swindon M.I., clerk—Arith. (2d)
420—Woodcock, Herbert, 18, Huddersfield M.I., bookseller—Eng. (2d); Shorthand (2d)
133—Woodward, William H., 34, Birmingham and Mid. Inst., goldsmith—Shorthand (2d)
663—Worthington, Henry, 22, Manchester M.I., warehouseman—Arith. (2d): Bkpg. (2d)
702—Worthington, John S., 24, Oldham Lyceum, clerk—Bkpg. (2d)
636—Worsley, Moses, 19, Manchester M.I., clerk—Bkpg. (2d)
63—Worstall, William, 40, Aldershot and Farnham district, soldier—Arith. (2d)
1038—Wortley, George, 19, City of London Coll., clerk—Bkpg. (1st)
*215—**Woozley, David A.**, 29, Carmarthen Lit. and Sci. Inst., Inland Revenue officer—Pol. Econ. (2d); Eng. (2d)
*881—**Wright, Charles**, 18, Birkbeck Lit. and Sci. Inst., clerk—Eng. (1st); Bkpg. (1st), with First Prize of £5.
945*-Wright, Joseph B., 22, Birkbeck Lit. and Sci. Inst., draper's assistant—Eng. (2d); Bkpg. (2d)
1039—Wright, William H., 20, City of London Coll., Civil Service writer—Arith. (1st); Bkpg. (2d)
*1040—**Wright, William H.**, 21, City of London Coll., clerk—Pol. Econ. (1st), with a prize of books to the value of £1; Eng. (1st)
1109—Wyatt, Anne, 18, St. Stephen's (Westminster) Ev. Classes, teacher—Eng. (2d)

*324—**Young, David W**, 20, Glasgow Anderson's Univ. Pop. Evg. Classes, correspondent—Arith. (2d); Eng. (2d); German (2d)
259—Young, James, 20, Gartsherrie Academy, clerk —Arith. (2d)

HEALTH AND SEWAGE OF TOWNS.*

Thursday, May 11th, 1876. Lord Alfred Churchill (Chairman of Council) in the chair.

DRY AND FOREIGN SYSTEMS.

Mr. Alderman Taylor, of Rochdale, gave the substance of his paper on the Rochdale system,† and said he regretted that Mr. Rawlinson was not present, for he should put it to him that if irrigation only were adepted they would be far from perfection. He advocated irrigation as earnestly as Mr. Rawlinson, but only for true sewage, that is the cooking and washing water, and there was no difficulty in the question except in the price required for land. The majority of landowners of the country unfortunately looked upon sewage farms as a means of levying black mail upon the ratepayers in the towns. He believed that sewage farms were not injurious but wholesome. It was extraordinary that those who objected to them on account of their supposed stench would cover their land with offensive manure, and think it was inevitable. He had frequently met gentlemen who run down sewage farms, but who had never seen them. As to the Rochdale system, it was in all respects a sanitary success. They had succeeded so perfectly that the inhabitants of Rochdale would not have anything else. There was a perceptible improvement also in the inhabitants of the cottages in censequence. If there should be the slightest overflow from the pails, which occurrence is most rare, or if there was any neglect in collecting, and this did not occur in more than 12 or 13 instances per week, they had prompt indication from the householder. The effect was so immediate that they could congratulate themselves on the improved state of the people. It was a test question for the system, but they were not without hope that it would be found to be in a sense a commercial success. The cost was now £55 per 1,000, for what originally was from £70 to £80 per 1,000. The Rochdale system was commenced in the first place in the inner circle of the town; that municipal area was subsequently extended by Act of Parliament, and the enlargement made a large difference in the cost of collecting. Had this been known at an earlier date, they would have had three depôts instead of one. The manufacturing of manure was the best means of disposing of night soil. He would not allow farmers to have it in a crude state. He might allow that it was only by experience that the exact and best methods could be obtained, and they were ready to improve. They had now on trial one of Kidd's machines, which was estimated to dry ten tens daily at a loss of one-tenth per cent. of ammonia, and it was hoped it would succeed.

Mr. Thos. Mason, the representative of the Goux system, asked Mr. Taylor whether the Rochdale system was beneficial to public health? Had it lowered the death-rate in the town? Was it fairly remunerative, and what was the opinion of its merits elsewhere? Had the Rechdale system not been classified with the dry sewage system, he would not have known that it was other than a modification of the old chamber system, with a modification of the old nightstool introduced. It had been stated by Mr. Taylor that the Goux system was a modification of the Rochdale system. Mr. Taylor stated that, on an estimated population of 52,000, with 5,644 closets and ash tubs, the collections for last year were 5,398 tons of excreta and 8,652 tons of ashes and refuse, at a cost of £30 per 1,000 population, or a total cost of £1,560, exclusive of interest and depreciation. But the cost at £74 a week as named was £13,848. Now if the 12·47d. per head, which was shown by the figures was taken, it would make £2,701 17s. 6d., and he (Mr. Mason) could not account for the discrepancy. The report of the Town Council for Rochdale gave the amount paid for the year 1875 at £7,057, with a loss of £5,276; and for the year ending 1876, the sum of £9,650 paid, and a loss of £7,300. Either the borough accountant or some one else must be wrong. Again, the manufacture of the manure was put at £24 per week, or £1,248 per annum. This sum added to £2,570, the mean average of the three sums quoted gave £3,818, leaving a loss for 1875 of £6,332. He also pointed out some discrepancies between the death-rate quoted by Mr. Taylor, and the figures published in the *Rochdale Observer*.

Dr. Wilson (Medical Officer of Health for Rochdale) said, in reply to the last speaker, that the death-rate in Rochdale from 1863 to 1869, both inclusive, was 26·22 per 1,000, from 1870 to 1875, inclusive, it was 23·57, and though the death-rate at the present time was over 30 per 1,000, the excess was almost entirely due to a severe epidemic of measles. No doubt other influences were at work in bringing about this reduction, but certainly a large share was due to the improvements following upon the introduction of the Rechdale system in 1870. One fact had struck him as most important, that up to the present time over 5,000 pail-closets had been substituted for old privies and stinking ash places, and at a low estimate. Nearly two acres of such soil and air-polluting places had been removed or prevented being made in the town. Another point was that they had to a very large extent done away with the necessity for those public nuisances, viz., public tips, such places were now every year being more certainly traced as insidious causes of disease from

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* For the convenience of those wishing to have the account of the proceedings in a more compact form than the various numbers of the *Journal*, the same will also be published as a pamphlet, which can be had in a few days on application at the Society's House. Price 2s. 6d.

† See *Journal* for May 26th, page 656.

houses being built upon this filth polluted soil, and at the present day with our accumulated experience this pernicious practice should not be allowed to go on anywhere. The details of the Rochdale system provided for a weekly collection of dry ashes and other household refuse in a separate tub, into which no slops or other water was thrown, and from these conditions, he did not believe that any nuisance could be traced to such tubs. As to the excreta pails being cleansed thoroughly every time, they were brought in, and a liquid disinfectant was put into each before being sent out. He could say after examination of a great number of these closets that the smell from them was infinitely less than in the old privies, and certainly not more than can be perceived in the best of our modern water-closets. He had recently been engaged in tracing out some cases of enteric fever which had been introduced into the Borough. Many of these cases were spread by the patients attending a school where the privy was on the old plan. In comparing the result of preventive measures in cases where some used the pail system, others the old privy, the control over the former was most marked, as the excreta being first disinfected the whole was removed every second or third day or oftener, and all danger to others then ceased. This was also borne out by the fact that after very careful inquiry no case of enteric fever could be traced among the workmen engaged about the manure works since their commencement. The nuisance from leakage from the carts while the excreta was being conveyed through the town was very exceptional, and even these cases would in future be avoided by the use of a more close fitting lid to the pails now being carried out.

Dr. Joseph (Medical Officer of Health for Warrington) inquired what price the manure realised, whether they got a good sale for it, and whether they had any accumulation?

Mr. Taylor said they sold 2,200 and odd tons, at an average price of 23s. per ton. The sale was always good, and was increasing. They had sold an increased quantity yearly to the same people.

Dr. Joseph wished to make a few observations with regard to the system in use at Warrington. He thought it was much the same as at Rochdale, although of course the method of manufacturing the manure was different. They sold their manure at 4s. per ton, whilst the net cost of the system to the borough was £751 1s. 8d. inclusive of interest upon the borrowed capital for the works and deposits*, and for the extra inspectors which they had employed to carry out the works. If they could get a shilling per ton more than they now did, the system would be self-supporting. For the first two or three years of his appointment as medical officer of health there was a great deal of prejudice against the system, but now people came to them asking them to convert their privies and even water-closets to the system. He could confirm what had been said with regard to the death-rate. During eight years, from 1864 to 1871, their average death-rate was thirty in the thousand. From 1872 to 1827 it was 23·9. He did not pretend to set down this decrease in the death-rate entirely to the introduction of the pail system, for they had made other sanitary improvements, such as making new roads and observing other sanitary precautions. But he was of opinion that the new system was mainly instrumental in the improvement. In conclusion, he might say that it was impossible for the dirtiest and filthiest people (and they had some very dirty people in their district) to make as great a nuisance as they did before.

Mr. Adam Scott asked if Alderman Taylor would say what quantity of manure was unsold when the 2,000 tons had been sold?

Mr. Taylor replied that it would be easy to mislead were he disposed to do so. Last year they had in stock 6,240 tons, and they had in stock this year 2,877. They had sold 2,140, and had apparently lessened their stock only by the sale of 2,140 tons, which would give 4,100 tons. Those were the figures, and the discrepancy arose from about 1,200 tons becoming worthless from exposure, and being given away. That was in consequence of the Town Council declining to give them storage room.

Mr. Haresceugh, of Rochdale, said that Warrington was situate in the best market for manure. At Rochdale they had 12 miles to go to market, through Manchester. But though in the very neighbourhood of Manchester and Salford, where people were selling their manure at 1s. 6d., 1s. 9d., and 2s., they had sold more of the Rochdale manure during the last year than they had sold before. With regard to the slopping, he had used the system for twelve months, and never found any inconvenience of the kind.

Mr. Bryan (Blackburn), said that in the town which he represented they used the tub system. The excreta and urine were put in tubs and collected in a similar manner to that of Rochdale. They made a most abominable stench.

The Chairman—Are your tubs covered?

Mr. Bryan said there were two coverings, but they, nevertheless, experienced a most decided nuisance.

Mr. Alderman Tatham (of Leeds) said that they had there a system of tub collection. They endeavoured to collect their dry ashes and dry excrement, and to manufacture them into manure, but they were not yet in a position to carry out that plan. The excreta was laid on layers of ashes and straw alternately. Their scavenging was let out.

Mr. Councillor Walker (Leeds) said they were in a very crude state. Last year they had the ashes in their own hands, and lost £20,000 in the year. They now let the collection of the ashes for £15,000 per annum. They had railway and canal facilities for carrying manure to market, but the cost of scavenging became greater every year, as an increasing town like Leeds was gradually receding from its outskirts. In the case of the pail system, which was not in favour with them, they had experienced great difficulties, and no doubt the same difficulties would occur with any dry system. One great disadvantage was in adapting the system to seats for children, and it was possible that they might be compelled to abandon it.

Mr. Gilbert Redgrave said he had paid great attention to the system under discussion. Whatever defects there might be arising from the carriage of the pails through towns, yet the system was a marvellous advance upon the old middens. One who had seen what took place when these middens were emptied, could not but acknowledge that the collection of the pails was much less of a nuisance than the heaps that used to be made in the roads. The Rochdale system was one which professed before all others to utilise all the materials collected. That was where Rochdale had made such an advance upon Blackburn, Warrington, or even the Manchester system. There was one point he wished to draw attention to, namely, the question of drying the contents of pails. Mr. Alderman Taylor had adopted a drying machine, which he had had the pleasure of seeing in use at Rochdale ten days ago. It was professed that that machine was capable of drying ten times as much as any other, but no reference had been made to its cost.

Dr. Syson (Medical Officer of Health for Peterborough) said he was a disciple of Mr. Alderman Taylor, and his experience of the pail system was gained at his feet. He looked upon him as a Gamaliel of sanitary science; but though a disciple once, yet now he thought he had got very far ahead of his master. The Medical Officer of Health for Rochdale had talked at some length about

* See page 759.

their ash-pits. His (Dr. Syson's) opinion was (and his experience had been larger) that the ash-pits were the greatest bugbear they had to contend with. It was a misnomer to say they contained dry ashes; some were dry and some were wet, and the remainder was cabbage and refuse of every kind. Such a stench came from the ash-tubs that the ash-pits became quite a nuisance. Some sanitarians imagined that they could dry the ashes, and deodorise with them. But directly they were mixed with urine and excreta, a chemical mixture took place, and sulphuretted hydrogen was given off. By all means they should keep their ashes and dust on one side, and their excreta on the other. With respect to middens, it did astonish him that people should like to retain them. He did not see what good it was throwing the dust into the excreta. In his opinion, the pail system they had at Rochdale was most admirable. But he took his departure from Mr. Alderman Taylor at a certain point, for he did not believe in deodorising the slop-pail. At the same time he might say that he considered the Rochdale system, as a simple pail system, to be a great advance.

Mr. Peter Spence said they were doing something to get over the difficulties mentioned by the last speaker. If fæcal matter were emptied into ash-pits a chemical process took place, and ammonia was given off. They used sufficient sulphuric acid to neutralise the ammonia produced. Instead of using the ashes which came to them in a moist state they mixed charcoal with the ashes and road scrapings. This was transferred then to a trough, and carried along on an archimedean screw into the tub which was the receptacle for the excreta. In that manner they avoided touching the excreta with their hands, and the method also got rid of the difficulty of the Goux system. The latter was very costly, as it involved a very considerable amount of labour in manufacturing the manure.

Sir H. Cole, K.C.B., said he had made similar observations to Dr. Syson. He would like to know whether in the case of Rochdale any disinfectant was used in the pails in the houses, and if so did it answer its purpose? The great question was whether a disinfectant was useful, and whether it wholly disinfected the excreta? A gentleman who had seen the system in work at Vienna, said there was no disinfectant known there.

General Scott observed that he had not heard the early part of the discussion. Mr. Bryan had remarked upon the stench from the carts as they passed through the streets. The speaker had seen carts on many occasions passing through the streets of Manchester and Rochdale, and had never remarked any slopping or smell. He had sniffed round the carts, and had never been able to perceive any nuisance. From his own experience he agreed with the remarks of Dr. Syson; the only point on which he differed being that the doctor described to them that people generally threw their slops on ash-pits, in order to avoid the overflow that took place in the pails. He was not, however, certain that the best plan would not be as Dr. Syson proposed. His own opinion was, and he had visited hundreds of carts to see what people did, that there ought to be a place provided for slops. If they only provided a place people would go any distance; it was only when they did not give them proper receptacles that urine was found on the ash-pits. He could not say the same with reference to the pails themselves. Instead of allowing the urine and slops to escape by some way or other from the pails, it was retained with the excreta. In Furness and elsewhere it was very common to keep it separate, that it might be treated distinctly from the contents of the pails. By that means the pails did not overflow, for the water was run into the sewer receptacle as the chamber slops. If there were only the slops to deal with, a very small quantity of disinfectant would render them harmless. He believed, with a very little care, the passage of the carts through the streets could be rendered harmless.

Mr. Alfred Haviland, M.D. (Medical Officer of Health, Northampton), said that ever since he first fully realised the requirements of his area, he had advocated the dry system of sewage disposal and periodical scavenging, under the superintendence of sanitary authorities. In 1874 he devoted his holiday to examining the different modes of sewage disposal, and eventually he gave the preference to that system known as the Goux. He (Dr. Haviland) had taken a great interest in the study of how to get rid of filth diseases, and had been most anxious to ascertain what were the facts connected with the adoption of that system in some large community. He selected Halifax, and had visited that town twice in order to see the practical working of this system, as well as to test its efficacy. He had free permission to inspect the death-register for Halifax, and the following figures were the result of his inquiries:—In the first place, he discovered that the death-rate in the borough of Halifax had from 1868 begun to rise, so that it reached 29 per 1,000 per annum in 1870, in the autumn of which year the Goux system was adopted as a remedial measure against the evils consequent on the use of cesspits or middens, and water-closets; and that this increase still continued during 1871, so that it actually amounted in that year to the alarming height of 31·5. After this date, concurrently with the more complete extension of the new system, the death-rate gradually subsided within the last few years to a mean annual average of 24·1 per 1,000. It would be convenient to divide the term 1870-75 into two triennial periods. The first, 1870-2, embraced the years in which the death-rate attained its maximum, and the Goux system began to be developed; and the second, 1873-5, comprehended those years in which the final establishment of the system took place, and a coincident reduction in the death-rate recorded. If they took the whole sexennial period, they would find from the returns which had been furnished, that the average number of closets to every 1,000 persons living in the borough of Halifax amounted to 25. He therefore took that number as the standard for the period under discussion. In 1870-72, however, there were only 14·0 to every 1,000 persons, whilst during the years 1873-5 this number amounted to 37·6. He found that in 1870-2 none of the ten wards contained 25 closets per 1,000 population. Thus, if a scale of ten degrees were formed ranging from the highest to the lowest number—viz., from 59 to 2 per 1,000 living—it would be found during 1870-2 that there was one ward (10) belonging to the 6th or lowest degree, 0·5; five (1, 2, 3, 4, and 9) to the 5th, 10·15; and four (5, 6, 7, and 8) to the 4th, 20·25. These figures showed that the Goux system had only been adopted to a very limited extent, and therefore could not at that be expected to have exerted any decided influence upon the death-rate; it was necessary, however, for future comparison, to see how matters stood during that time, both as to mortality from all causes and that arising from enteric fever and its allied forms. Dr. Haviland took the death-rate from "all causes," first, and in recording it proportionally in each of the ten wards in the two triennial periods, said he would use a scale of degrees which he had found useful and easily understood when making similar reports. The average annual death-rate for the whole of the borough of Halifax during the sexennium 1870 to 1875 amounted to 26 per 1,000 persons living. Dr. Haviland then referred to some carefully prepared coloured maps of diseases in Halifax, which he had published in accordance with the plan recently laid down in his "Geographical Distribution of Heart Disease, Cancer, and Phthisis in England and Wales." These coloured diagrams of disease in Halifax showed that during the first triennium, when the Goux closets had just been introduced, and were distributed only to the extent of 14 to every 1,000 of the population, the annual average mortality from "all causes" exceeded the average in eight out of the ten degrees; the annual death-rate ranged from 32 per 1,000 in West Ward to 19 per 1,000 in that of Northowram. It would be seen from the figures that,

coincident with the fact of the Goux system having been only partially adopted in Halifax during the first triennium, and that principally during the last of the three years, the general mortality of the borough reached a high rate in all but two of the wards. He would refer to the prevalence of "fevers" in the borough during the same triennium; and in these he included typhoid and its various forms, and eliminated typhus, relapsing, and other fevers not traceable to sewage sources. The average annual mortality in Halifax from this group of causes amounted to ·8 to every 1,000 persons living. Although an excessive mortality had been obtained from fevers during the first triennium, it would be wrong to attribute to this group alone the high general death-rate; but they might safely believe that the filth accumulation which brought about the high fever-rate greatly conduced to intensify other concurrent causes. During the first triennium he found that seven out of the ten wards had an excessive mortality from fevers. Thus, in four, viz., Ovenden, Southowram, the South and East Wards—registered a mortality of from 1·5 to 1·8. This, indeed, was a state of things sufficient to alarm any sanitary authority, and was the faithful expression of a gradually increasing evil. Three wards only had a mortality below the average—the West, Market, and Skircoat. Having now seen what the health of Halifax was during the triennium when it was practically unscavenged as regards its sewage, and when the midden system had begun to tell its tale, which it always did sooner or later, let them briefly examine the mortality returns for the second triennium, 1873-5, when the Goux tubs had been more widely and thickly spread—when, in fact, as a mean for the three years, there were 37·6 tubs to every 1,000 persons, instead of only 14·0. In the first triennium not one of the wards enjoyed a Goux closet distribution above the average: whilst in the second there was in eight a distribution equal to the first or highest degree, or from 50 to 55 per 1,000; two to the second, 40 to 45 per 1,000; and three to the third, 30 to 35 per 1,000. They had therefore evidence of multiplied sanitary action in the form of the abolition of a number of middens, and the substitution of some 2,280 movable tubs, which are scavenged once a week. It would be remembered that of the ten wards in the first triennium, only two wards had a mortality below the average death-rate from "all causes, viz.," Northowram and Skircoat. In the second triennium, however, he found this number trebled, only four wards having a death-rate above the average. The contrast was striking. Let them see what the fever returns indicated. In the first triennium were four wards, having a death-rate belonging to the first or highest degree of mortality, and three belonging to the third degree, seven in all. In the second triennium, however, a marvellous change took place; for instead of there being only three wards with a fever death-rate below the average, there were only two in which the rate was exceeded. It was significant that one of these wards, the one which had the highest mortality, was the one which even in the second triennium was shown to be the least supplied with the Goux tubs, and therefore the worst sewage scavenged. Ovenden afforded another illustration. In the first triennium it had a very high mortality from "all causes," and the highest from "fevers," whilst its closet distribution was only 11 to 1,000. In the second triennium its closet distribution was quintupled, its general death-rate reduced from the 2nd to the 5th degree, and its fever-rate, which had attained the highest degree in the first triennium, was reduced to the fourth in the second. These illustrations were sufficient in themselves to show what could be done in a short time by the Goux system of sewage disposal. He had advocated it throughout his sanitary area, and was pleased to be able to give the results of the practical working of the plan. Of course, in Halifax even, it could not be said to be in full operation; for he should not consider the plan fully carried out until the entire midden system has been uprooted, and the number of closets largely increased. The power of this mode of dry sewage disposal to starve out enteric fever and its allied forms was great, simply because it rested upon sound principles—principles which he had advocated ever since he thoroughly knew the requirements of the area, and he was pleased to lay before the company assembled the facts which he had collected, as they inconvertibly proved the value of the Goux system of sewage disposal, which, in 1874, he first brought into notice. He might thus summarise the facts:—1. During the first triennium, 1870 to 1872, the annual rate of mortality in Halifax was high and increasing, amounting in 1870 to 29 per 1,000 inhabitants. In 1871 it was 31·5, and in 1872, the year in this period, when there were the greatest number of Goux tubs, to 26·8. The average death-rate for that triennium being 29·1, whilst the fever-rate for the same period was also excessive, amounting to 1·0 to every 1,000 persons living. Coincident, and with these high rates, was an extensive midden or cess-pit system, the evils of which had aroused the energy of the sanitary authorities, who wisely determined to substitute the Goux system. During the triennium, however, only fourteen Goux tubs to every 1,000 persons were in use. 2. During the second triennium ending 1875, the general death-rate was reduced to 24·1 as against 29·1 in the first, and the fever-rate was reduced to ·7 as against 1 per 1,000. There, lessened death-rates were coincident during this triennium, with a larger extension of the Goux system amounting to 36·6 to every 1,000 persons, and an wholesale destruction of the cesspools. It would be seen from the above figures that the difference between the fever death-rate in the first and second triennium exceeded the rate of one death to every 4,000 persons annually in favour of the last triennium. Now, in a population like that of Halifax that apparently trifling amount of life-saving assumed large proportions. For instance, it was calculated that there were ten cases of fever to every death from this cause, and that each case cost on an average 30s. a week for loss of wages, medical attendance, nursing, &c. Now, supposing the estimate to be correct that each case of fever lasted on an average five weeks, the actual amount saved in Halifax alone year by year, when one in 4,000 of the population, 68,167, was prevented from dying from fever, equalled £1,272. In 1873 fever cost England nearly a million of money. Why he was so anxious that this system should be adopted throughout his area was that it involved regular and systematic scavenging, and offered the speediest mode of getting rid of the fever which was so endemic amongst them, and thus enabled the scavengers to devote their time and energy to the destruction of the other serious evils which surrounded them on all sides.

Mr. Tarbotton, C.E. (Nottingham) would like to ask Alderman Taylor to what extent at Rochdale, and other places, where his system was carried out, the so-called sewage difficulty was affected. In his own experience in various towns in the country, the refuse might be collected in a pail or tub, but that did not in any way affect the difficulty that arose from the volume of water in the sewers. They had in them not only the urine from the public urinals, but the slop water still to be dealt with. He considered the system of removal of excreta in pails as indelicate. It must be borne in mind that they did not continually have winter weather, and in hot weather it must be a nuisance. They were liable also to strikes of workmen, and in what a state would that leave a town? He was free to acknowledge that it was an enormous improvement over the abominable midden system of past ages.

Mr. Alderman Tatham said he should like to make a few remarks concerning the carts or waggons that were used for the conveyance of the tubs from the houses to the central depôts. No doubt there was very great need for cleanliness in respect of the carts. At Manchester they had 19,000 pails in operation, and there was so

little smell to be found with the waggons, and such care was taken to cleanse them, that no nuisance occurred. If it did, the workmen would be speedily reprimanded for allowing it; he had frequently passed between the carts when he saw them in a string to be able to see what nuisance arose. He could see very little nuisance whatever. He had known a dozen carts pass without being aware of any smell whatever from the excreta.

Mr. Councillor Walker said it was the practice of private firms in Leeds to use the new system. He knew firms that employed from 1,200 to 1,500 workpeople each, using the pail system. The buckets were removed once a week, and they were so satisfied, that he knew of several instances where the owners of these establishments had introduced the same system into their own houses.

Mr. Charles Elcock (of Manchester) asked to be allowed to mention that during the last few days he had heard that peat charcoal had come into use. Yesterday he received a letter from the chairman of the Sanitary Board of Halifax, in which he said that they had found a considerable nuisance at the central depôt; as it was increasing, they used peat charcoal about a fortnight since. They found that a large bucket of it was sufficient to deodorise the quantity returned from the depôt at the end of each week. In fact, the application of a very small quantity of this material in a second or two entirely stopped the stench. It was used in the form of a powder.

Mr. Alderman Taylor then commenced to reply to the observations which had been made. He would have replied seriatim, but for the time it would occupy. First, what Mr. Mason had said was not at all correct. There was in Rochdale a coroner who was a lawyer, and interested for his client in tho Goux system. It was tried during some eight or nine months, but at Rochdale they found it an utter failure. So utterly impracticable was it found, that the pail system with the Goux lining, as originally adopted by the Goux people, was given up, as it could not be worked, and the Corporation took upon itself the collection and manufacture according to the plan he, Mr. Taylor, had proposed.

Mr. Mason said that, as he represented the Goux system, he must tell the Chairman that Mr. Taylor was chairman of the Sanitary Committee of Rochdale, and had sufficient influence to carry anything he liked into effect.

Mr. Alderman Taylor went on to say that the county coroner once made a statement to which he made a counter statement. The coroner, he was sure would not say now what he did say two or three years ago. They took nine months to try the system. It had given them the results of the sale of the manure they now manufactured, but the Goux people never manufactured a ton of manure they could sell. But unfortunately politics had been occasionally introduced into the question at Rochdale. In Rochdale also, the old night soil committee had been dead set against the pail system. Mr. Taylor then proceeded to remark on discussions which had taken place in the Town Council of Rochdale.

The Chairman said he was sorry to stop the discussion, but Mr. Taylor had exceeded his time. He would, however, take the sense of the meeting as to hearing Mr. Taylor further.

The meeting being in favour of hearing Mr. Taylor, he continued. The Conference would more clearly understand the present position of the question by his reading a paragraph which he had written for insertion in his paper, but had left it out of the paper, with the intention that local strifes should not be introduced. It read as follows: "This year has been a remarkable year in the history of the trial of the cost of manufacture and non-manufacture. Twelve months ago there was a large stock of manufactured manure on hand, and the cry was raised that this was a great cost, and the old night soil committee persistently stated that the whole excreta could be sold without perfect manufacture. A majority of the Council gave credit to this view, and the Health Committee, which had the manufacture under its control, was refused more convenience for the manufacture, upon which it recommended that no more should be manufactured than could conveniently be done. Accordingly, the total manufacture this year has been but 755 tons. The result has been an increase in the cost of about £3,500 to the town." He might add that he believed there would be no difficulty as to the perfect manufacture in the future. He said that with the dry system of collection the volume of sewage was lessened one-half. It must also be borne in mind that in the water-closet system the water was costly; the cost of water would be £1 per house additional, and that was a very serious question. The public urinals and slaughter-houses were visited by them, and the contents collected. It had been said by Dr. Haviland that the Halifax system was more perfect than the Rochdale system; why did he not visit Rochdale? How did he know? The observations and suggestions of Mr. Spence were of great value to the discussion, and if he found Mr. Spence's plan better, it was very likely he would adopt it. The Salford experiments of Dr. Syson were very extraordinary. He allowed that the Goux plan had been tried at Salford, and at his recommendation they abandoned it. He improved upon it, and yet he then abandoned it. He did not exactly understand what Dr. Syson meant by saying he had left him. He wanted to say a word on the general question. The way he put it was this: their system meant perfect collection, perfect manufacture. Some said they would adopt something where they would have perfect collection. Let them adopt their system in its entirety, let them try it, and if it failed adopt another. They took nine months to try the system. It had given them the results of the sale of the manure they now manufactured, but the Goux people never manufactured a ton of manure they could sell.

Mr. Mason asked what the Rochdale system was? Would Mr. Taylor describe it in a few words.

Mr. Taylor said they collected the excreta in pails, without offence, and without sloppiness in collection.*

Mr. W. Pearse then read some extracts from his paper† on Morrell's ash-closet, and remarked that for perfecting the dry system of collection, it should not be forgotten that the liquid refuse had still to be dealt with; this, however, owing to the absence of excreta was of a consistency which made it less difficult to treat than under the water-carriage system. As far back as 1860, Mr. Morrell proposed the adoption of the intermittent filtration system through natural soils divided with parcels for daily and fortnightly alternate use, without, however, attempting to grow crops on such parcels during the cleansing process. By adopting a second series of arranged parcels, and by using such second portion, in its twice growing crops on the already saturated portion the liquid refuse was utilised (as far as possible), and the efficiency of the cinder sifting ash-closet system completed.

Mr. Harescough (Rochdale) asked what the cost of the apparatus was? They had one that cost three guineas. If they were to apply it, it would take 24,000 guineas. Each vessel lasted three years; what, therefore, would the cost come to annually? He considered sending cinders out to be sifted was like sending out beds to be made.

Mr. G. B. E. Galloway, C.E., said the paper reminded him of what occurred to himself many years ago, when he was asked by the Rev. Mr. Moule to turn his attention to the dry earth system. He proposed a plan, and

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* For full description of system, see Mr. Alderman Taylor's paper, in *Journal*, May 26th, page 656.

† For paper, see *Journal* for May 26th, page 659.

was asked to attend a meeting at Leamington, at which the Earl of Warwick took the chair. He then proposed the very thing that had now been patented. It was part of his proposal, that instead of taking the trouble to first bring earth into a town and then to have to take it out again, to use fine ashes, in connection with a sifter which he fixed behind the ordinary closet. By these means he deodorised and rendered innocuous the fæcal matter. It was a matter of great interest to him as an inventor to see the fruit of his brain carried out by others.

Mr. W. Pearse said two questions had been asked with respect to the cost of the closets in Morrell's system. The cost for new erections was from five to six guineas including brick work. That cost was scarcely greater than that of the old objectionable middens.

The meeting here adjourned for half an hour.

On the members of the Conference re-assembling, the discussion on the various dry systems was resumed. The chair was taken by **Captain Douglas Galton, C.B.**

Mr. Lewis Angell, C.E., said that anything more disgusting and unclean than the pail system, as carried out at Manchester, he had never seen. What he wished to call the attention of the meeting to was something unique at Manchester and Salford. On one side of the town dustyard was a filthy deposit, in a crowded neighbourhood; and on the other side of the road was the magnificent abbatoir of the Manchester Corporation, where meat was killed and dressed upon the most scientific principles. If there was any truth in the germ theory of Professor Tyndall, it must be most dangerous to have the mixing going on on one side of the road while meat was dressed on the other. The meat must be covered with excreta dust and ashes; a very good arrangement to disseminate disease.

Mr. Elcock said that nothing in connection with putting a town abattoir alongside of a street where an accumulation of town refuse was stored, could be said to affect the pail system. It was a misfortune that the refuse was placed in the position it was, but he did not see how it could possibly be contended that it was any demerit to the system. There was an improvement under consideration at Manchester, which would result in a very considerable change in so far as smell might be concerned. At present he did not think the smell much; it might be very much more. He had himself spoken of the unhealthiness of having the abattoir so close to the sewage works and the town yard. It could not, however, be avoided at present.

Mr. Adam Scott then read a paper* on the pan and pail system in Edinburgh, which was not, however, discussed.

Mr. Elcock (of Manchester) then brought before the meeting his paper† on the process of the Universal Charcoal and Sewage Company, now in action, to a limited extent, at Salford.

Mr. Robert Pulling remarked on the advantage of the system of Moule's earth-closets; he said that under a proper system of the application of mother earth, which was the finest deodoriser in the world, it would be a most productive one. If they could arrive at a mode of bringing the dry earth to the different houses, and taking back the solid earth manure to be utilised for manurial purposes, it would be most profitable and conducive to public health. He would mention an illustration of his plan.

The Chairman inquired where the plan was in operation?

Mr. Pulling said at Beddington a gentleman of great renown as a schoolmaster had adopted the earth-closet system for the last 15 years. He did not know whether there had been any measles there, but amongst the young men whom he was training for Oxford and Cambridge, not a single case of typhoid or diphtheria or other preventible kind of disease had occurred. To any one that went there he would be happy to show the advantages of the system. He thought the subject deserving of consideration, for they knew that earth was the finest deodoriser, and if that system was adopted public health would be very much improved.

Mr. Alfred M. Fowler (Borough Engineer, Salford) said he had had a great deal to do with various systems in connection with the disposal of the refuse of towns. He thought in public inquiries like the present they should consider very seriously what they were going to do with the refuse when they got it to the depôts. Of all the dry systems which he had seen, Moule's earth system appeared to be the best. It must be borne in mind that the fæcal matter was collected and deposited in the town, and not taken out of the town. Then, again, they only removed a portion of the liquids. In Salford, and in some places eastward of Leeds (where he was for eight years), he found that it cost 7s. 6d. per ton for collection, and was not then taken out of the ward. The evil was not removed when the excreta and ashes were removed from the houses, for they could not remove it actually from the town, although they might take it from the houses. In the cholera epidemic of 1849, the inhabitants in the neighbourhood of Cavalier-street were almost exterminated by reason of the want of proper sewage and sanitary arrangements. So much for the collection system. Supposing they adopted the water-closet system, they dealt with it in a more comprehensive way.

The Chairman observed that the water-carriage system had already been discussed on the previous days, and therefore could not now be brought forward.

Mr. Fowler said that by means of the water-closet system all the refuse was turned into the sewers, and they knew what they were doing. But if they took it in tubs and deposited it in the town, they had one of those pestiferous nuisances that arose in large towns.

The Chairman inquired whether Mr. Fowler spoke from his experience at Salford. They had there a pail system of collection as well as a water-carried system of sewage, which drained into the river.

Mr. Fowler said that in one district they had the pail system, and in another a modified midden system, by which the liquid was kept out of the midden as far as possible and diverted into the drains. There was a difference of opinion as to the best mode of dealing with the town refuse. It became a very serious matter for the engineer of a large town having charge of the improvements, to do his duty. When, therefore, he heard that the present important inquiry was being held, he considered it a part of his duty to come there and express his opinion. It was a very serious thing to have these depôts in towns. Zymotic diseases arose in their neighbourhood. Let them look at Leeds, for instance, where fever prevailed in the north-east ward, near the Lemon-street depôt.

The Chairman—Do you mean that fever is prevalent near the depôts?

Mr. Fowler said he did. The malarious, deadly stench arising from those depôts was impossible to be kept down. Fresh fæcal matter did not do so much damage, but when they came to store it in a town it became a very serious matter. It took all the energies of the town engineer to stamp out disease arising from it, therefore they wanted a universal plan similar to that in use in towns where people went for health, such as Brighton, Scarborough, or Hastings; there the tub system would not be tolerated. If they wanted to remove the refuse of a town they must do it quickly by flushing with water. Soil rapidly took a liquid form. In

* See *Journal* for May 26th, page 664.
† See *Journal* for May 26th, page 659.

hot weather there would be a liquid, and not a solid in the tubs. If people inquired, they would find that soil all became liquid, and the tubs in hot weather, when ashes were scarce, became full of a liquid, and not deodorised. Mr. Moule's system was the best he had seen where dry earth was used, but it required very great care in carrying out. They used the earth over and over again, and if there was any good in it, it added to its value. But looking for this value was like searching for a needle in a stack of hay. The difficulty was so great in carting the earth, that it became worthless. They knew from practical experience, and farmers would confirm it, that it was all very well to set a fictitious value upon the manure. For a time the A B C Company obtained a large price for their manure, but the price went gradually down, and it is stated they now are glad to give it away.

Mr. Elcock remarked that the question had been put as to whether there was any traceable effect on health by the introduction of the pail or tub system. As an instance, he would mention that in Salford, at a row of 30 cottages, the midden system was formerly in operation. On the testimony of Dr. Latham, these houses were never free from fever, but by the introduction of the pail system, the result had been that they had never known fever since.

Mr. Alcock, of Sunderland, said that the Corporation of Sunderland had sent a deputation to visit the different towns, with a view of eliciting information upon the various dry systems. Of course, one went to Salford; there the tub system had not been given a fair trial, as they did not treat the contents of the tubs in any way, but turned them out into what he could certainly understand might be considered a pestiferous heap. There were streams of liquid running from these heaps in all directions about the town yard at Salford. At Manchester, where they manufactured manure, there was no nuisance, and opposite the abattoir, there were no such signs of nuisance as had been represented. Of necessity some means must be taken to get rid of middens. In small towns, they would have one system universally applicable, but he believed in large towns they would have to adopt various systems. In one shape or another, they would have to adopt in some form the dry system.

Mr. Alderman Taylor said that when Mr. Fowler spoke officially it was of great weight. Mr. Fowler had never been to see the Rochdale system in operation. What that gentleman said might be true of Salford, and of any place where they did not manufacture. At Rochdale, they had no such thing as that of which he spoke, and he should be careful before making statements in his capacity of engineer. They only stored manure at the Rochdale depôt.

Mr. Fowler observed that he said it was barbarous to take the midden refuse of the town and store it up. They had the tub system only in the township of Salford and in Pendleton, and there managed it in the best way possible, yet it was not free from stench. About the town yard at Salford, there was very little difference from the state of things before the tubs were used. If it were heaped up, it stood to common sense that it must throw off a great amount of vapour.

Mr. Alcock inquired whether there were not three separate and independent government districts worked by three separate and independent committees. Was it not found that there was great difficulty in working, because each board pulled against the other?

Mr. Fowler said they had only one sanitary health committee in Salford, but they had three district committees. In Pendleton they had a midden system, and carried it out upon agricultural land.

FOREIGN SYSTEMS.

Florence.

Mr. C. N. Cresswell said he was in a position to give the Conference some interesting information with reference to the city of Florence. Ten years ago he was engaged in negotiating a concession for improving and enlarging the city of Florence, just at the time it was made the capital of the kingdom of Italy. A company was formed, and had constructed a boulevard, which had been styled the beautiful boulevard of the most beautiful city in the world. From the outset sanitary laws had to be considered, as they were called upon to construct houses upon the most approved model. The Syndic of Florence, in pressing him upon the subject, hoped that he would be the means of introducing something of British civilisation into the kingdom. The question discussed was the removal of refuse from the new blocks of buildings. It was desired to construct water-closets upon the model of the English water-closets, or rather as English water-closets ought to be, and the first difficulty was, when the water-closets were constructed, to deal with the question of drainage. Part of the duty of the company was to construct a magnificent sewer right through the city, and draining some miles above Pisa into the River Arno. The company proposed to drain their water-closets into the main sewer, as in England, after the manner of the great city of London. He should never forget the indignation the proposal met with. "What, drain your water-closets into the river! In the 19th century you tell us that is the custom of England?" He asked what was proposed instead, and what was to be sent down the great drain. They said the drains were for the rainfall from the tops of the houses and from the roads. They could not believe that in London, the civilised capital of the most advanced country in the world, they turned raw sewage into the River Thames. He told them that a most magnificent scheme of drainage carried all the sewage into the river, twenty miles below London. They refused to believe it until they could send over commissioners to inquire, and a special bye-law was passed and imposed upon the company, that under no circumstances should water-closets in any of their buildings be drained into the sewers. The houses were to be drained into cesspools, to be constructed under the superintendence of the authorities. It was necessary that he should explain to the meeting the construction of these cesspools, and the mode of emptying them. Every cesspool was designed and built upon a system approved by the municipal engineers, and subject to their supervision, the size being fixed in proportion to the number of inmates resident in each block of buildings. It was air and water tight, and provided with a suction pipe, inserted at the bottom, and also a tube from the arched roof of the cistern, carried up to the level of the surface similar to an ordinary water main. These cesspools were periodically emptied by the municipal *employés*, by means of an air-tight tumbrel, connected with an exhaust-pump, and drawn upon wheels to the spot where it was required between the hours of one and four o'clock in the morning. The process was as follows: the air was exhausted in the tumbrel sufficiently to produce a partial vacuum, the hose was then attached by a nozzle-screw to the suction-tube before mentioned, the air-pipe was opened to let in the outer air, and, by atmospheric pressure, the cesspools were emptied in a minute and a half. The contents are sold for the benefit of the municipality to the farmers in the vicinity, who compete eagerly for the privilege, and use this sewage to fertilise the vine, fig, and olive gardens, which abound in the highly cultivated valley of the Arno. Mr. Cresswell mentioned that the Italians were great consumers of vegetable food, and that the kitchen slop-waters were also carried into cesspools by means of pipes, well

trapped to prevent the escape of gases into the sculleries, which, in Italian houses, were on the same floor as the drawing-room. This rendered it the more imperative to take precautions against a nuisance of which Italian noses are peculiarly sensitive. He stated that the pneumatic scavenging cars were supplied by the municipality, and that, partly from the unpopularity of the Grand Duke of Tuscany at the time of their introduction, and partly from the pungent odour which surrounded them, they were styled the Grand Duke's snuff-boxes. The value of the contents of the Florentine cesspools was estimated so highly by the neighbouring farmers, that they stipulated eagerly for the privilege of emptying them, at an annual rent varying from £3 to £7 per year for each cesspool. The lessors of the company's offices justified the high rent demanded for the premises occupied by them in Via del Giglio, by the fact that the garden surrounding them possessed the special advantage of three large cesspools, which would be worth at least from £15 to £20 per annum to the proprietors. In conclusion, Mr. Cresswell said that he was not prepared to give any statistical data as to the death-rate of Florence, but that during the last two visitations of cholera, while the neighbouring towns were decimated by that scourge, Florence had altogether escaped the epidemic.

The Chairman said they were all very much indebted to Mr. Cresswell for the interesting account he had given of the drainage of the city of Florence.

Mr. Alderman Taylor asked if the cesspools were also air-tight.

Mr. Cresswell observed that all the cesspools must be of a certain size, having regard to the number of houses in the block; they were emptied periodically by scavengers as required. He did not know whether they were ventilated or not.

The Chairman remarked that Mr. Cresswell thought the cesspools air-tight. But how did the water run into them? There must be some escape for the air which ran in when the water-closet was pulled up.

Mr. Cresswell said there must be some escape for the air, but the cesspools being below the level of the water-closets, the water would overcome any resistance. He was not prepared scientifically to explain the mode of ventilation. He would only say he had often witnessed the process of emptying, which usually occupied about a minute and a half.

Dr. Britton said the cesspools were connected with the water-closets. The sewer gas must certainly collect in the cesspools. How was it that it did not get from the various drains into the house?

Mr. Cresswell said the cesspools communicated with drain and waste pipes properly trapped, so that the sewer gas could not escape into the house. The Italians were peculiarly sensitive on such matters, and required it to be certified that there was no smell in the house. The cesspools were generally under the gardens, which at Florence were remarkable for their beauty.

General F. C. Cotton, C.S.I., here took the chair.

Mr. Adam Scott made some remarks with reference to his papers* on the Liernur system as at present worked in Holland, and stated that the system was a comprehensive one, and solved the whole question of town drainage and river pollution. It consisted of separate purification of manufacturing refuse, of separate collection of excremental matter and sink sediment (separated by a simple process from the bulk of the water accompanying it), and of the prevention, by simple upward filtering street gullies, of street detritus entering sewers. Further than that, it consisted in the purification of sewer water, which, from the arrangements referred to, simply consisted of dirty house and street water, without solids, by coke filtration, before it was allowed to enter streams. The coke being afterwards used for the pneumatic furnaces, the cost of purification was that of labour only. As it would have been impossible to have entered into technical detail in the short time allowed him, Mr. Scott referred the meeting to the six papers upon the system that had been written at the request of the Council, and circulated among the members of the Conference. He would merely confine himself to the most novel subdivision of the system, viz., the pneumatic system, for the collection and utilisation of the excremental matter. This system was in operation in parts of Amsterdam, Leyden, Dordrecht, Prague, Brunn, and Olmutz, is being laid down in St. Petersburgh, and is adopted by Winterthur. The advantages claimed for it were that it gave at the same time the sanitary advantages of a properly conducted pail system, with the conveniences and privacy of the water-flushing plan. If any pail system allowed pollution of air, of soil, or of water, and if the water-flushing system allowed of similar pollution, they were contrary to sanitary laws, therefore, the first principle of the Liernur pneumatic system was to remove excremental matter (which was frequently the cause of certain fearful diseases), in such a way that it would be impossible for any of these elements to pollute either the air or water. For this purpose the town was divided into districts, or small drainage areas, each centering in an air-tight iron tank under the pavement, and with which the closets of each house were connected by air-tight iron branch pipes and mains. The tanks of each district were in their turn similarly connected together, and with a central station, chosen according to local circumstances, for each 40,000 or 50,000 of the population. In that central station air-pump engines were kept working, maintaining a vacuum in the pipes between its reservoirs and the street tanks. Now, the operation of the system was simply this:—Once a day turnkeys visited each street tank, created a vacuum in it, and then, by throwing what might be termed unscientifically the vacuum power, thus momentarily stored up, upon any given street pipe, the matter was drawn from the house into the tank. This was repeated as often as necessary, and before leaving the tank the turnkeys closed all connections between it and the mains leading to the houses, and they also despatched the accumulated contents to the central station, by means of the pipe which first caused the vacuum. The closets designed by Captain Liernur were simple, had nothing moveable or liable to get out of order, and required no water for flushing. They were perfectly inoffensive, and in this respect had been very generally described by English deputations as infinitely superior to the ordinary water-closet. Captain Liernur, however, allowed, when required, the use of a water-closet for those who insisted upon it, but only one of a water saving character, as dilution lessens the value of the manure. A few words may be said as to the cost of the pneumatic system. The only place where the whole cost, including that inside and outside houses, and engineering, &c., of every kind, was paid by the town was at Leyden. There the cost stated by the authorities was £1 15s. 8d. per head, at a time, however, when iron was more than double its present price. In Amsterdam the cost was larger, but could not be definitely ascertained. That city was built on piles, and the pipes, therefore, had pile foundations, which added to the expense. The earthenware funnels of the closets were manufactured in Liverpool, and thus had to bear the additional cost of carriage to Holland. Iron, too, was twice the present price. As to the working expenses, these could not be obtained at Amsterdam, being mixed up with other items. At Leyden they appeared in 1874 to have been 2s. 4d., and the receipts from manure 2s. 9d. per head per annum. The engine and labour employed being capable of working several other districts, with only a little extra cost for fuel, the expenses if proportioned

* See *Journal*, May 26th, pp. 667 *et seq.*

would be about 1s. 4d. per head per annum. The revenue derived from the liquid manure gave no results from which to form a reliable opinion as to its marketable value. In Bohemia the contracts were eagerly sought for, not for one year only, but for a period of years, and were at the rate of 8s. per head per annum, the farmers paying also all expense of removal. In Holland, however, where manure was little required, the country being chiefly pastoral, the prices had varied much, and in most cases had been such as not nearly to cover the working expenses. This state of things arose from the manure being in a liquid state, and not converted, as the Liernur system prescribed, into a dry manure by evaporation. This process was for the first time on a commercial scale being carried out at Dordrecht. Until, however, considerable quantities had been made and came into the market, it would be too soon to say anything definite as to its value. The trials on a small scale produced manure containing 10 per cent. of ammonia, so that no doubt the poudrette would be valuable. The mode of evaporation was such that the only heat used was that derived from the exhaust steam of the engines working the pneumatic system; this heat used, *à double effet, in vacuo*, as in sugar refineries, being found by experience to be ample. With regard to the technical working of the pneumatic system there could be no question. The experience of years had shown it to be perfect, and people might just as well doubt the good working of railways and telegraphs as of this particular system. People generally are not aware that in London seventeen miles of under-ground air-tight pneumatic piping is daily working for the post-office. The last and most important question was the sanitary one. As excremental matter was removed every day before decomposition and the formation of any gases could set it, and, moreover, was removed in air-tight iron pipes and hermetically sealed vessels, and treated by heat (the only disinfectant known, if the International Medical Congress of Vienna was right); it was therefore evident that neither the air, soil, nor water could be polluted by the excreta, and that thus there was no possibility of such diseases as typhoid and cholera being propagated. Even all the air that was drawn with the excreta through the pipes was, before being discharged into the open, passed through the engine furnaces, and thus effectually purified; so that, however infectious the matter might have been, its power to work evil was destroyed for ever, and the excreta converted into a valuable handmaid to agriculture. In Holland, where they had compulsory registration of all cases of infectious diseases, it was stated officially that those arising from excremental pollutions of air, soil, and water had entirely disappeared wherever the pneumatic system had been put into operation. This was the highest praise that could be given to it, and showed that it well deserved the official testimony of the 12 Government medical inspectors of that country, when they unanimously declared in an official report to the Minister of the Interior, that "from a sanitary point of view, and for convenience to the inhabitants of the houses, the pneumatic system was, without doubt, the best of all systems hitherto known." Mr. Scott proceeded to give such information as he was able on the cost of the Lienur system. He said Colonel Haywood reported that the expenses in 1874 were £140, against £166 receipts, showing a profit of £26. At Leyden the system cost 1s. 4d. per head, but the price varied according to the size of the district, being greater in proportion for a small one. In Amsterdam they found a great difficulty in disposing of the manure; so the Corporation had either used it on their own land or sold it at unremunerative prices. They made a considerable profit at Leyden in one year. It was not, therefore, possible at present to show the cost of the system in all places where it had been adopted.

Mr. Walker said that within the last few years they had heard a great deal about the Liernur system, and a great deal of curiosity had been excited about it. The amount of information that had been given was very great, but on some points it was defective. Mr. Adam Scott had explained to them the sanitary and financial phases of the system, but he had neglected to explain the mechanical. There were several points in connection with the system that he should like to have cleared up. He should like Mr. Scott to say whether they had any difficulty with the bends in connection with the pipes, and if the fæcal matter could readily pass them. They were told that the pipes were disconnected with the receptacle during the day; there must therefore be an accumulation, either in the houses or in the pipes. He suggested these points in no hostile spirit, it being his duty, in the position he held in his town, to obtain information from every source. There was another point he should like explained. The cavities were air-tight, they were told, and had no communication with the external air. They had heard a great deal about "vacuum force." He would remind them that the pressure was obtained from the atmosphere. If, therefore, the cesspools were filled with solid fæcal matter, the atmosphere must be admitted, in order that the matter could be removed into the main pipes connected with the engine. He should like information as to how that communication was managed. About twelve months ago there was a considerable discussion on the Liernur system carried on in various scientific journals, and Mr. Scott promised to furnish him with a document which completely set a statement he had read in the wrong. This document had not been furnished to him, no doubt, through pressure of business. It would also be interesting to know whether the Liernur system proposed also to adopt the present expensive system of drains. Were they to have a separate system of sewers for the Liernur? With regard to systems of sewage disposal generally, it must be remembered that no system could be adopted; in some places the dry system might universally be profitable. But the chief difficulty, it seemed to him, in Mr. Scott's way was, that as he (Mr. Walker) contended the cheapest carrier was gravitating water, when they went beyond the mere arrangements for managing the fall of the water, and introduced mechanical means, they entered upon an item of expense not easily met by the profits of any manufacture arising from the manure.

Mr. Scott referred Mr. Walker to the official evidence for an answer to some of the points mentioned. Mr. Walker was of course right as to the force of the atmosphere. He only used the expression "vacuum power" in a popular sense. The air which was admitted did not come through the closet, but through the soil pipe which was continued up to the top of the roof when possible. Practically there was no such thing as an escape of air or gas from the pipes. In one case, after 13 months, the pipes were found free and uninjured. Mr. Scott also referred to the statements that had been made by Mr. Bush, at Liverpool, and the contradictions which had been given of them. The pneumatic system as alluded to by Mr. Cresswell was only a particular modification of Captain Liernur's. Captain Liernur would in no instance allow manufacturing refuse to come into his drains, for manufacturers knew best how to deal with their particular refuse. The town refuse could not be properly treated when mixed with the excreta. There was scarcely any refuse which, by itself, could not be utilised. As to Mr. Walker's observations he could show that the water system of carriage was not the cheapest in any way whatever.

Mr. Walker could scarcely understand the reply of Mr. Scott to his question. How could they draw fæcal matter through the pipes?

Mr. Scott replied that there was no solid matter, as all became converted into a semi-liquid state.

Mr. Walker observed that he had seen solid matter in precipitation tanks which had travelled through

miles and miles of liquids. Surely some solid matter would remain in the pipes of the house for twenty-three hours and three quarters.

Mr. Scott said that as every new accretion sent it into the soil-pipe, there was no possibility of any air reaching it.

Mr. Walker observed that the system had been presented to them as a pneumatic system, in opposition to the water-closet system. They said that it was a water-closet system in which, instead of the matter being carried away by the natural fall of water, it was carried away by mechanical means. It was their contention that water was the cheaper force, unless it could be proved by Capt. Liernur that it was not so.

Mr. Spence observed that tho mode of evaporation required the use of about a ton of coal per individual per annum. The result of that expense was the powder they had seen. The great question was what was the quantity of ammonia contained in it?

Mr. Scott said an analysis that had been made of some of the powder showed 10 to 11 per cent. of ammonia. He did not refer to it before.

Dr. Britton inquired as to the state of the pans immediately below the seats, and whether the pneumatic system was sufficient to thoroughly cleanse them. He had been informed that they were ordinarily coated with fæcal matter, which became offensive, and that the pans were purposely made of a dark colour to conceal the offensiveness.

Mr. Rogers Field, C.E., enquired as to the shape of the closet pans, whether they were of the hopper pattern.

Mr. Walker asked what would be the result of the breaking down of one or both engines; if they were in duplicate, and whether they were provided for in the cost of the scheme?

Mr. Edward H. Fuller (chairman of the Chorlton Rural Sanitary Authority) said his district was one of 6,000 acres, but at present had only 12,000 inhabitants. Therefore, to a large extent, it was at present an agricultural district, but in a few years it would be the leading residential district of Manchester. When they came into office there was no system of sewage, and they were called upon to provide some means of getting rid of fæcal matters. They were prevented from discharging fæcal matters into the streams, and were unable to devise any satisfactory sanitary scheme to meet the wants of the inhabitants. Under those circumstances he went to Holland and saw Captain Liernur's system in operation; at Amsterdam and Leyden he went into various closets, and in no instance could he discover anything offensive; he might say that the abominable smells of the many London hotel water-closets was unknown there. In three cases in Holland, he found a slight incrustation of fæcal matter, but nothing offensive. In many cases in Holland closets were placed in positions that would not be permitted in this country, for instance, leading out of the kitchen, and with no other opening. So impressed was he with the advantages of the Liernur system, that on his recommendation they invited Captain Liernur to come over and see whether the system could not be adopted in their district. Captain Liernur made an elaborate report, but they found that there were certain local difficulties in the way, viz., they found that they had no power to suppress water-closets, moreover, theirs was but a thinly populated district, and it would have been employed under great disadvantages. That report they had had printed, and any gentlemen who thought it sufficiently interesting could get from it some information in addition to what they had heard.

The Chairman said Mr. Fuller's evidence was of great value. The system might suit one place but not another, and it did not follow that because it suited Amsterdam, it would be suitable for every town in England. Some parts of England were as flat as Holland; there was nothing against the system, because it might answer in one place and not in another.

Mr. Scott, in answer to the questions put, read an extract from a report made to the Corporation of Leyden. It stated that when the pipes were examined in consequence of a break down, they were found lined with a slight coating of greasy matter; this could, however, be wiped away with the finger, and was perfectly fresh; there was no incrustation of any kind in the pipes. In reply to some observations, he might say that what in water-closets would be water mixed with fæcal matter, in Liernur's would be fæcal matter simply. As to a break down, it was provided against by Captain Liernur's subdividing the engine power, and in lieu of having one engine of 100 horse-power, he preferred having four of 25 horse-power each, but no harm would result from the power ceasing for a week or even longer. As applicable to this country, the method made the water system useful, because its gradients were useful to Captain Liernur. It was easily adaptable also to towns of very great declivities. With respect to other matters, if any gentleman wanted further information, he could supply them with documents on the subject.

The Chairman then said that the last subject on the agenda having now been discussed, he desired to express the feelings of the Council in thanking the representatives and gentlemen present for the manner in which they had come forward and furnished the conference with such valuable practical information. In conclusion he begged leave to call their attention to the fact that the present conference was convened as the first of an annual series of conferences which the Society of Arts proposed to hold, and looking to the great interest that had been displayed on the present occasion he saw a hopeful augury for success in the future.

Mr. Walker said that in Mr. Stansfeld's opening speech he had suggested that a committee or office should be opened in connection with this Society, for the purpose of collecting and distributing information upon the subject of sewage; so that anyone desirous of ascertaining what had been done, or of inquiring upon the subject, should be able on application to this committee or office, to obtain the desired information.

The Chairman said that the subject would not be lost sight of, and that it should be brought before the Council.

Mr. Alderman Taylor wished to move a vote of thanks to the various chairmen who had presided over them. They could have wished that Mr. Stansfeld could have remained with them, but the admirable manner in which the subsequent chairmen had succeeded him had left them no reason to regret his absence. He had great pleasure in moving a vote of thanks to Mr. Stansfeld, Lord Alfred Churchill, Sir Henry Cole, Captain Galton, and General Cotton, for presiding over them, and he felt sure that they would be perfectly unanimous in that vote if not on other points.

The motion was carried unanimously.

The Chairman expressed his thanks for the honour they had done them.

Mr. Scott thought before they separated they should, by a vote of thanks, recognise the services of the Society of Arts in organising the present conference, and should also vote their thanks to the staff of the Society.

The meeting then separated.

WARRINGTON.—STATEMENT SHOWING COST OF WORKING THE NIGHT SOIL BRANCH OF THE SCAVENGING DEPARTMENT, FOR THE YEAR ENDING 31st AUGUST, 1875.

Dr.	£	s.	d.
To Interest on £698, purchase of land for depôt, and weighing machine, &c., at £5 per cent.	34	18	0
„ Do. on £798 for purchase of vans, horses, &c., at 20 per cent.	159	12	0
„ Wages of inspector	91	0	0
„ Do. of night soil men	1,064	4	0
„ Cartage, including drivers' wages, provender, shoeing, hired horses, &c.	1,122	8	7
„ Sundry other charges	91	0	0
	£2,563	2	7

Cr.		£	s.	d.	£	s.	d.
By Cash received for night soil		1,697	3	11			
„ Accounts owing for night soil, 31st August, 1875 ..		376	0	0			
Estimated value of night soil at depôt		368	0	0			
Deduct		2,441	3	11			
Accounts owing for night soil, August 31st, 1874	350 0 0						
Estimated value of night-soil at depôt at the same date..	279 3 0						
		629	3	0			
					1,812	0	11
Net cost of working the branch					751	1	8
					£2,563	2	7

Selling price of manure at the works, 4s. per ton.

MISCELLANEOUS.

POLLUTION OF RIVERS.

A Bill has been brought in by the Government to prevent the pollution of rivers. In introducing it, the following statement was made by the President of the Local Board:—

Mr. Sclater-Booth, in moving for leave to bring in a Bill to make further provision for the better prevention of the pollution of rivers, said that he would not at so late an hour detain the House by a lengthened statement. He wished, however, to remind the House that the subject was entirely removed from a party character. A Royal Commission on the Pollution of Rivers had been sitting for many years, and last year the final volume of their report was published. The time had therefore arrived when something ought to be done. Three or four Bills had been presented to Parliament, and, although they had from various causes failed to pass into law, there had never been any dispute as to the necessity for legislation on this subject. The obstacles, were, however, very great, and the alarm of the manufacturers had been so difficult to deal with, that successive Bills had been brought in and withdrawn. Last year there was a reasonable opportunity of passing the Bill brought into the other House by Lord Salisbury if it had not been for the late period of the Session at which the measure came down to that House, and the necessity of proceeding with other measures. A Bill for preventing the pollution of rivers, however, formed no part of the Government programme of the Session and advisedly so. But several members had within the last few months urged him to bring forward a measure on the subject, and he had reason to believe that a Bill somewhat of the character of that which had passed the House of Lords last year would be generally acceptable. The present Bill, he might add, proposed to enact generally that rivers were to be kept free from pollution, and that their pollution in various ways was to be a statutable offence. In the first place it was intended to prohibit the casting of noxious refuse, whether manufacturing or mining, into rivers, so as to pollute the stream or to impede navigation. The second part of the Bill related to the mode of dealing with the sewage of towns, and it was proposed that the pollution of rivers by that means should also be made a statutable offence, but that ample time should be given within which proceedings should be instituted, as well as ample time to the authorities within which to construct necessary works. There was nothing in that portion of the Bill more stringent than had for many years been the law with reference to the streams which flowed into the Thames and the Lea, in both of which cases the arbitrary power of preventing the throwing of noxious sewage into those streams had been prohibited. The manufacturing and mineral pollution of rivers stood in a very different position, but it was not deemed expedient in such a Bill as the present to make any exceptions from the general obligations of the law, but it was proposed in the case of manufacturing and mineral pollution not only that ample time should be given, but that industrial interests should be duly considered, and that no prosecution should be instituted except by the public sanitary authority with the sanction of the Local Government Board. Up to that point the Bill stood very much in the position of that which had passed through the House of Lords last year, but there were two or three important additional provisions. It was proposed to constitute a Conservancy Board which would take in hand the function of carrying out the necessary works, and that the sanitary authorities might be permitted to pass bye-laws and regulations and give facilities for the use of their sewers. The prosecutions under the Bill were, he might add, to be carried on before the County Court Judges, as under the Bill of last year. Other points of importance would remain which might be dealt with in future measures, but he hoped the present Bill, as an initiative measure, would in future secure our rivers from pollution. He moved for leave to bring in a Bill to make further provision for the better prevention of the pollution of rivers.

Lord Robert Montagu supported the motion. There was a general consensus of opinion in favour of Watershed Boards.

It is to be hoped that the measure will be passed this session.

The Société d'Encouragement has awarded a gold medal to the Terrenoire Company, on account of their making phosphorus steel with the aid of ferro-manganese.

CORRESPONDENCE.

HEALTH AND SEWAGE OF TOWNS.

Sir,—To those who are fully acquainted with Mr. Baldwin Latham no explanation of the circumstances under which he writes to you will be necessary from me.

Those who do not know the circumstances under which Mr. Baldwin Latham brought into being the Croydon Farming Company, may understand it better if they will refer to a letter in the *Echo* of September 29th, 1871. If they then compare that letter with the letter he has addressed to you, they will be under an impression that they were not written by the same person.

Mr. Latham states in that letter that the profits realised in the first year of the farming company were 30 per cent.; he also states that all the capital called up at that time was £2,028. (The first balance-sheet says £1,500.)

Mr. Latham speaks of a ruinous policy pursued since I have been chairman of the committee. I confess that I did pursue a wrong policy, because at that time I believed in Mr. Latham as a sanitary authority, and I did not like to alter a policy inaugurated by himself without practical evidence of its worthlessness. The exaggerated statements put forth by Mr. Latham himself are my excuse.

We have unfortunately discovered in Croydon that Mr. Latham is not a safe guide to follow in sanitary work. Whilst he followed the road which was pointed out to him by the Croydon Local Board he kept right, but as soon as he attempted to lead, and we trusted to him, we fell into evils as bad as those from which we were trying to escape.—I am, &c.,

Alfred Carpenter, M.D.

Croydon, June 12th, 1876.

GENERAL NOTES.

Patent Office.—Several changes are impending in the arrangements of this office. An order has just appeared which puts an end to the abridgments of provisional specifications which have since 1866 been required from each applicant with his provisional specification. This will be a slight relief to inventors, and it is only an official acknowledgment of a fact that has long been obvious to all concerned, that these so-called abridgments were quite useless for any purpose whatever. This order is to take effect on the 1st of July next. Notice is also given that in future the drawings accompanying specifications will be reproduced by photo-lithography, and the copies of the originals filed for the purpose of reproduction are, after the 30th of June, to be sent in in a condition such that they may be copied by means of photography. It is understood that it is intended to make a considerable reduction in the scale on which the drawings are published, with the object of economising space and lessening the cost of printing. In order to give time for the examination of the filed drawings, the Commissioners of Patents request that they may be sent in at least six days before the expiration of the time allowed, thus limiting by a week the six months' provisional protection granted under the Act of 1852. It is likely that further changes will be made in the constitution of the office in pursuance of a report prepared by the Master of the Rolls and the Permanent Secretary to the Treasury, and that such changes will be in the direction of limiting the facilities hitherto enjoyed by the public in connection with the Patent-office Library and the issue of official publications. A proposal has been made that, should a national Library of Science be formed at South Kensington, the Patent-office Library should be incorporated therewith, but no definite conclusion on this point has been arrived at.—*Times*.

Instruction in Cookery.—Mr. E. J. Reed has given notice that, in the debate on the education estimates, he will move, "That, in order to give effect to the grants offered by the Educational Department to promote instruction in food and cookery in elementary schools, it is desirable that effective encouragement be given to training teachers of cookery."

Drainage of Public Buildings.—In the House of Commons, on the 8th of June, the following incident took place:—Mr. C. Denison asked whether the rumour was correct that these new offices, owing to carelessness on the part of the builder or architect, were most defective in their drainage, no communication having been made between the drainage of the buildings and the main drain in the street. Lord H. Lennox said the drainage of the Home and Colonial Offices had been found on one or two occasions to be in a very deficient state, and, of course, the person responsible was the man who designed and under whom the contractors built—namely, Sir Gilbert Scott. His (Lord H. Lennox's) attention was called to the matter, and in an incredibly short time the evil was remedied, as far as possible.

MEETINGS FOR THE ENSUING WEEK.

Mon.....Royal United Service Institution, Whitehall-yard, 8½ p.m. 1. Mr. R. Griffiths, "The Best Method of Propelling Steamships, so as to give the Greatest Facility for Manœuvring in Action, and for Avoiding Collisions at Sea." 2. Dr. J. Collis Browne, "New Propeller."
Royal Geographical, University of London, Burlington-gardens, W., 8½ p.m.
British Architects, 9, Conduit-street, W., 8 p.m.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 8, Adelphi-terrace, W.C. 8 p.m. (At the House of the Society of Arts). Professor Morris, "The Theory of Unconscious Intelligence as Opposed to Theism."

Tues....Statistical, Somerset House, W.C., 7¾ p.m. Right Hon. James Stansfeld, "The Validity of the Annual Government Statistics of the Operation of the Contagious Diseases Acts."
Zoological, 11, Hanover-square, W., 8½ p.m. 1. Dr. J. S. Bowerbank, "A Monograph of the Siliceo-Fibrous Sponges." (Part VI.) 2. Rev. O. P. Cambridge, "Catalogue of a Collection of Spiders made in Egypt, with Descriptions of New Species and Characters of a New Genus." 3. Mr. W. T. Blandford, "Note on the 'Africa Indien' of A. Von Pelzeln, and on the Mammalian Fauna of Tibet." 4. Mr. W. T. Blandford, "Some of the Specific Identifications in Dr. Günther's Second Report on Collections on Indian Reptiles, obtained by the British Museum." 5. Mr. Howard Saunders, "The *Sterninæ* or Terns, with Descriptions of two New Species." 6. Mr. G. E. Dobson, "Peculiar Structures in the Feet of Certain Species of Mammals, which enable them to Walk on Smooth Perpendicular Surfaces."

Wed....Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. Francis Shaw, "The Climate of Scarborough." 2. Rev. Joseph Crompton, "Notice of Upward Currents during the Formation and Passage of Cumulus and Cumulo-stratus Clouds." 3. Rev. W. Clement Ley, "Suggestions on Certain Variations, Annual and Diurnal, in the Relation of the Barometric Gradient to the Force of the Wind." 4. Mr. John MacLaren, "Average Weekly Temperature of 30 years for Cardington."
Geological, Burlington-house, W., 8 p.m.
Royal Horticultural, South Kensington, S.W., 1 p.m.

Thurs...Antiquaries, Burlington House, W., 8½ p.m.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Second General Meeting.
Zoological, 11, Hanover-square, W., 8½ p.m.

Fri.......**SOCIETY OF ARTS**, John-street, Adelphi, W.C., 11 a.m. Annual Educational Conference. 9 p.m. Conversazione at the South Kensington Museum.
Royal Society Club, Willis's Rooms, St. James's, S.W. 6. p.m. Annual Meeting.
Royal United Service Institution, Whitehall-yard, 3 p.m. Mr. T. Brassey, "The Resources of the Mercantile Marine for Naval Purposes." To be followed by a discussion.
Quekett Club, University College, W.C., 8 p.m.
Royal Botanic, Inner Circle, Regent's-park, N.W., 4 p.m. Professor Bentley, "Organs of Nutrition in Plants." (Lecture VII.)

Sat.......Royal Botanic, Inner Circle, Regent's-park, N.W., 3¾ p.m.
Physical Science Schools, South Kensington, S.W., 3 p.m.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,231. Vol. XXIV.

FRIDAY, JUNE 16, 1876.

PROCEEDINGS OF THE SOCIETY.

FINANCIAL STATEMENT.

The following statement is published in this week's *Journal*, in accordance with Sec. 42 of the Society's Bye-laws:—

TREASURERS' STATEMENT OF RECEIPTS, PAYMENTS, AND EXPENDITURE, FOR THE YEAR ENDING MAY 31st, 1876.

Dr.

	£ s. d.	£ s. d.
To Cash in hands of Messrs. Coutts and Co., 31st May, 1875	228 14 3	
Do. do. Secretary	20 19 6	
		249 13 9
To subscriptions received during the year from Members and Institutions in Union	6,504 6 0	
Life Contributions	278 5 0	
		6,782 11 0
To the following amounts withdrawn from deposit with Messrs. Coutts & Co.:—		
Memorial Window Fund	345 0 0	
Fishmongers Co.'s Scholarships	50 0 0	
Cash belonging to Society	5 0 0	
To Sale of Stock	899 17 11	
		1,299 17 11
To Dividends on Stock:—		
Consols	146 4 0	
Reduced 3 per cents	93 12 10	
New 3 per cents	11 11 0	
Great Indian Peninsular Guaranteed 4 per cent. Railway Debenture Stock	86 1 6	
Bombay and Baroda Guaranteed Railway Stock	122 9 9	
Oude and Rohilcund do. do.	121 19 6	
United States Funded Bonds	25 2 5	
Indian 4 per cent. Stock	4 4 8	
To Interest on Deposit Account with Messrs. Coutts and Co.	9 18 8	
		621 4 4
To Donations to Endowment Fund		19 16 0
To Examinations (Commercial, &c.):—		
Prince Consort's Prize	26 5 0	
Clothworkers' Company's Donation	10 10 0	
Fees, &c.	3 5 0	
Ditto (Technological):—		
Salters' Company's Subscription	10 10 0	
Donation (G. N. Hooper, Esq.)	10 10 0	
Ditto (Col. A. A. Croll)	10 10 0	
		71 10 0
To Sales:—		
Cantor Lectures	23 11 8	
Books, &c.	3 1 6	
Journals	80 10 11	
Sewage Conference Pamphlets	2 0 0	
		109 4 1
To House and Office (gas)		28 7 0
To National Training School for Music (examination fees)		28 5 0
To Special Lectures on "Unhealthy Trades," donation by Benjamin Shaw, Esq.		50 0 0
To *Journal* Advertisements		1,759 10 8
		£11,019 19 9

Cr.

	£ s. d.	£ s. d.
By House and Premises:—		
Rents, Rates, and Taxes	309 17 11	
Insurance, Gas, Coal, and House Charges	284 12 7	
Repairs and Alterations	285 12 8	
		880 3 2
By Office:—		
Salaries, Wages, and Commissions	1,791 5 6	
Stationery and Printing	273 1 0	
Advertising	160 0 5	
Postage Stamps and Parcels	253 19 5	
		2,478 6 4
By Library, Bookbinding, &c.		146 14 5
By Conversazione		238 10 5
By *Journal*, including Printing, Advertisements, Stamps, and Distribution to Members		3,729 1 1
By Union of Institutions, including Commercial Examinations, Prizes, Fees, Postage, Printing, &c.	552 18 0	
Prince Consort's Prize	26 5 0	
Technological Examinations, including Prizes, Fees, Printing, &c.	206 19 3	
		786 2 3
By Howard Prize		25 0 0
By Albert Medal	22 18 0	
Society's ditto	15 18 6	
Fothergill ditto	6 0	
		39 2 6
By Memorial Tablets		42 2 2
By Memorial Window		1 8 0
By Cantor Lectures		214 15 10
By Special Lectures on "Unhealthy Trades"		130 12 6
By Juvenile Lectures		29 9 10
By Sections:—		
African	94 13 11	
Chemical	83 13 3	
Indian	89 18 2	
		268 5 4
By National Training School for Music, including Society's Scholarships, and donation of £50 by Fishmongers' Company, held by the Treasurers		507 10 3
By National Training School for Cookery, including Society's Scholarships		56 17 0
By Committees:—		
General	14 12 8	
Conflagration	30 5 0	
Drill	8 11 11	
Food	0 14 6	
Mercantile Marine	1 18 0	
Museums	3 12 6	
Patent Law	17 0 0	
Railway Lamps	21 0 0	
Revolution Indicators	100 4 0	
Road Traction	20 1 6	
Sewage	15 8 0	
Steel Prize	1 8 0	
Stove Competition	6 1 6	
Trade Marks	3 19 6	
Wine	3 10 3	
		248 7 4
By Vote to Mrs. Davenport		150 0 0
Interest on Temporary Loan by Messrs. Coutts and Co.		21 18 7
By Purchase of £410 19s. 10d. Reduced 3 per Cent. Stock (Life contributions)	383 5 0	
By ditto £343 14s. 3d. Metropolitan 3½ per Cent. Stock (Memorial Window Fund)	345 0 0	
		728 5 0
By Powers of Attorney (Coutts and Co.)		1 8 0
Cash in hands of Messrs Coutts and Co., 31st May, 1876	269 13 10	
Ditto in the Secretary's hands	23 5 11	
		292 19 9
		£11,019 19 9

Liabilities.

	£ s. d.	£ s. d.
To Sundry Creditors:—		
Rent, Rates, and Taxes	45 6 8	
Tradesmen's Bills	931 1 10	
Prince Consort's Prize	26 5 0	
Examination Prizes (Commercial, &c.)	134 10 0	
Examiners' Fees	144 18 0	
Technological Examination Fees	73 10 0	
Ditto ditto Prizes (estimated at)	92 10 0	
Clothworkers' Company's ditto	105 0 0	
Sir Walter Trevelyan's ditto	100 0 0	
Sections: — Indian, African, and Chemical	195 0 0	
		1,848 1 6
By excess of Assets over Liabilities		6,885 19 0
		£8,734 0 6

Assets.

		£ s. d.	£ s. d.
By Society's Money invested in—			
Reduced 3 per Cent. Stock, £3,124 1s. 11d., viz., £2,878 11s. 3d., less £577 12s. 6d. reserved to meet trusts stated below		2,300 18 9	
Great Indian Peninsular Railway 4 per Cent. Debenture Stock		200 0 0	
Subscriptions of the year uncollected	£1,646 8 0		
Less 15 per cent.	246 19 0		
		1,399 9 0	
Ditto of former years unpaid	2,509 10 0		
Less 50 per cent	1,254 15 0		
		1,254 15 0	
Barry's Pictures and other property		2,000 0 0	
Prince Consort's Prize		26 5 0	
Mrs. Harry Chester's ditto		5 0 0	
Journal, by Advertisements*		1,054 13 0	
			8,241 0 9
Cash in hands of Messrs. Coutts and Co., 31st May		269 13 10	
Ditto on Deposit		200 0 0	
Ditto in hands of Secretary, petty cash		23 5 11	
			492 19 9
			£8,734 0 6

* A portion of this sum is still subject to charges for printing, &c.

P. Le Neve Foster, *Secretary.*

Stock and Cash Standing in the Name of the Society.

Consols	£4,757 19 8
New 3 per Cents.	388 1 4
Reduced 3 per Cents.	3,124 1 11
Great Indian Peninsular Railway 4 per Cent. Guaranteed Debenture Stock	2,170 0 0
Oude and Rohilcund " 5 " "	2,150 0 0
Bombay and Baroda " " " "	2,450 0 0
Cash in hand of Messrs. Coutts and Co., in deposit	200 0 0
United States 2,500 dols. Five per Cent. Funded Bonds, 1871	509 1 3
Indian 4 per Cents.	105 18 7
Metropolitan 3½ per Cent. Stock	343 14 3

Trust Funds included in the above.

Dr. Swiney's Bequest	£4,500 0 0	Consols, chargeable with a sum of £200 once in five years.
John Stock's Trust	100 0 0	" " " the Award of a Medal.
North London Exhibition Trust	157 19 8	" " " Award of the Interest as a Money Prize.
Fothergill's Trust	388 1 4	New 3 per Cents., chargeable with the award of a medal.
J. Murray, Esq., in aid of a Building Fund	50 0 0	Invested in Reduced 3 per Cent. Stock.
Subscriptions to an Endowment Fund	437 12 6	
Dr. Aldred's Bequest	90 0 0	
Thomas Howard's Bequest	500 0 0	" " United States 5 per Cent. Funded Bonds, 1871.
Dr. Cantor's Bequest	5,052 19 8	" " Bombay and Baroda and Oude and Rohilcund Guaranteed Railway Debenture Stock.
Mulready Trust	109 12 9	" " Indian 4 per Cent. Stock.
Alfred Davis's Bequest	1,800 0 0	" " Great Indian Peninsular Guaranteed Railway Debenture Stock.
Memorial Window Fund	345 0 0	" " Metropolitan 3½ per Cent. Stock.
Sir W. C. Trevelyan's Prize	100 0 0	In Deposit with Messrs. Coutts and Co.
Technical Examinations, Clothworkers' Company Prize	100 0 0	

The Receipts of the Society set forth above have been credited by Messrs. Coutts and Co.
The Payments set forth above have been made by authority of the Council.
The Assets, represented by Stock at the Bank of England, and securities, cash on deposit, and cash balance at Messrs. Coutts, as above set forth, have been duly verified.

J. Oldfield Chadwick, } *Auditors.*
B. Francis Cobb, }

H. Reader Lack, *Treasurer.*

Society's House, Adelphi, 19th June, 1876.

CONVERSAZIONE.

The Society's Conversazione will be held this evening (Friday) June 23rd, at South Kensington Museum, by permission of the Lords of the Council on Education. Cards have been issued to the Members.

ANNUAL GENERAL MEETING.

The One Hundred and Twenty-Second Annual General Meeting, for the purpose of receiving the Council's report and the Treasurers' statement of receipts, payments, and expenditure during the past year, and also for the election of officers and new members, will be held, in accordance with the Bye-laws, on Wednesday next, the 28th of June, at 4 o'clock p.m.

By order,

P. Le Neve Foster, *Secretary.*

June 21st, 1876.

ANNUAL EDUCATIONAL CONFERENCE.

This Conference, which, with the view of giving special interest to it this year, the Council decided should deal with the subject of Adult Education, will be held this day (Friday, 23rd June), at 11 a.m. Sir Henry Cole, K.C.B., in the chair.

The discussion will take place under the following heads:—

1. Adult education as now conducted in literary and mechanics' institutes, workmen's colleges, clubs, &c., night classes, public elementary schools, &c.
2. Aid to adult education given by the Education Department.
3. Aid to adult education given by the Science and Art Department.
4. Aid given by the Universities of Oxford, Cambridge, London, &c., in examinations, lectures, and otherwise.
5. Aid obtainable from the surplus of the Exhibition of 1851, held by the Commissioners.
6. Subjects which it is especially desirable to promote in adult education, such as laws of health and cleanliness, household economy, food, music, &c.
7. Annual report on the Union of Institutions, and suggestions for improving the Examinations of the Society of Arts.

The following papers will be laid before the Conference:—

AID TO ADULT EDUCATION GIVEN BY THE EDUCATION DEPARTMENT.

By J. G. Fitch,

Assistant Commissioner under the Endowed Schools Act.

1. It has been deemed desirable that this Conference should have before it, in a concise form, a statement showing the nature of the aid now granted by the Privy Council to night schools and evening classes, and the extent to which the provisions of the Elementary Education Act and of the Code of the Education Department are made actually available in these schools.

2. The amounts of the grants claimable under the regulations of the Education Department by such schools are set forth in Art. 22 of the Code:—

"*Grants to Evening Schools* (*Articles* 106-112).

"22. The managers of a school which has met not less than 45 times in the evening, in the course of a year, as defined by Article 107, may claim (Articles 108 and 109),—

"(*a.*) The sum of 4s. per scholar, according to the average number in attendance throughout the year (Article 26).

"(*b.*) For every scholar who has, in the year, been under instruction, in secular subjects, for not less than 40 hours during evening meetings of the school, 7s. 6d., subject to examination (Article 28), viz., 2s. 6d. for passing in reading, 2s. 6d. for passing in writing, and 2s. 6d. for passing in arithmetic."

The conditions under which a school is recognisable by the Department, and becomes entitled to claim such a grant, are laid down in Articles 106-112 as follows:—

"*Evening Scholars.*

"25 lays down that attendances may *not* be reckoned for any scholar in an evening school under 12 or above 21 years of age.

"106. The managers of any school to which annual inspection has already been promised (Article 11) may apply in writing, before the 1st of January, to the Inspector of the district for an examination of their evening scholars (Article 22). The application must be renewed annually.

"107. Only one examination is held per annum of evening scholars in the same school, and it may be held on any day, between the 1st of February and 30th of April, that may be arranged with the Inspector, provided that the school has met the required number of times (Article 22) since the date of the last examination.

"108. If the evening school is connected with a day school, in receipt of annual grants, and the accounts of the two schools are kept as one account, the grant for the examination of the evening scholars is paid as part of the next annual grant to the whole school (Article 13).

"109. If the evening school is not connected with a day school, in receipt of annual grants, or, being so connected, has a distinct and separate account, the grant is paid as soon as possible after the 30th of April; at which date, in such cases, the evening school year is considered to end.

"110. The Inspector may make arrangements for the examination, at some convenient centre, of the evening scholars of several schools.

"111. A separate examination will not be held for any school, unless 20 scholars are to be presented to the Inspector. If less than 20 scholars are to be presented, they can be examined only at a collective examination (Article 110), or at the same time with the day scholars. The number to be presented must be stated in the managers' annual application (Article 106) to the Inspector.

"112. The Inspector may either hold the examination himself, or entrust it to an assistant approved by the Department."

3. The general requirement applicable to all schools receiving aid from the Department is, that every such school shall be under the care of a certificated teacher. But this requirement may be relaxed in the case of evening schools, by recognising as qualified instructors (1) pupil teachers who have served with credit their five years of apprenticeship, or (2) assistant teachers, upwards of eighteen years of age, approved by the Inspector, and employed in an evening school connected with some public elementary school.

4. In the returns that have recently been presented to Parliament for the year 1875, and which will be embodied in the annual Blue-book about to appear, we find that the total number of evening schools in England and Wales which have fulfilled these conditions, and applied for grants from the Department, is 1,392, of which 1,307 were attached to day schools, and 85 only were wholly separate. The 1,392 schools are thus described in the returns:—

	Connected with day schools.		Unconnected.
Church of England	893	..	19
British, Wesleyan, and other Protestant Schools	232	..	61
Roman Catholic	53	..	0
School Board Schools	129	..	5
	1,307	..	85

In these schools there were found present at the inspector's visit 37,666 scholars, of whom 30,027 were boys, and 7,639 were girls. The average attendance in the schools for the past year had amounted to 43,382; and the number of scholars who had attended 40 times or a sufficient number

of times to qualify them for examination, was 43,734. But of these the number actually presented for examination was only 35,353, who offered themselves in the following Standards respectively:—

Standard	I	10,196
,,	II	8,620
,,	III	7,710
,,	IV	3,976
,,	V	3 452
,,	VI	1,399
		35,353

5. Out of the whole number thus presented, 31,093 passed in reading, or 88·28 per cent.; 24,940 passed in writing, or 80·04 per cent.; and in arithmetic, always the subject most fruitful in failures, 20,934 passed, or 70·91 per cent.; showing that nearly 30 per cent. were unsuccessful in this subject.

6. The sum paid out of the Parliamentary grant, in respect of these scholars, to the managers of evening schools, amounted to £18,758 16s. 10d., or to an average of 7s. 9d. per head on the number of scholars in average attendance. It is interesting to compare this fact with the amount paid on behalf of the scholars in day schools, which averages 12s. 7¼d. per head, and to bear in mind at the same time that while 40 attendances qualify a night scholar, 250 attendances are required to qualify a day scholar to present himself, or herself, for individual examination.

7. The inquiry may naturally be made whether the usefulness of these provisions, as measured either by the number of schools or scholars, or by the aid granted to them, is increasing or diminishing. The answer to this question is not to be satisfactorily obtained from a comparison of the present year with the last, as the slight increase of £862 in this year's estimates may easily be accidental and misleading. It seems safer to compare the statistics of the present year with those of 1870, the year before the Education Act of Mr. Forster came into force, and before the duty of providing day-school instruction for every child in the kingdom was recognised as a national obligation. Taking the statistics of that year we find that the number of evening schools visited by the inspectors was 2,504, the average attendance was 73,645, the number who had fulfilled the easy conditions of attendance then in force—a minimum of 24 times—was 89,513, while the number actually presented to the inspectors for examination was 74,692, of whom 69,089 passed in reading, 63,649 in writing, and 61,540 in arithmetic. The total grant paid on behalf of night schools in that year was £24,879 10s. 2d. Thus the five years since 1870 have witnessed a diminution in the number of night schools of 1,112; in the number of scholars of 30,263; in the number of those who were actually presented for examination of 39,339; and in the amount paid by Government in support of these schools of £6,120 13s. 4d.

8. I do not understand it to be the business of the reader of this paper to comment on these facts. On the face of them, it is evident that the improvement of day schools, and the gradual enforcement of attendance, and of elementary instruction, before the age of 13, is reducing, and will continue to reduce *pro tanto*, the number of scholars above that age who will require instruction in reading, writing, and arithmetic in evening schools. This Conference will not fail to observe that the extra grants obtainable in day schools for such additional subjects as history, mathematics, language, and elementary science are not available in night schools; and that so far as these institutions are recognised by Government at all, they are regarded as supplementing the deficiencies of the day schools in respect to the rudiments of instruction only, and not as institutions in which higher subjects are to be taught or higher culture encouraged. For the limited purpose thus defined, therefore, it may reasonably be expected that ere long the Parliamentary grant and the operations of the Educational Department for evening schools will become superfluous, and will die a natural death. The great work of enlarging the mental resources, and carrying on the studies of the young artisan who has passed through the elementary school, must be taken up by other hands, and be stimulated and encouraged by other agencies. And it is to such agencies that the attention of this Conference will probably be directed with all the more solicitude in just the proportion in which the field occupied by the Government becomes narrower in extent.

AN ANALYSIS OF THE SCIENCE CLASSES OF 1875.

School or Institution.	Number
National Schools*	334
Board Schools	114
Wesleyan Schools	93
British Schools	61
Public Schools	59
Private Schools and Academies	56
Parish Church Schools	48
Grammar Schools	28
Endowed Schools	30
Agricultural Schools	3
Charity Schools	5
Commercial Schools	5
Church of England Schools	19
Orphan Schools	5
Sunday Schools	3
Blue Coat Schools	5
Navigation Schools	4
Collegiate Schools	23
Middle-class Schools	23
Barrack Schools	4
Baptist Schools	8
Presbyterian Schools	6
Friends' Schools	3
Trade Schools	3
Congregational Schools	61
Roman Catholic Schools	11
New Jerusalem Schools	5
Unitarian Schools	3
Methodist Schools	6
Model Schools	22
Central Schools	4
Colliery Schools	8
Episcopal Schools	3
Schools of Art	50
Schools of Science	17
Practising Schools	11
Training and Normal Colleges	38
Laboratories	3
Mission Rooms	5

* Many of these are cases where the elementary school premises are made use of for evening classes.

School or Institution.	Number.
Youths' Clubs	9
Miners' Associations	3
Public Halls, Free Libraries, and Museums*	50
Young Men's Christian Associations	9
Church Institutes†	10
Mechanics' Institutes‡	90
Working Men's Institutes	42
Royal Institutes§	5
Educational Institutes‖	17
Village Libraries	3
Co-operative and Mutual Improvement Societies	18
Literary Institutes	38
Miscellaneous Schools and Institutions which cannot be grouped under any of the above headings	71
Examination Committees (*i.e.*, classes examined for prizes only)	31
Total	1,545

ART NIGHT CLASSES HELD IN 1875.

		Classes.
Held in Literary and Mechanics', Artisan, and other Institutions		168
" National Schools		163
" Board Schools		70
" British Schools		32
" Parochial and Church Schools		41
Miscellaneous, viz.:—		
Held in Hospital, Blue-coat, and Endowed Schools	15	
" Roman Catholic Schools	7	
" High and Grammar Schools	12	
" Model Schools	2	
" Academies	9	
" Barracks	3	
" Congregational Schools	5	
" Unitarian Schools	1	
" Collegiate and Commercial Schools	12	
" Baptist Schools	1	
" Charity Schools	2	
" Factory and Works	8	
" Science and Art Schools	9	
" United Methodist Free Church Schools	1	
" Presbyterian Schools	5	
" Friends' Schools	3	
" Training Schools	1	
" Primitive Methodists	2	
" H.M.S. *Impregnable*	1	
" Various	45	
	—	144
		618

In 1874 there were 653 classes, with 21,851 students, on behalf of whom the Department of Science and Art paid £6,539.

UNIVERSITY EXTERNAL ADULT EDUCATION.

By James Stuart, M.A.,

Professor of Mechanism and Applied Mechanics in the University of Cambridge.

1. The Universities of Oxford and Cambridge first took steps, beyond the limits of what may be called their internal work, in the establishment of the Local Examinations. As these, however, had nothing immediately to do with the question of Adult Education, I only mention them as having led by their success to the first step taken by these Universities in the matter of external Adult Education, viz., the establishment by the University of Cambridge of the Higher Local Examinations. These were established seven years ago, by the University of Cambridge, at the instance of the North of England Council for the Higher Education of Women, who feeling, to use their own words, the need of some examination "to test and attest the attainments of women," and having collected information as to the real existence of this need, and of the desire for its supply, brought a large and influentially signed memorial before the University of Cambridge, asking them to establish such an examination. The result of the consequent inquiry made by the University was the establishment of the Higher Local Examinations for Women over eighteen, as a tentative measure, which, after three years, had manifested such continued success of progress that it was permanently established. Owing to a representation made to the University by a Committee in Birmingham, these examinations were thrown open to men in 1874, on the same conditions as to women, but no men have as yet presented themselves. The examination is divided into six groups of subjects, including one elementary group in which all candidates must pass. The candidates may then select what other group or groups, if any, they shall present themselves in; and certificates of merit are granted to the successful. Examinations are held in any centre where at least 25 candidates present themselves. The centres at the last examination, which was held in June, 1875, were Birmingham, Cambridge, Cheltenham, Leeds, Liverpool, London, Manchester, Norwich, Plymouth, and Rugby; and the number of candidates who entered was 251, of whom 226 presented themselves for examination.

2. The Universities are, however, primarily teaching, and not only examining bodies; and there has grown up at Cambridge a system of classes for women, for preparing them for this examination, as well as for educating them generally; this system, however, I only mention, and do not enter into, because, though conducted by members of the University, it has not any official University recognition.

3. The system of non-collegiate students, now adopted at both of the Universities, is one which offers increased facility for adult education, but comes so much within the scope of the internal work of the University as not to require further mention here.

4. About eight or ten years ago, I gave a course of lectures in connection with the North of England Council for the Education of Women, inaugural of a system whereby that body determined to endeavour to improve, by regular and methodical teaching of a professorial kind, the higher education of women. These lectures were so successful as to be continued (with equal success) by a number of other lecturers from time to time, with more or less regularity, in various places in England and other parts of the United Kingdom. Having tried a similar system of continuous teaching among working men in various places, I brought the subject before the University of Cambridge, with the suggestion that that body should itself take the matter up. My appeal was ably

* Of these, two are schools of art.
† Of these, one is a school of art.
‡ Of these, three are schools of art.
§ Of these, one is a school of art.
‖ Of these, one is a school of art.

supported by memorials to a similar effect from bodies in Nottingham, Leeds, Liverpool, and other places, which pointed out the advantages of such a method of diffusing education being adopted and systematised by the University. These memorials pointed out that the funds would be forthcoming from local sources, in the event of the University acting in the matter. The University responded to these appeals by appointing a syndicate to enquire and report, and the result of their inquiry was the inauguration of a tentative measure, which has since been rendered permanent, in the appointment of a "syndicate for organising and superintending courses of lectures and classes in populous places, where the requisite funds are guaranteed by the local authorities." That syndicate has now been in active operation for three years, and the following extracts from a paper, issued under the authority of that syndicate in December last, will convey information as to the method and principle of its operations.

Design.

The design of the syndicate of the University in this scheme is, by sending out graduates well qualified in the several departments of learning which they are appointed to teach, to provide higher education of an accurate and methodical kind for the various classes of the community.

Conditions.

Before the syndicate can enter into business arrangements with any particular locality, two conditions must be fulfilled; first, a competent local committee must be appointed (see below) with a secretary to correspond with the syndicate; and, secondly, a guarantee fund, sufficient to meet all expenses, must be secured from local sources, extending over a period of one, two, three, or four years, as may be arranged between the syndicate and the local committee, so as to secure a fair trial of the scheme in that locality. It will be found very desirable that some portion of this fund should be raised in subscriptions to defray the expenses, which are usually larger during the first year than afterwards; the remainder remaining in promises, to be called up *pro rata*, if required.

On these conditions being fulfilled, the secretary of the local committee should send to the syndicate a list of the subjects for lectures and classes to which a preference is given in that locality, and of the number of courses required. The secretary should also send the names of the towns in the neighbourhood, in association with which the courses may, if requisite, be arranged. This is especially important, inasmuch as the ability of the syndicate to supply teachers at the rate indicated depends on those teachers obtaining full work, which can in general only be managed by some co-operation between neighbouring places.

Co-operation.

The above conditions refer to places about to enter into direct communication with the syndicate. Places, however, in the neighbourhood of any town where the system is already at work, would find it advantageous to communicate with the local secretary of that town, and to affiliate themselves to the work by that means, subject, of course, to the sanction of the syndicate. It is obvious that, educationally, and in order to secure a more complete curriculum of study, it is desirable to concentrate in any group of towns as large a number of teachers as possible; for that end the number of places co-operating in any group should be as large as possible, and therefore the syndicate look favourably on the engagement of a staff of teachers by a Committee in a large town, and the supplying by that Committee of the services of these teachers, when they can be spared, to smaller places in the neighbourhood. As this can be done by a special pecuniary arrangement (sanctioned by the syndicate) between the Committee and the place concerned, the syndicate recommend such arrangement, where opportunity offers, especially as such an application can sometimes be made more easily than direct to the syndicate.

Expense of Working.

With the exception of the travelling expenses of the lecturer, and of the expense of printing his syllabuses, which are shared proportionately between the variou, neighbouring towns associated in securing his services, all expenses in any town are borne by that town itself. The expenses incurred by any place for one course (including one lecture and one class a week) for a term of twelve weeks, are as follows:—(1) a sum of from £45 to £60 payable to the University for teaching, examinations, and certificates; (2) the local expenses of rent of rooms and advertising; (3) the share above referred to of the travelling expenses of the lecturer, and of the expense of printing his syllabuses.

Receipts.

The amount of the fees charged to the pupils who attend is left to be determined by the Local Committee. In some cases one fee has been charged for the lectures and classes; in other cases these charges have been separated. The fees charged for evening courses have generally been smaller than those charged for morning courses. In some cases, where there have been two evening courses in the same town, the fees for one have been considerably smaller than for the other, to meet the pecuniary convenience of persons attending. The fees for morning courses of lectures and classes have varied from 10s. to 21s.; and those for the evening from 3s. to 21s. for the term. In some cases for the course of evening lectures only, not including the classes, the fees have been as low as 1s. 6d. If the expenses payable to the University for a course be taken at £55 for the term, it is obvious that 110 pupils paying an average fee of 10s. for the course would meet the amount due to the University for that course, thus rendering unnecessary for that portion of the expenses contributions from subscribers or guarantors. As to the amount of the local expenses for rent of rooms and advertising—these are so different in different places, that it is not easy to form an accurate estimate.

Subjects.

The subjects hitherto treated by the University lecturers have been as follows:—Political Economy, Logic, Origin and Growth of Language, English Literature, French Literature, English Constitutional History, the Social History of England, History of the French Revolution, Physical Geography, Geology, Chemistry, Light, Spectrum Analysis, Heat and the Conservation of Energy, Astronomy, Elementary Mechanics, &c.

Students.

During the term October—December, 1875, 7,000 pupils of both sexes and from various classes of society have been under the training of 17 lecturers, in 24 large towns and their suburbs, and the sum of £2,300 has been paid to the Syndicate. The number of courses during that term has been about 50, of which rather more than half have been evening courses. The morning courses have generally been attended chiefly, though not exclusively, by young women of the more wealthy classes.

5. The following extracts from the latest report of this Syndicate just issued will tend to give some further information on the subject:—

"The conclusions to be drawn from the reports of the Examiners may perhaps be summed up as follows: (1)

that the more important points which have been treated of by the lecturers have been accurately apprehended and intelligently reproduced in examination; (2) that the knowledge obtained by the students does not in so many cases as desirable extend beyond the matter contained in the lectures; (3) that a comparison of the present examinations with previous examinations in the same subjects at the same centres shows a sensible improvement in the number of candidates who reach a fair standard.

"The Syndicate continue to receive very satisfactory accounts of the attention and earnestness of the pupils, and of the care with which they do the weekly papers set by the lecturers. In several places the same subjects are, at the request of the pupils, to be continued for another session. The students' associations, of which the formation in several places has been noticed in a previous report, continue to prosper. These associations have been formed for the reading of papers during the summer on subjects connected with the lectures, for conducting geological excursions, &c.

"While the difficulty of maintaining a sufficient subscription or guarantee to supplement the fees of the pupils will most probably prevent the permanent establishment of the scheme in some places, there can be little doubt that in other places due provision will be made for a regular and systematic curriculum*."

6. With a view to encourage regularity and permanence, the Syndicate have lately issued the following regulations as to certificates:—

Regulations as to Certificates.

1. At the end of each course of lectures and classes Certificates of Attendance and Examination will be given to all who, having attended the lectures and classes, also pass the examination satisfactorily. The Certificate, which will be signed by the lecturer under the authority of the Syndicate, will specify the subject and duration of the course and the distinction, if any, which the student has gained in the examination, and in the class-work during the course.

2. Any student who obtains Lecturers' Certificates of Attendance and Examination (see paragraph 1) for courses extending over a period of at least six terms in subjects all of which belong to the same group (see paragraph 3), will, on presentation to the Syndicate of these Certificates, become entitled to receive a Certificate signed by the Vice-Chancellor of the University, stating that the student has passed through a course of study approved by the Syndicate, and signifying the courses attended and the distinctions, if any, which have been gained.

3. The groups referred to in the preceding paragraph shall be: (1) Literature, Language and History; (2) Political Economy, Logic, History and Moral Science; (3) Natural Science.

The Syndicate intend, as soon as adequate arrangements can be made, to prescribe a definite course of study in each of these groups.

4. The Syndicate reserve to themselves the right of altering these regulations from time to time or of rescinding them, and of requiring satisfactory evidence of a sufficient elementary knowledge on the part of the pupils, and also of charging such a capitation fee as they may from time to time deem advisable.

7. The following is a list of the numbers presenting themselves for examination in the various branches taught during the year 1875-6. These members will give a rude idea of the proportionate number of students studying in the various branches. The actual members attending the courses are of course much in excess of those presenting themselves for examination.

Table shewing the Numbers presenting themselves for Examination, and the Numbers Placed in each Class.

Michaelmas Term, 1875.

Subject.	Examined.	1st Class.	2nd Class.
History	206	61	127
Literature	203	47	140
Political Economy and Logic	113	26	75
Geology and Physical Geography	177	58	107
Chemistry	30	6	19
Astronomy	15	3	11
Total	744	201	479

Lent Term, 1876.

Subject.	Examined.	1st Class.	2nd Class.
History	311	87	196
Literature	246	66	171
Political Economy and Logic	177	94	79
Geology and Physical Geography	182	75	90
Chemistry	11	3	5
Astronomy	12	6	6
Light, Sound, and Energy	41	27	14
Total	980	358	561

8. The following paragraph, quoted from one of the reports of the Syndicate, tends to give a fair idea of the classes of society from whom the pupils generally are drawn. The paragraph refers to the Examination held at Nottingham for the year 1874-5, and is as follows:—

"Of the 58 examinees in Political Economy and Literature there were 31 men and 27 women. Of the men 4 were students, 5 artisans, 4 warehousemen, 9 clerks and shopkeepers, 6 large manufacturers, 1 schoolmaster, 2 unknown. Of the women 7 were daughters of manufacturers, 2 of ministers, 12 of tradesmen, 6 of the milliner class."

I have given above some indication of the fees charged in various places. These fees are not in general such as to make the system supported from the fees of the pupils only. Perhaps the Liverpool district is the only district where this is practically accomplished; but then the fees are decidedly higher than in the other districts. The evening courses are in no case under 17s. 6d. per term, the day course being £1 1s., and in some cases more.

9. At Sheffield, Leeds, and Nottingham, there were last Michaelmas term, in each place, two evening and one day course, besides several subsidiary classes. The total sum to be paid by these places

* The negotiations in Nottingham referred to in the Report of the Syndicate, dated February 23, 1875, have been brought to a successful issue: the Town Council of Nottingham has voted a sum of £40,000 for the erection of a building to include University lecture rooms, a free library, and accommodation for the science and art classes, and the University lectures have been endowed with the munificent gift of £10,000 from an anonymous donor. In Sheffield, Mark Firth, Esq., late Mayor, has signified his intention of presenting to the town a building to be erected in a central situation for the accommodation of the University lectures, to which there is also indication that certain endowments will be attached.

to the University for the teaching and examination was £500, and the total receipts from tickets were about £550. Besides the expenses of teaching and examination, however, there were the following additional expenses to be borne, viz.:—

Lectures, printing, and travelling expenses ..	£70
Expense of rooms for lectures..............	180
Expense of advertising	150
	£400

The total expense may therefore be put at £900 for the term; the total receipts at £550. The difference had to be met by subscription. In these places the fees are all low, the afternoon course being in no case—fee for both lectures and classes —above 10s.; and a course of evening lectures and classes generally under 5s. Of course the endowment now subscribed in Nottingham and Sheffield will supply permanently the money necessary to supplement the fees, otherwise there is apparently no alternative besides that of raising the fees, or having a constant annual subscription, in whatever form they may be collected.

10. I should mention that in some cases the fee charged for the course has included both lectures and classes, in other cases there has been an additional fee charged to all who attend the classes. The latter plan has generally been adopted in those cases where the classes are held on different days from the lectures. The former plan in cases where the classes are held on the same days as the lectures, and immediately preceding or following them; in this case, generally, a much larger proportion of the pupils attend the classes, sometimes amounting to nearly as many as attend the lectures. The average attendance at the classes is probably about one-half of that at the lectures.

11. In conclusion, I may quote the following from the Report of the Syndicate:—

"We have reason to be well satisfied with the working of the scheme, and believe that by means of it accurate and methodical instruction has been received by a considerable number of persons, who would not otherwise have had the opportunity of obtaining such instruction."

And I may add that I consider the system of syllabuses, and of weekly papers of questions, to be the real backbone of the system.

12. I should add also that, while the Syndicate have endeavoured to meet all classes of society, they have also been particularly careful to harmonise their arrangements with the arrangements of local institutions; and it is the experience of the Syndicate that the position of local institutions is not injured but improved by the co-existence of this scheme with their local efforts. In Nottingham, where lectures in geology have been given in connection with this scheme during the past session, there have entered, I am informed, a larger number of pupils for the Government Science Examinations in this subject than in previous years.

THE EXTENSION OF UNIVERSITY TEACHING IN LONDON.

By Walter Leaf.

Fellow of Trinity Coll., Camb.; Honorary Secretary to the London Society for the Extension of University Teaching.

1. It will, I trust, be permitted to me, in consideration of the limits within which this paper must be restricted, if I assume a knowledge of the main features of the Cambridge scheme of University Extension. They are at all events briefly set forth, as far as concerns our own Society, in the programme accompanying the present paper.

2. When the Birkbeck Institution, a year ago, asked the Cambridge Syndicate "for the Establishment of Courses of Lectures and Classes in Populous Places," to send lecturers to them in the same way as to the large towns of the centre and North of England, it was clear that there were many difficulties in the way of the scheme peculiar to London. In the first place there was already a London University in existence, which though not itself a teaching body, could hardly be ignored by any other University coming in to occupy its ground. Secondly, there were many large educational bodies in London, whose interests would of course have to be largely consulted by modifications of a scheme originally adapted to a comparatively virgin soil. Thirdly, London is so enormous in extent, and so disjointed in composition, that the simple machinery of a single central committee seemed hardly large enough to cope with the great amount of local work required to keep in order a system supplying education for all London.

3. The Cambridge Syndicate accordingly replied to the request of the Birkbeck Institution that they could hardly single out any one institution in London to treat with, but that they would regard most favourably any proposition which should be made to them by any persons who could fairly claim to represent the metropolis at large. This answer led to public meetings held at the Royal Institution and the Mansion-house at the beginning of June of last year, at which a committee was appointed, under the presidency of Mr. Goschen, to draw up a scheme for London.

4. The scheme submitted by them and adopted at a second public meeting held at the Mansion-house at the end of July last, turned mainly on the three provisions intended to meet the three difficulties I have mentioned; or rather it was by these three provisions that it differed from the already existing Cambridge scheme, on which it was avowedly founded.

5. In the first place it was provided that not only London, but Oxford as well, should be invited to join in the work; for so large was the field to be covered, that it seemed that we could not enlist too large a force of helpers, either to teach or to advise. It was therefore determined to apply to the three Universities together to appoint a Board which should stand to our own Council in the same relation as the Cambridge Syndicate to the local committees by which the work was managed in the provinces; a Board which should appoint as many teachers and examiners as we should ask for, and should give us the advantage at once of the experience and of the prestige of the Universities.

6. Secondly, in order to secure harmonious co-operation with existing institutions, it was provided that ten of the most important should be invited to nominate one member each to the Council, by which it was proposed that the affairs of the Society should be managed, twenty-two other members being elected by the Society itself. To this invitation, I may add, the ten institutions have all responded, and have thus put at the service of

the Council their most valuable fund of experience acquired during the years they have already been at work.

7. In view of the peculiar character of London, it was contemplated that a number of local centres should be established in different parts of London, each with a local committee subordinate to the central Council, and prepared to take upon itself the expenses of the hire of rooms, advertising, and so forth, and to guarantee at least a part of the expenses of the lectures.

8. The scheme drawn up by the Committee was adopted at a public meeting at the Mansion-house, and embodied in the Articles of Association of the new London Society for the Extension of University Teaching. The Council was elected in February last, and was composed of names, which would, it was hoped, prove by the variety of opinions which they represented a security against any accusation of onesidedness, whether sectarian or political. The first act of the new body was to send to Oxford, Cambridge, and London, applications for the appointment of three members from each to sit on a joint Board to assist the Council in the manner I have already described. To this application Cambridge replied at once, that their Council would submit to the Senate a Grace empowering them to act as we wished, on the consent of Oxford and London being obtained. London actually voted their consent on the 14th inst. The Oxford Hebdomadal Council submitted on Thursday, the 8th instant, a Decree to the same effect. But, through some unfortunate misapprehension of the scope and real meaning of our scheme, a strong opposition was formed, and the request was rejected by a majority of 13; 91 to 78. There is, however, good reason to hope that a favourable vote may even now be obtained before Christmas, and it is in hope of this that we are at present working. Nor need this delay of the adhesion of the Universities in their corporate capacity prevent the immediate co-operation of such of their individual members as are friends of the scheme, though the form in which the Society will ask for the co-operation is still under deliberation; and there is good reason to hope that the Society will be able to begin its work next October, practically, although in the matter of the joint Board not formally, under the same conditions as those originally designed.

9. Meanwhile, a Committee presided over by Lord Aberdare has been prosecuting inquiries in different parts of London as to the means of education already existing. A glance at the map is enough to show the very great inequality with which different parts of London are supplied with the higher teaching, such as our Society desires to give. The area between Bishopsgate-street and a line through Baker-street and Westminster, and bounded on the North by the line of the City-road, far more than includes all the various institutions elected to nominate representatives for our Council, and I hardly think that any can be found outside this region which could claim to be giving any regular or systematic course of superior teaching; while a part from the Royal Institution, whose aim is different, King's College and University College are the only two Institutions which offer to working men and others education really of the highest class, and stand on so much superior a footing, in virtue of their teaching staff, that we may hope to gain from their co-operation at least as much assistance as we can give. All the enormous region of London lying beyond Bishopsgate-street to the East, and containing, it is said, 800,000 inhabitants, is practically destitute of a provision for higher education, though a serious effort is now being made to establish a large College in connection with High Schools for the East-end; an effort which is at once wider and narrower than our own, for it is limited in the area it proposes to supply, but at the same time it aims at giving a good school education, and so far goes beyond us. Such a scheme, however, so far from being a rival to our own, should, I think, be eminently capable of working in harmony with it, to the great mutual benefit of both. A discussion of the details of such a union would, however, be as yet premature.

10. In Shoreditch then, we propose to establish one of our centres. Here we have the advantage of the experience gained last winter by Mr. J. E. H. Gordon, of Caius College, Cambridge, who organised on his own responsibility three series of Lectures on Physics, English History, and English Literature; in which he was assisted by Messrs. Hallam Tennyson and Macaulay, of Trinity College, Cambridge. This voluntary lecturing was avowedly of the nature of an experiment, but the results may be regarded on the whole as very satisfactory, especially as evincing the existence of a really intelligent demand for good teaching, and an intelligent willingness to make the most of it when offered. Indeed, Mr. Gordon speaks in most enthusiastic terms of the ability shown by many of his pupils in their answers to the papers which he set; and it is only in such a feeling as this, that we can find a really solid foundation for our scheme.

11. Similar centres are to be established in the North, West and South, all of them including crowded districts which have outgrown their means of instruction; while in the centre we propose to send our lecturers to at least four of the Institutions which have already joined us, arranging with them to take part either of the profit or of the loss which may accrue from the difference between the students' payments and the necessary expenses of the courses. With some eight centres to begin with, each provided with its own machinery, and to a large extent paying its own way, we shall have at all events a sound starting point for providing London with a number of head quarters of education easily accessible to every one, and, we have every reason to hope, amply provided with teachers, who will carry on a real mission for education in every part of the metropolis, and who ought to be met by the people with at least as eager a desire for better teaching as that which has been found in the Midland and Northern Counties, and has there ensured the success of the Cambridge scheme.

Programme of the London Society for the Extension of University Teaching.

1. This Society has been formed with the object of adapting to London the scheme for the establishment of lectures and classes in populous places, which has been conducted with very great success in many provincial towns by the University of Cambridge.

2. The "Syndicate" (or committee appointed by the

University of Cambridge to organise this movement, reported in November last that they were educating in twenty-four large towns of England and their suburbs no fewer than 7,000 students. They state that in all places where the scheme has been for some time in operation there is a marked improvement in the quality and thoroughness of the work done; and that there are satisfactory indications that in some of these towns at least the scheme will become permanently established, and that provision will thus be made for carrying out a regular and systematic curriculum of study.

3. It appears eminently desirable that London should have some share in the advantages of a system which has, after four years' experience in the provinces, given such remarkable proofs of soundness and vitality. Numerous and excellent though the educational institutions of London already are, it must be remembered, in the first place, that they are all to be found within a comparatively small area of the metropolis, while large and important districts, alike in the north, south, east, and west, are left absolutely without any permanent provision for higher education; and, in the second place, that the institutions themselves lack what is so essential a feature in the Cambridge scheme—the public authority and guarantee of excellence in work, which can be given in no way so well as by a direct connection with our great Universities.

4. The London Society for the Extension of University Teaching proposes to ask for the assistance of the Universities of Oxford and London, as well as of Cambridge, in carrying on a similar work in London. It is felt that the enormous magnitude of the metropolitan population, as well as its peculiar circumstances, are difficulties which will best be met by drawing from the largest possible sources at once of teaching power and of educational experience. It is hoped that the three Universities will appoint three representatives each, to sit on a joint Board, which will "nominate such teachers and examiners as the work of the Society may require, and advise the Council generally upon educational matters."

5. The fundamental principle of the Cambridge system, adopted by this Society, is to bring higher education of an accurate and methodical kind within reach of those who reside in great towns by a combination of lectures, classes, and examinations. With this object the following regulations have been laid down by the Cambridge Syndicate—

"The teacher to remain in the lecture-room for some time after the conclusion of each lecture and class in order to answer questions and to give advice as to the reading of text-books and other means of efficiently studying the subject.

"Each lecture to be accompanied by a syllabus distributed to the pupils, and by questions. Those who desire to answer these questions to do so in writing at home, and to be at liberty to submit their answers to the teacher for correction and comment.

"The class in each subject to be formed only from among those who attend the lectures in that subject, and to consist of those who are desirous of studying it more fully. The class, at the discretion of the teacher, either to take up the subject of the lectures or cognate subjects bearing directly thereon and necessary for the better elucidation of the subject of the lectures. The teaching in the class to be more conversational than that in the lecture.

"Written examinations are held at the conclusion of each course by examiners appointed by the Syndicate, open to any pupil who has attended the course; and certificates are granted to the candidates who manifest sufficient merit in these examinations."

6. It will be seen that these rules offer an excellent guarantee that the education given shall approach as nearly as possible to the high standard maintained in the Universities, and shall be in no danger of degenerating into the fallacious half-knowledge too often associated with the idea of popular lectures.

7. The subjects which have been thus taught by the Cambridge lecturers fall naturally into three divisions: (1) Physical Science, including Applied Mechanics, and such portions of Mathematics as are closely connected with practical work; (2) History and Literature; (3) Economic Science, with portions of History and Logic. It has been found that the most popular subjects have been Political Economy, English Literature, and Constitutional History; but the classes in Geology, Light, Heat, French History, the Formation of Language, and other cognate subjects have met with such success as abundantly to justify their formation.

8. In the general arrangement of their curriculum, the Council of the Society would propose to be guided by the experience thus acquired. They would, however, wish it to be understood that where a demand for higher instruction in other branches than the above may be shown to exist, they will be prepared to extend the scope of their teaching, so far as is consistent with the maintenance of that high standard of education which is a fundamental principle of the Society.

9. In order to bring this teaching before the people of London it is proposed to make use of two channels. In the first place, instruction is to be given in direct connection with the existing educational institutions of London, and, in the second, their efforts are to be supplemented by stimulating in districts, where no such institutions exist, the formation of local committees, who will superintend the establishment of courses of lectures and classes in their own neighbourhood.

10. The assistance which can be given to existing institutions is mainly of three kinds. Firstly, labour can be economised. The Council, by the appointment of a regular staff of teachers under their immediate control, will be enabled to organise into a comprehensive system the work done throughout London; thereby applying to the best advantage both the power of the lecturers and the resources of the institutions which may employ them. It is clear, for instance, that by a proper disposal of time, the power may be saved which is at present wasted in the independent preparation of many courses of lectures where one might be repeated with economy. Secondly, the institutions will thus be enabled to draw upon a regular supply of practised teachers, devoted to this work alone, instead of having often to depend on the intermittent leisure, and sometimes on the generosity, of partially employed amateurs. Finally, they will obtain what is of still greater importance, the University supervision and University stamp for their teaching, a warrant at once of its quality and its popularity.

11. Further, it is hoped to find in many parts of London, hitherto comparatively neglected, substantial and hearty help from residents who are interested in the advance of higher education. Such persons will be asked to form committees, which will take upon themselves such local arrangements as the central committee can hardly be expected to supply; and will obtain, towards covering the expenses of their own centre, the guarantee of such sums as the Council may consider necessary.

12. It may reasonably be expected that in many districts of London, as in several of the large towns included in the Cambridge scheme, the fees received from students would be sufficient to defray the cost of the lectures. The teachers' fee for a course of lectures and classes for the term of three months, of which there would be two in the year, will probably be placed at about £30. For this sum there would be given one lecture and one class every week, and the answers written in the interval by the students would be examined and commented upon, as is indicated in the quotation already given from the Cambridge regulations.

13. The question of the fees to be paid by the students must, of course, be settled independently for each course. Lectures given in the wealthier parts of London, and especially those delivered in the morning, and thereby suited to the convenience of the upper classes, will, it is hoped, be so well attended as to justify the charging of

a comparatively high fee; but it is, at the same time, to be expected that in many districts the payments must be kept low; the Council therefore look upon it as necessary that a guarantee fund should be raised at every centre, sufficient to cover at least the local expenses of rooms, advertising, &c., as well as the lecturer's remuneration to such an extent as the Council may think fit.

14. It is earnestly hoped that any institution or person willing to co-operate in this important work will at once communicate with the secretaries at 22, Albemarle-street, W., who will be glad to give every information in their power.

AID OBTAINABLE FROM THE SURPLUS OF THE EXHIBITION OF 1851, HELD BY THE COMMISSIONERS.

1. It must have been a welcome announcement to the promoters of Adult Education, to read in the *Times* of the 27th May last, that Her Majesty's Commissioners for the Exhibition of the Works of Industry of all Nations in 1851, contemplate at once realising £350,000 by sale of land, in which they had chiefly invested the surplus of the exhibition. They will also clear off all their actual and possible liabilities. It is announced that they are resolved to go on with the work of extending and strengthening the machinery for Education and Science and Art. It is stated that they have schemes for founding scholarships liberally endowed in connexion with the Schools of Science and Art, for helping local museums with grants for buildings and collections. The profits of the great exhibition, amounting to £180,000, under the successful management of the Commissioners have produced many fold that amount.

2. In 1850, to promote the exhibition, about £68,000 was subscribed from the principal cities and towns of the United Kingdom. The places which subscribed £400 and upwards were:—

Manchester	£4,079
Glasgow	2,483
Leeds	1,600
Bradford	1,100
Bristol	788
Huddersfield	700
Birmingham	500
Newcastle-on-Tyne	457
Edinburgh	400
Stockport	400

3. About ninety places subscribed above £100. These facts will lead the contributors in 1850 to consider what representations it may be desirable they should make to Her Majesty's Commissioners to help them to carry into effect the views which they have published.

THE IMPORTANCE OF A KNOWLEDGE OF THE LAWS OF HEALTH.

By Thos. Bond, F.R.C.S., M.B., and B.S.Lond.,

Assistant-Surgeon to Westminster Hospital, and Lecturer on Medical Jurisprudence.

1. On an average, one-half of the number of out-patients treated by a hospital surgeon suffer from diseases due primarily to a want of knowledge of the laws of health and cleanliness. The ignorance of hygienic laws, which affects so disastrously the health of the rich as well as the poor, exists chiefly in regard to dress, ablution, and ventilation. This statement may, at first, appear startling, but an enumeration of the diseases that can be constantly traced to the above causes will show upon how sound a basis the statement rests. The following are examples:—Varicose ulcers from dress; skin diseases from want of cleanliness; chest diseases and fevers from defective ventilation. The vast number of ulcerated legs treated in the out-patient department of hospitals, in workhouse infirmaries, and in private practice, arise from varicose veins. Now, a varicose ulcer is caused by a distended condition of the veins of the leg, which have to sustain the pressure of the blood caused by gravitation. In varicose veins, the valves which help to support the column of blood are, to a great extent, destroyed, through the veins having been distended by mechanical obstruction to the free return of the blood from the extremities, thereby distending the lower veins and separating the edges of the valves. Thus, the weight of an uninterrupted column has to be borne by the veins. This, of course, causes further distention, giving rise to congestion of the capillaries of the skin, and causing swelling, eczema, and ultimately ulceration. This is the varicose ulcer so common in the labouring classes. It is always difficult to heal, and often impossible, except by prolonged rest in bed. Hence it is the dread of the surgeon, and the cause of misery to thousands. Varicose ulcers are seldom admitted into general hospitals, so that hundreds of poor families are driven to the workhouse, and such cases form a majority in the workhouse infirmary. The most frequent and flagrant cause of obstruction is the ordinary elastic garter. Children should never wear them at all, as the stockings can be perfectly well kept up by attachment of elastic straps to the waistband. If garters are worn, it is important to know how to apply them with the least risk of harm. At the bend of the knee the superficial veins of the leg unite, and go deeply into the under part of the thigh beneath the ham-string tendons. Thus a ligature below the knee obstructs all the superficial veins, but if the constriction is above, the ham-string tendons keep the pressure off the veins which return the blood from the legs; unfortunately most people, in ignorance of the above facts, apply the garter below the knee. Again, in nine out of ten labouring men, we find a piece of cord or a buckled strap tightly applied below the knee, for what reason I could never learn. Elastic bands are the most injurious. They follow the movements of the muscles, and never relax their pressure on the veins. Non-elastic bands during muscular exertion become considerably relaxed at intervals, and allow a freer circulation of the blood.

2. The habit of tight lacing again predisposes to varicose veins, in consequence of the abdominal viscera being pushed downwards into the pelvis, causing undue pressure on the veins of the lower extremities when they enter the pelvis. Physicians also have reported numerous cases of heart and lung disease caused by this pernicious habit.

3. The use of dress is often misunderstood; most persons evidently study and practice it with regard to appearance, or only to keep out wet and cold. The hygienic use of clothes however, is not so much to keep cold out as to keep heat in. The mistake is often made, of taking great care to put on extra wraps and coats

when preparing for out-door exercise. This is not at all necessary in robust persons. Sufficient heat to prevent all risk of chill is generated in the body by exercise. The care should be taken to retain sufficient clothing after exercise, and when at rest, to prevent the heat passing out of the body. Indeed, persons very often catch chills from throwing off extra clothing after exercise, or from sitting about in garments, the material of which is not adapted to prevent the radiation of heat from the body. Linen and cotton underclothing, when moistened by perspiration, parts with heat very rapidly, whereas flannel and silk, being non-conductors, prevent the rapid loss of heat.

4. The most recent offence against the laws of health is the habit of wearing false hair. The perspiration of the scalp is prevented by the thick covering from evaporating, thereby causing a sodden and weakened condition of the skin which predisposes to baldness and other diseases of the scalp. Again it produces headache and confusion of the intellectual faculties. We all know what a relief it is during hard mental work, simply to raise one's hair by running the fingers through it. I should think literary ladies either do not wear false hair or take it off when at work.

5. Ablution is another subject of paramount importance to health. Mr. Urquhart, the introducer of the Turkish bath into this country, is one of the benefactors of the age, and it is to be hoped some day there will be a bath in every town and village in England. Doctors are very much to be blamed for allowing themselves to be prejudiced against it. The usual opinion given by medical men to their patients is that it is debilitating, and only to be borne by the robust. The reverse is really the case; it is stimulating and strengthening, it is a preventive as well as curative in disease. The effect of the Turkish bath on the skin is to cause an active condition of its functions of elimination, by removing the hardened epithelial scales, by removing the fat from the pores, and by causing the sweat glands to maintain the activity of their functions, giving a general stimulus to the vital power of the skin. Again, it keeps the body in a state of perfect cleanliness, which is so essential to robust health, but these are not its only virtues, it promotes purity of mind and morals. The man who is accustomed to be physically clean, shrinks instinctively from all contact with uncleanliness.

6. There are, however, certain precautions to be observed in the use of baths. Persons who are apoplectic, or suffering from fatty degeneration of heart, should not venture to disturb the circulation by the excitement of baths. The first effect of Turkish baths is to stimulate the circulation, the second to cause active congestion of the skin, the third to produce profuse perspiration, the fourth to keep down the temperature of the body by rapid evaporation. On leaving the Turkish bath the body should be douched with cold water; the capillaries are thus emptied of their blood by contraction, but immediately after the stimulation causes them to resume a state of activity, and produces vigorous circulation through the skin.

7. In taking a cold bath in the morning the same conditions should be present. The surface of the body should be warm and moist; therefore, the bath should be taken immediately on rising from the bed, and before the surface of the body has had time to cool or the capillaries to contract. The shock of the cold water should cause them suddenly to contract, then quick reaction will take place in the same way as after a Turkish bath. Unless this reaction occurs after the bath there is great danger of getting a chill, at any rate the full benefit of the bath is not obtained. Persons with weak circulation who cannot take an ordinary morning bath, often derive great benefit from the Turkish bath. It opens the pores and improves the circulation of the skin, so that the shock of cold water can afterwards be borne. The same persons can generally bear a cold bath if they get for a few minutes into a warm bath first, and then immediately plunge into cold water. By these means an active reactiou is brought about. Warm baths should, in my opinion, never be taken on rising except under the above conditions, but warm baths at night are often desirable. They should be taken just before going to bed, when they have the effect of relaxing the muscular system and of promoting sleep by soothing the activity of the brain by the withdrawal of blood from it. I do not think warm baths at night are weakening, as the depression of vital energy which may occur is recovered during sleep. In river and sea bathing, persons should be careful not to remain in the water too long, nor should they exert themselves sufficiently to cause exhaustion, as the power of reaction is much impaired thereby; neither should persons get into cold water when cooling. The old fashioned idea that persons should wait to cool before plunging into the water is a fallacy. There is no danger in plunging into the coldest water in a state of profuse perspiration if the heart and arteries are in a healthy state. Of course it would be unwise to do so immediately after a full meal, as the action of the heart might be impeded by the distended stomach.

8. Many persons complain of always getting up tired in the morning. This is very often due to defective ventilation of the bedroom, or from using an undue amount of bed-clothes and bedding. Feather beds are too soft and yielding, and partially envelope the sleeper, thus producing profuse perspirations. The habit of lying too much under blankets is also very pernicious, by reason of the carbonic acid exhaled by the sleeper being respired. Again, it is a common error to suppose, that by simply opening a window a little at the top a room can be ventilated. people forget that for proper ventilation there must be an inlet and outlet for the air. In bedrooms there is often neither, and if there is a fireplace it is generally closed up. Again it is a mistake to suppose that foul air goes to the top of a room. Certainly the heated air goes to the top, but the chief impurity, the carbonic acid, falls to the bottom. There is nothing so efficacious in removing the lower strata of air as the ordinary open fire-place, especially if there is a fire burning. The usual defect in ventilation is the want of a proper inlet for the air. If the window be open the cold air being heavier pours down into the room, causing draughts, if the door be open, or ajar, the same thing occurs. The perfection of ventilation may be obtained in any room with a fire-place by simply providing proper inlets for the air, and nothing answers so

well for the purpose as the upright tubes invented by Mr. Tobin. By this means the heavier external atmosphere ascends vertically through the tubes like the jet of a fountain, displacing the warmer and lighter atmosphere of the room, which finds its exit up the chimney. The tubes should communicate with the outer air on a level with the floor, and should be carried vertically upwards in the room for about four or five feet. A constant supply of fresh air is thus ensured without the slightest liability to draught, as the current goes directly upwards till it strikes the ceiling. It is then diffused downwards, mixed with the heated air of the ceiling. The same principle can be carried out in any room with a sash window, by cutting out two or three holes an inch wide and three inches long in the woodwork of the upper sash where it joins the lower one. The columns of air ascend directly upwards, just inside the window, and mix with the heated air in the upper part of the room. If this system were universally carried out, we should hear less of rheumatism and chills caught by sitting in draughts.

9. Persons should cultivate the faculty of detecting sewer gas in houses. Typhoid fever is often caused by the escape of this gas into the house through defect of the traps and drains. However bad the drains may be outside the house, there is little to fear, provided the gas can escape externally. The following two very simple precautions would naturally diminish the cases of typhoid fever; first every main drain should have a ventilating pipe carried from it, directly outside house to the top of the highest chimney. Secondly, the soil pipe inside the house should be carried up through the roof, and be open at the top.

THE IMPORTANCE OF A PRACTICAL KNOWLEDGE OF CLOTHIMG.

By Mary Willis.

1. The ignorance prevalent among the people with regard to needlework, and the cutting out and preparing of the simplest and most necessary clothing, is an evil daily felt, and appears to us to be on the increase in all classes alike. It is, therefore, much to be deplored that measures should not be taken to make needlework and its accessories an obligatory part of female education.

2. Few young ladies upon whose accomplishments hundreds of pounds have been spent, can dress a doll decently or shape a petticoat for themselves, though they may be quite able to work point lace stitches and Berlin-wool patterns. The experience of the lady manager of any parochial or village work society will furnish abundant instances of the deplorable incompetence of the willing volunteer assistants upon whom she must necessarily depend for help in cutting out, &c. I have known of a strip five inches wide torn from a piece of calico sixty yards long, and thus wasted, because the cutter-out was incapable of fitting a shirt pattern to the material she had undertaken to convert into those useful garments, thereby largely raising the price of the smaller number of shirts produced. In a lower class it is a rare thing to find a girl going into service who is capable of making her own outfit properly. The little instruction she gets at her parish school is of the most perfunctory and imperfect character. It becomes daily more difficult to find a servant capable of being entrusted with the ordinary mending and darning needed in a household, and it will generally be found in the case of one who can work that she has had the luck to be trained by some superior nurse or careful mistress, from whom she has gained the knowledge that she had not the chance of acquiring at the school where she was taught to read, write, and cast accounts very tolerably. There are, of course, some exceptions, as there are some schools where needlework in all its branches is most admirably taught, but they are few. From long experience as a housekeeper we can certify to having only had two female servants who had acquired at school a satisfactory knowledge of cutting out and fitting. A certain and almost invariably tasteless skill in millinery is common enough, which is to be ascribed to the powerful influence of the characteristic vanity of the daughters of Eve, in all classes, and is capable of co-existing with a total incapacity to cut out and neatly make the most ordinary garment.

3. It is curious to see how the deftness of hand acquired in good sewing will manifest itself in other things, as it will almost invariably be found that the servant who is handy with her needle is the one to be trusted with the best china, or to arrange a bouquet for the dinner table in the absence of her mistress.

4. Perplexing as this ignorance is felt to be by the mistress of servants, how much more trying and pernicious is this incapacity, when these handless women come to marry, and have homes to care for and children to clothe; and it is on this account that we would so strongly urge upon all connected with schools and teaching, the paramount importance of early and careful training in needlework in all its branches, as it is only in youth that this skill of hand and eye can be obtained with ease and certainty.

5. Occupation which encourages the use of the hands has besides an invaluable moral influence upon children, we believe, and is not half enough considered in our schools for boys as well as girls. It is not found that Scotch children are behind ours in book learning, though the shepherd lads knit their own stockings, and much of the fine white embroidery used for trimmings is in Scotland made by boys. In large orphan asylums and institutions it has been found that the teaching of tailoring and shoemaking has a most marked influence upon the happiness and well-being of the boys; it is much to be deplored that in similar institutions for girls the instruction, often excellent in itself, is still of a kind that is practically useless in after life. I therefore look with much anxiety for the devising of some means by which instruction of the sort we urge could be obtained by those who have left school; and we are convinced that it would be anxiously sought after, not only by those women who find themselves incapable of achieving their necessary needlework in service, but afterwards, when a knowledge of the quantities required and the greatest economy are needed in cutting out and making their own and their children's garments. I say nothing here of the difficulties many

women experience who have to make their bread by needlework and dressmaking. Prizes should be offered in our schools and work societies, not only for excellence in actual needlework, but for the exhibition of practical skill and economy in cutting out garments.

6. As a rule, the patterns used in parish schools and societies are anything but good or economical, and much could be done to amend this if means were taken to provide every school with really good paper patterns, pasted upon cotton material to make them durable, which could be lent out, and on which children could receive instruction in planning and cutting out. In the late examination on this subject, nothing was more striking than the want of acquaintance with the use of patterns and of skill in economising material among the candidates, many of whom showed a sufficient knowledge of the mechanical use of the needle; only two of the examinees produced really good and practicable patterns.

7. The demand for real practical workers increases daily, now that everybody dresses better than in the olden time, when variety of materials was less, and people were content with much more limited wardrobes; the rate of remuneration for good work has risen in proportion, and this makes it the more imperative that something should be done to facilitate the acquirement of an art—for it is an art, even when applied to the most ordinary articles of clothing — that is so indispensable.

ON INSTRUCTION IN COOKERY.

By Edith Nicolls,

Lady Superintendent of the National Training School for Cookery.

1. The Society of Arts, some months ago, set the meritorious example to corporations of establishing five Scholarships for young women of education, to be trained as teachers of cookery. These Scholarships were obtained by competition, and the successful candidates were trained at the National Training School of Cookery, South Kensington, and were nearly ready for employment in local centres of instruction in cookery.

2. In the last twelve months there has been awakened through the country a great sense of the need for the improvement of cookery among the middle and working classes, more especially the latter, and efforts are already being made in many of our large towns to teach the people how to make a better use of the materials which are ordinarily in use for food. A National Training School of Cookery has been for some time established at South Kensington, which supplies teachers as fast as they can be trained; but to make this instruction thoroughly national, and of real benefit to the working classes, there should be in every centre, where there is a Mechanics' Institute and schools for public elementary education an organisation for teaching cookery and household economy, in the same way that there is a class for grammar and arithmetic. I am convinced that, if the working women were taught how to prepare simple wholesome food, and to work in the kitchen with method and cleanliness, it would effect a wonderful reform in the life of the poor, and, by the increased comfort of their homes, go a long way towards curing the drunkennes and consequent crime and misery of our working classes.

3. Cookery is now encouraged by the Education Code but under rather difficult conditions. The School Board for London has for some time past been aware of the need for instruction in cookery among the working classes, from which their pupils are taken. There are now established four cookery centres, at work in London with great success, and giving satisfaction both to the pupils and the Board. The girls are showing a most intelligent interest in the instruction they receive, and they take full and sensible notes in their copybooks of all they learn during their two hours' lesson.

4. The various country School Boards are about to follow the example set them in London, and several teachers are now in training for other School Board schools.

5. The cookery taught at the National Training School is fitted for every grade of society. The dishes taught have been selected with great care, the object being to illustrate some principle in every example taught. The dishes taught at school are suited for all classes of people; for instance, the best *consommé* for the epicure is made there at the cost of 1s. 9d. per pint, and an excellent soup for the artisan for 2d. a pint; the best calves-foot jelly for the rich at 2s. a pint, and poorer jelly from ox-foot for the poor at 7d. a pint. The greatest pains are taken in the school to teach the pupils that, with careful management, dishes can be made of the best materials at a moderate cost; no waste is allowed, everything being turned to good account by care and method in the housekeeping and cooking. With an institution like this in our very midst, it is surely a great oversight that more advantage is not taken of the benefit it offers to all classes.

6. I submit these observations to the Conference on Adult Education, in the hope of stirring up an interest in the subject of cookery. I trust institutions where adults get learning will find out among their members and send a competent person, to go through the course of instruction at the National Training School for Cookery, which lasts three months, and when she has taken her diploma, engage her services for the institution, as a teacher of cookery to all classes.

THE TEACHING OF MUSIC.

By Alan S. Cole,

Examiner for Fine Arts applied to Industry.

1. In the important reform of the Society of Arts' Examinations for 1876, it may be observed that the Examinations in Music have been omitted. It is true that the numbers who came up for examination in 1875 were only 154, certainly a very small number for an examination open to the whole of the United Kingdom; but I would point out that that number showed an increase upon the numbers in 1873, which were only 93.

2. The Government Examinations—according to the Education Code—are limited to singing, and do not, therefore, cover the ground in music which was occupied by the Society of Arts, either in respect of persons or extent of subject. Indeed, I venture to think that the action of the Government in this direction increases the

duty of the Society of Arts to continue its own Examinations in Music. Parliament has sanctioned a principle set forth in the Education Code, of paying one shilling on behalf of every child who is reported as learning singing satisfactorily. There are upwards of 2,000,000 children under instruction upon whom such payment might become due. The liability for encouraging music may, therefore, be stated to be £100,000 a year. Surely some organisation is necessary for continuing musical instruction after the child leaves the elementary school. I am not aware that the subject of music is included in the scope of the public examinations held by the Universities, and so it would seem to be desirable that the Society of Arts should re-instate music in its programme of Examinations. It is hardly necessary for me to remind the Society that its labours in the cause of musical education have recently been marked in an important manner by the successful establishment and opening a National Training School for Music. In a year or so, therefore, we may look forward to the prospect of having a source from which we may derive the teaching power which would become necessary if musical classes were, like science and art classes, to be founded throughout the country. In the meantime, mechanics' institutes and educational societies, the special object of which is to promote adult education, can effectively assist both the cultivation of music, as well as the National Training School for Music, by creating scholarships to be competed for, and held at the school by those who intend to make music their profession. The country has emphatically intimated a wish for music to form a part of general education, and in response, as I have already said, the Government have made a commencement in the realisation of this wish, by offering payments to elementary schools where music is taught.

3. Twenty-five years ago the United Kingdom held an indifferent position in the ranks of art-producing countries. Now, however, thanks to the 25 years' training of the people's taste by means of museums which have sprung into existence during that time, as well as to schools and classes of art, by which the demands of this higher taste are largely met, that position is completely altered for the better. The United Kingdom displays and produces decorative art works which have become examples for the imitation of foreign countries. A similar condition in regard to music may soon and will surely be effected. And it is a special duty of the Society of Arts to stimulate, so far as in its power lies, the cultivation of musical science and art in the United Kingdom. The history of music might be well taught in all institutions. The practice of the fine arts arises from a desire to gratify the higher senses with which man is endowed. This desire has existed from the creation of the human species down to the present time. Although the practice of the fine arts varies according to the varieties of families which compose the human race, still it is evident that such practice has always aimed to improve what exists. Many of the arts have fluctuated in their existence, and the history of them presents all kinds of phases of success and of failure. But the desire to improve is innate in mankind. The character of ancient Greek music is a matter of discussion. All that we now know is that the Greeks had music which may or may not be closely related to what may, by comparison, be called modern music. As John Stuart Mill as said, "In every department of human affairs, practice long precedes science," and so it is with our modern music. The development of the science of acoustics and musical sounds has guided musicians to frame rules, by which pleasant sounding music is produced. To acquire a proper appreciation of modern music necessitates a cultivation of both practical and mental faculties. Fortunately the majority of the British nation are endowed with these faculties. Shakespeare, whose pre-eminent perception of human character is undisputed, says that—

> "The man that hath not music in himself,
> Nor is not moved with concord of sweet sounds,
> Is fit for treason, stratagems, and spoils."

Englishmen do not nowadays indulge in "treason, stratagems, and spoils," but we cannot shut our eyes to the fact that England is behindhand in musical education.

4. Germany, France, and other foreign countries are more advanced than England in the cultivation of music. They have their State *conservatoires*, well-trained choirs and orchestras. The United Kingdom in a far less degree has similar sources of musical education. Here then a reform becomes necessary. Wherever the recreation of the people is encouraged, music always holds a prominent place, and it is better that music should partake of the qualities of refinement rather than be restricted to mere developments of primitive noises like those of the fife and drum. What musically gifted person has not hoped that our Volunteer bands and our village club bands might be trained to dispense with the preponderance of drum beating which is now so marked a feature of their performances. Again, how depressing to anyone with an ear for music, is the effect of undisguised discords, which result from the untrained efforts of congregations to raise their "tuneful voices" in joyful hymns. Out of respect to religion, serious thought should be turned to the means of curing such offending results.

5. Instruction in music can be stimulated by the systematic establishment of musical classes in mechanics' and similar institutions, by inviting portions of congregations at first to constitute themselves musical leaders for the remainder of the congregations, and by holding week-day practises of psalms and hymns in churches. No one can gainsay the elevating influence which such simple efforts would produce. By providing rational recreation of this kind, an antidote is at once created to the idleness which generates all kinds of vice.

ON TECHNICAL EDUCATION.

By George Howell.

1. As a mere sentiment, the value of technical education is universally admitted, but little, comparatively, has as yet been done towards making it general. No doubt, taking into consideration all the circumstances, great advances have been made during the past few years, and greater efforts are being made, but up to the present the results may be said to be almost insignificant.

2. Every kind of education, if at all worthy of the name, must of necessity be slow—technical education very slow; and when we have to deal with adults whose primary education has been altogether neglected, and who have to earn their daily bread, ofttimes with families dependent upon them, then it requires something more than a mere sentiment before they can be induced to enter upon its study.

3. It is all very well to say that people ought to do this and that, because it is right that it should be done, or even that personal advantages will inevitably follow, if it be done. It must, however, be recollected that the great mass of mankind do not act from well-defined motives, or from noble impulses; they are content to go along in the old jog-trot style, doing the same as their fellows, or following in the footsteps of those who have gone before them.

4. Scientific education and technical skill are of the very highest importance, but it requires, to some extent at least, a cultivated mind to be able to see the many and various advantages which will result from such a course of study. It becomes necessary, therefore, to offer every inducement to men to cultivate the required knowledge for a proper scientific and technical treatment of the particular branch of industry in which such persons are engaged.

5. If the great mass of employers were fully alive to the importance of scientific and technical training, and were anxious to advance such training among their *employés*, much difficulty and many obstacles would thereby be overcome. But, as a rule, employers are too busy calculating the profits accruing, or likely to accrue, from the particular job or business in hand, to think of the possible advantages of a far-off future. Of course, there are exceptions to this rule, but they are too few to be able to exert any appreciable influence upon the great majority, who are, to say the least of it, apathetic and indifferent.

6. Here, then, we stand between the workmen on the one hand, who are too poor to do much, who have but little time at their disposal, and who are careless as to and neglectful of the future; and we have the employers, who are likewise too indifferent, apathetic, or selfish to do much towards encouraging the cultivation of science and art as applied to industry.

7. What, then, remains to be done? One of two things. Either the Government must take the whole question in hand, or it must be left to voluntary aid and private enterprise. Now, private enterprise can do much, has done much, but it is inadequate to the immense work which lies before us. It is, moreover, by far too local and spasmodic to grapple with a subject so vast in its proportions and multifarious in its details.

8. In our opinion, it is the paramount duty of the State to provide the means, for in no other way can we overtake the necessities of our people, or the requirements of the case, so as to make such training at once general and effective. The opportunities for acquiring this education should be everywhere—not long distances from workmen's homes, but in their very centre; the facilities should be such that no one need go without it. The instruction should be ample, varied, and of the very best, and the inducements offered should be of such a character as to be real inducements to study.

9. Private enterprise cannot do all this, however generously it may be exercised. In our opinion, if the Government were to spend ten millions sterling in elaborating a plan for embracing the whole country, and in laying the foundation for carrying out such a scheme, it would be the cheapest ten millions ever spent, and would well repay the outlay. But all this money should not be spent upon costly buildings, or in grand museums, good as these are; it should be spent in really starting a scheme which in the future would be to a great extent self-supporting, and in any case effectual. It is not for me to say how it should be done, I only say it should be done.

10. A broad and national system once set on foot, would be generously supplemented by private individuals, and by societies such as the Society of Arts and similar societies. But, in my opinion, there is a vast field for the exercise of voluntary and philanthropic effort, without having to provide the means for initiating and perfecting a national scheme. For even if such a scheme were prepared, and schools founded, there would still be the necessity for gathering together the students, so as to form classes worthy of the teachers who might be appointed.

11. As before remarked, men are to be induced, nay, almost compelled to attend, and we cannot apply the principle of compulsion, as in the case of children, for we have to deal with grown men. It is necessary, therefore, to seek these men out, to explain the objects of such tuition, to interest them in the subject, and to develop an emulation amongst those who can be induced to attend. If people would rush to do a good thing because it is good, the schools we now have would be better attended, and the progress made would be quadrupled. But human nature is frail.

12. Only those who have had to strive against great difficulties and many disadvantages, can know how great the impediments are to evening tuition after the day's work is done. It is not like attending a lecture or a public meeting, which comes only now and then. You have to screw up your courage, so as to attend regularly and continuously the classes of instruction, if you are to reap the full advantage of such teaching, and we need scarcely say that it requires great moral courage to keep oneself up to the mark so as not to neglect a single evening. Besides which there are very many other difficulties connected with one's work which cannot at all times be overcome.

13. What then is to be done, seeing that we have not as yet any real national scheme for securing this scientific and technical training? In my opinion, the system of Technological Examinations established by the Society of Arts, in connection with the Science and Art Department of South Kensington, is most useful as a supplement to the work being done by that Department. And it must not be understood for one moment that we underrate what has been, or is being done in various parts of the country under the auspices of South Kensington.

14. In looking over the Programme, however, of these Technological Examinations, they appear to me to be too elaborate for the class of persons for whom it was prepared, and to whom it is addressed.

I say appear, because on examining the past examination papers, we find that they are of such a character that there are plenty of workmen, who, with a little theoretical instruction, would be able to pass with credit to themselves, and with honour to the Society of Arts.

15. But the programme, especially clause three, seems to imply a far wider acquaintance with abstract science than the workman can find time to acquire. We say this, not in condemnation of the programme, for it is right enough as an ultimate goal to be aimed at in the future, and, as we, hope attained at no distant date, at least by those who are now being instructed in our Board schools. The object now is, however, to get our grown men into science and art classes—men who have not had the advantage of an early education, such as would fit them for the examinations of the Science and Art Department.

16. It is necessary, therefore, that we should not frighten the student from becoming a candidate for examination by a too elaborate statement of what is called the preliminary knowledge for such examination. It is rather our duty to encourage them to make an effort, and this can best be done by showing them how little is really necessary, in addition to their previously acquired knowledge, either practical or theoretical, to enable them to compete for prizes in these examinations. What we mean is this, simply to put in the mildest form the amount of theoretical knowledge requisite for passing these examinations, rather than by making it to appear greater than it really is, to deter them.

17. In addition to the subjects already proposed, we think that there are some others which might very well be added to the list, such as building construction, both as to design and ornamentation, embracing carpentry, masonry, brickwork, plastering, and decoration. There is room for vast improvement in our buildings, both public and private.

18. Now, just a few words as to the apparent want of success, both as regards science classes, and as to the Technological Examinations. In one sense no doubt these complaints are well founded; on the other hand we think that there is no reason for great disquietude, when all the circumstances are taken into consideration. It must be recollected that the apprenticeship system of former days has well nigh gone, lads have to learn their trades under greater disadvantages than formerly, when the master had really to teach the craft to his apprentice. Now the boy is thrown as it were into a shop to "pick up" his trade, it being nobody's duty to teach him. The master gets all the advantage of the apprenticeship, if it can be dignified by that name, and the workman none, but rather the disadvantage of having to teach the boy for nothing, and at the same time to find that he is brought into the market in competition with him as to wages.

19. Again, there is so much sub-division of labour, that general skill is very seldom required, and consequently not often acquired. Speed and deftness are the principal things aimed at in most of our large establishments.

20. Moreover, there is not that premium for skill which would of itself repay the workmen for the time, and trouble, and expense necessary to acquire it. The alleged action of trades' unions with regard to extra pay for extra skill is not true, and may, therefore, be at once dismissed, for it only leads us on a false scent, and lands us in wrong conclusions.

21. The slowness of our progress is inevitable from the nature of the work, and the time has scarcely come for arriving at a judgment, when we consider how much had to be done, and how little preparation there was for it. The work at present is essentially a missionary work; the harvest is plentiful, but the labourers are few, and the Society of Arts, aye, and even South Kensington, may well take a lesson from the trades' unions, and send out men to explain and enforce the great national as well as individual benefits which will accrue to us by the higher culture of our powers, and to show to the workmen how it will benefit our trade, increase our commerce, add to our wages, and thereby give greater wealth and happiness to all our people.

SOCIETY OF ARTS' EXAMINATIONS.

Report of the Educational Officer.

To the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce.

Gentlemen,—I have now the honour, for the seventh time, to submit to the Council, for the information of the Conference, a report upon the Society's Examinations held during the present year.

2. I need only briefly refer to the changes that were made some years since in the Society's General Examinations. Four years ago they were threatened with extinction, but this decision having been rescinded, in deference to the strongly expressed wish of several of the principal institutions, they were continued, the number of subjects having been considerably reduced.

3. Up to and including 1875, the number of candidates in the subjects remaining on the list had, generally, been increasing, and in my report for last year, I stated that, in 1874, the number of candidates examined was 1,073, while in 1875 there were 1,236, an increase of 163. The number of papers worked in 1875, was 1,558, as against 1,452 in the previous year, an increase of more than a hundred.

4. Last year, the Council decided that a very important change should be made in the system. It was determined that the plan of granting certificates in each separate subject should be discontinued, and that a new certificate should be established, to be described as a "Certificate in Commercial Knowledge." The opening paragraph of the Examination Programme says:—"Since the Society of Arts' General Examinations were established in 1856, the Universities of Oxford and Cambridge, the Science and Art Department of the Government, and other public bodies, following the example of the Society, have instituted Examinations, which, to a certain extent, supply the place of those of the Society of Arts. None of them, however, are specially adapted to young persons entering commercial life, whether as clerks or otherwise, and the Council have decided to substitute for the General Examinations those hereafter described, believing that such examinations

will be of great practical benefit, and specially come within the province of a Society established for the Encouragement of Arts, Manufactures, and Commerce." The following are the subjects in the Commercial Programme :—

1. Arithmetic.
2. English (composition and correspondence, extra marks being given for précis writing).
3. Book-keeping.
4. Commercial Geography and History.
5. Shorthand.
6. Political Economy.
7. French.
8. German.
9. Italian.
10. Spanish.

5. In order to obtain a "Certificate in Commercial Knowledge," it was decided that a candidate must pass in three subjects at least, two of which must be Arithmetic and English; the class, first or second, obtained in each subject to be recorded on the certificate. The third class has been abolished.

6. In the above list it will be noticed that there are two new subjects. "English," a substitute for that hitherto described as "The English Language," and, as may be seen by a comparison of the examination papers, very different from it, and "Shorthand." Another change made was the reducing the minimuum age of candidates from 16 to 14, but only a small number below 16 came up for examination.

TABLE I.

RESULTS OF THE EXAMINATIONS OF 1876.

NAME OF LOCAL BOARD.	No. of Candidates Examined.	No. of Candidates who Passed.	No. of Unsuccessful Candidates.	No. of Papers Worked.	No. of First-classes obtained.	No. of Second-classes obtained.	No. of Papers not Passed.	No. of Commercial Certificates awarded.	No. of Prizes awarded.
Aberdeen ...	47	33	14	61	9	34	18	1	1
Aldershot ...	11	9	2	22	3	9	10	...	...
Ashford ...	7	7	...	13	7	5	1	...	...
Bacup ...	15	12	3	35	1	16	18	...	...
Belfast ...	11	3	8	19	3	3	13	...	...
Birmingham ...	25	17	8	42	6	22	14	4	2
Bolton, Church Institute ...	18	4	14	22	1	5	16	...	...
,, Mechanics' Institution ...	15	4	11	19	1	4	14	...	...
Burnley ...	24	12	12	39	1	12	26	2	...
Cardiff ...	4	2	2	7	2	2	3	...	...
Carlisle ...	10	10	...	15	6	7	2	1	3
Carmarthen ...	2	2	...	4	1	3	...	1	...
Dudley ...	9	3	6	13	...	5	8	...	...
Dundee ...	17	10	7	39	2	16	21	1	...
Edinburgh ...	1	1	...	2	1	1	...	...	...
Freetown (Glossop) ...	2	2	...	3	...	3	...	...	...
Gartsherrie...	60	12	48	60	2	10	48	...	...
Glasgow, Anderson's University...	11	9	2	14	1	10	3	1	...
,, Athenæum ...	40	24	16	69	12	27	30	5	1
,, Mechanics' Institution ...	10	8	2	16	2	9	5	...	...
,, Young Men's Society ...	12	4	8	18	...	5	13	1	...
Halifax, Mechanics' Institution ...	3	1	2	3	1	...	2	...	...
,, Working Men's College ...	3	3	...	7	...	3	4	...	...
Hitchin ...	1	1	...	1	...	1	...	...	...
Huddersfield ...	7	2	5	11	...	3	8	...	...
Hull, Church Institute ...	11	8	3	12	3	5	4	...	...
,, Young People's Institute ...	55	33	22	73	16	27	30	2	...
Ipswich ...	7	5	2	12	...	8	4	1	...
King's Lynn ...	17	6	11	16	3	2	11	...	...
Leeds Young Men's Christian Association ...	14	3	11	24	2	5	17	...	2
Leicester ...	35	15	20	47	...	12	35	...	...
Liverpool ...	27	21	6	39	11	19	9	3	3
London, Birkbeck Literary and Scientific Institution ...	83	62	21	143	43	65	35	15	13
,, City of London College ...	74	53	21	117	30	51	36	9	4
,, Islington Youths' Institute ...	16	9	7	18	4	7	7	...	...
,, Kentish-town Literary Institute ...	5	4	1	9	3	3	3	...	1
,, Quebec Institute ...	26	14	12	44	7	18	19	4	3
,, Royal Polytechnic Institute ...	11	9	2	19	1	14	4	2	1
,, St. Stephen's (Westminster) Evening Classes...	22	17	5	41	2	23	16	2	1
,, Walworth Literary Institute ...	2	2	...	6	...	2	4	...	...
Manchester ...	87	60	27	154	28	69	57	8	6
Mossley ...	7	...	7	11	...	...	11	...	...
Oldham ...	7	4	3	9	...	4	5	...	...
Paisley ...	3	3	...	5	...	3	2	...	...
Penzance ...	14	10	4	18	...	12	6	...	...
Rugby ...	11	6	5	26	3	9	14	...	...
Salford ...	32	12	20	34	2	11	21	...	...
Sheffield ...	16	14	2	35	3	18	14	1	...
Stourbridge ...	7	6	1	16	...	10	6	1	...
Swindon ...	13	9	4	17	3	10	4	2	...
York ...	7	2	5	9	...	3	6	1	...
Totals ...	974	582	392	1,508	226	625	657	68	41

Number of Local Boards, 51.

N.B.—The Prizes in Writing from Dictation, in Writing and Manuscript Printing, and for Handwriting generally, are included in the Prize column.

7. The number of candidates examined in 1875 was 1,236, and 974 this year, of whom only 62 were between 14 and 16. The number of papers worked in 1875 was 1,558, while in 1876 there were 1,508; but it must be borne in mind that one of the most popular subjects, Music, in which there were no less than 154 candidates last year, had been removed from the list, and the new subject, Shorthand, brought no less than 66 candidates. In the Domestic Economy subjects (of which I shall speak presently) there were 37 papers worked, so that if Music had remained, the total would have been 1,662. I cannot but express a hope that, though this subject can hardly find place in a Commercial Programme, some arrangement may be made for including it in the Society's system next year. It would seem right that a Society to whose efforts the foundation of the National Training School for Music is due, should do its best for the encouragement of a sound knowledge of this art amongst the people.

8. A glance at the table shows that in Arithmetic (one of the subjects, be it observed, necessary for a commercial certificate) there are 518 candidates this year, as against 459 last year; the new subject, English (also a necessary qualification for a commercial certificate), has brought no less than 333 candidates, or compared with 212 in "English Language" last year, and in Book-keeping there is a small advance. In the other subjects, however, especially in modern languages, so necessary for those entering commercial life, there has been, in most cases, a falling off. In French, German, and Spanish, the numbers are reduced; in the first, from 250 last year to 157 this year; in the second, from 77 last year to 30 this year; and in the third, from 30 last year to 9 this year. The candidates in Political Economy are only about half as numerous as in the two previous years, and the same may be said of a subject newly introduced in 1875, Commercial History and Geography. The diminution in number in the last-mentioned subject is certainly a cause for regret, and, indeed, for surprise, for there is hardly one upon the list, a knowledge of which is more essential to the very class for whom these Commercial Examinations are intended.

9. The list of Prizes published in last week's *Journal* is certainly encouraging. No less than thirty-four have been awarded in the Commercial Examinations, and seven in those for Domestic Economy.

10. The Prince Consort's Prize of twenty-five guineas, graciously placed by Her Majesty at the Council's disposal each year, has been awarded to Paul Juste Descours, of the Birkbeck Institution, who obtained in the specified period seven first-class certificates or classes, a large number, when it is borne in mind that the subjects in the programme are now so few, that candidates have not the opportunity they formerly had of obtaining numerous certificates. The Council has also awarded the Council Prize for Female Candidates,

TABLE II.—Number of Papers Worked in each Subject in the Present and Three Past Years, with the Results for the Year 1876.

SUBJECTS.	1873.	1874.	1875.	1876. No. of Papers Worked.	No. of First-classes obtained.	No. of Second-classes obtained.	No. of Papers not passed.
Arithmetic	428	404	459	518	81	197	240
English	..	..	..	333	24	218	91
Book-keeping	265	290	311	325	58	114	153
Commercial Geography and History ..	..	..	23	11	..	4	7
French	177	227	250	157	11	33	113
German	41	61	77	30	8	9	13
Italian	2	4	7	5	2	2	1
Spanish	9	26	30	9	2	5	2
Political Economy	28	34	33	17	7	8	2
Shorthand	..	..	..	66	23	24	19
Domestic Economy:—							
Clothing	..	..	..	10	3	2	5
Cookery	..	..	..	10	4	6	..
Health	..	..	..	8	1	..	7
Housekeeping, &c.	..	..	..	9	2	3	4
* English History	93	111	..	..	..	..	..
* English Language	183	162	212	..	..	..	..
* Logic	21	8	..	..	..	..	..
* Floriculture	9	6	..	..	..	..	..
* Fruit and Vegetable Culture	10	7	..	..	..	..	..
* Gardening	..	..	2	..	..	..	..
* Theory of Music..	93	112	154	..	..	..	..
Totals	1,359	1,452	1,558	1,508	226	625	657

* Examinations in these subjects have been discontinued.

which has been gained by Mary Lattimer, of the Carlisle Mechanics' Institution, who obtained three first-classes within the specified period, and also a special prize for females. I may mention that a candidate from the same institution obtained the Council Prize last year. The special prizes offered to females have been taken in Book-keeping and French. In Domestic Economy four of the prizes have been taken by females. The four additional prizes in Political Economy, kindly given by Mrs. Harry Chester, have all been awarded, and the same may be said of the prizes for Writing from Dictation, for Writing and Manuscript Printing, and for the best specimens of Handwriting, as shown in the papers generally.

11. There can, I think, be no doubt that the effect of the new regulation, granting no certificates in separate subjects, and granting only First and Second Classes, abolishing the Third Class, has been, at the outset, discouraging to candidates, and I fear that this feeling will not be lessened when I announce that out of the 974 candidates who have been examined this year only 68 have fulfilled the conditions entitling them to a certificate in commercial knowledge. It must be borne in mind that a considerable number of our candidates in former years were persons whose position or occupation had little of a commercial character. They were artisans of a high class, to whom the possession of a certificate in certain special subjects, to the study of which they had been led either by interest or inclination, was of considerable value, but to whom the commercial certificate would be virtually useless, and these will no longer appear at our examinations. Perhaps when they find their names, with the "classes" obtained in each subject, appearing in the Society's *Journal*, some of them may realise that this publication of the results of the examination will be nearly as valuable to them as a certificate itself. But, however this may be, there can be no doubt that certain classes of persons who formerly sought to have their knowledge tested by the Society's examiners will do so no longer, and thus, for a time at least, the numbers will be lessened.

12. I am not, however, prepared on this account to advise the Council to return to the former system. The granting of certificates in commercial knowledge would seem to be so useful a work, and so especially within the purview of our Society, that I think the present plan ought to have a fair trial. This is the more desirable, as a large number of the candidates have already passed in several subjects in the programme, but have not succeeded in one of the two essential subjects (Arithmetic and English), a failure, which, no doubt, they will easily remedy in a future year.

13. It will be remembered that, for several years, a subject, entitled "Domestic Economy," appeared in the Examination Programme, and attracted a fair number of candidates. It was, however, for various reasons discontinued, but this year the Council decided upon reviving it in an improved and extended form. Special Examinations in Domestic Economy were established, embracing four heads, as follows:—

1. Clothing and its Materials.
2. Health.
3. Housekeeping and Thrift.
4. Cookery.

14. As stated in the Programme, these examinations apply particularly to women, but there is no reason against men taking certificates in them. In the Code of the Education Department they are limited to girls, and this is a good reason why young men should not be excluded from the Society of Arts' examinations in them, if they please to attend to these important subjects. Their object is not to test the power of candidates to repeat what they have acquired only from books, but as far as possible to elicit evidence of practical knowledge and skill in each subject.

15. The subjoined table shows that about ten candidates have appeared in most of these subjects, a number decidedly encouraging for the first occasion. The relative number of certificates obtained has, however, been too low. I may especially instance the subject of Health, where the examiner, though he had intentionally set an easy paper of questions, was only able to pass one candidate out of eight, showing how much the study of this extremely important subject is neglected.

16. I have now to touch upon another branch of our educational scheme, the Technological Examinations, first held in 1873. In the first year's programme there were five subjects—Cotton Manufacture, Silk Manufacture, Paper Manufacture, Steel Manufacture, and Carriage-building, but only in three of them did candidates appear. In 1874, the five subjects above-mentioned were retained, with the addition of four more, Cloth Manufacture, Glass-making, Pottery and Porcelain, and the Manufacture of Gas; and last year five more were added, as follows:—Agriculture, Silk Dyeing, Wool Dyeing, Calico Bleaching, Dyeing, and Printing, and Alkali Manufacture. All these were retained in the present year.

17. The following table shows the number of candidates that have appeared in each of the four years, in the various subjects:—

	1873.	1874.	1875.	1876.
Cotton manufacture	1	10	13	19
Paper "	..	..	..	..
Silk "	..	..	..	..
Steel "	2	14	16	26
Carriage-building	3	3	4	3
Manufacture of Pottery and Porcelain	..	..	1	..
Gas manufacture	..	7	6	10
Glass "	..	..	..	..
Cloth "	..	2	3	2
Agriculture	..	..	2	..
Silk-dyeing	..	..	..	1
Wool-dyeing	..	..	1	1
Calico-bleaching, dyeing, and printing	..	..	..	..
Alkali manufacture	..	..	..	..
	6	36	46	62

18. It will thus be observed that in the first year, with five subjects, three of them were taken up, the number of candidates being only six. In the second year, with nine subjects, only five of them were taken up, but the total number of candidates increased to thirty-six; in the third year, with fourteen subjects, eight of them were taken up, and the number of candidates advanced to forty-

six; and in the present year, with the same number of subjects, seven of them were taken up, and the number of candidates has advanced to sixty-two.

19. These results must be regarded as encouraging. A larger number of candidates might perhaps have been expected, but it must not be forgotten that the subject is new; that much is required of the candidates, and that the necessary knowledge of science is probably as yet possessed by but few of our best artisans, and moreover it is to be feared that the scheme has not met with much cordial encouragement from the employers of labour, with, however, some exceptions.

20. As I observed in my report last year, it is interesting to look at the above table, and notice what subjects have and what have not attracted candidates in anything like numbers. At the head of the list, as might have been anticipated, still stands Steel Manufacture, in which it is evident that workmen of great technical knowledge and skill are required, and where the standard is necessarily high. In this subject there are no less than twenty-six candidates. Cotton Manufacture, with nineteen candidates, stands next on the list, and Gas Manufacture third. The numbers in the other subjects are but insignificant.

21. As these Technological Examinations are specially remarked upon before this Conference in a paper by Mr. George Howell, so well known as an authority upon the views and requirements of the higher classes of artisans, and to whom I last year expressed my obligations for valuable aid in the circulation of our programmes amongst the various organisations of workmen most likely to avail themselves of the examinations, a matter in which his special knowledge was of the greatest value, I need not enlarge upon them further, except to express a hope that some modification may be made in the system, tending to render it more attractive and available for the class whom it is intended to benefit.

22. I must not omit to mention an addition to our examination system, which, though it has this year produced no candidates, may become of importance in the future. It is a subject entitled "Fine Arts Applied to Industries," the examination being specially intended to apply to subjects which are not at present included in the general Art Examinations of the Science and Art Department, and especially to test a literary knowledge of the decorative arts. Candidates are required to possess the power of illustrating the answers by diagrams drawn from memory, and to show a knowledge of styles of all nations. The subjects of examination were to have reference to Fine Art applied to some useful objects, such as furniture, dress, utensils, &c., or to well known public buildings, museums, &c. Candidates must have taken a second-grade certificate (Art) of the Science and Art Department, a regulation which somewhat curtails the numbers of those eligible.

23. There are so many questions before the Conference this year, that I have confined my report entirely to the working of our system of examinations.

I have the honour to be, Gentlemen,
Your obedient Servant,
Charles Critchett,
Educational Officer.

APPENDIX.

Examiners' Remarks.

The Examiner in *Arithmetic* says:—"The work, as a whole, is very fairly done, and many of the papers are equal, if not superior, to any of those in former years."

The Examiner in *English* says:—"An impression left on my mind after reading the papers is that the grammar teaching in the classes which supply these candidates might possibly be improved by a few suggestions from the Society of Arts to the teachers. One series of papers, by the evidence they give of proper study, contrast remarkably with some other sequences that seem to indicate very bad teaching somewhere. Although it may not be desirable to suggest text-books, yet freedom in the relation of grammar seems in many places to have been interpreted with a liberty to use the shortest and the emptiest; and if it were possible to give teachers a notion of what they ought to do for the students who learn grammar of them, there might be in a few years a decided raising of the standard of attainment."

The Examiner in *Political Economy* reports a considerable improvement as compared with former years. He says:—"The papers of those candidates whom I have recommended for a First-class, show both a knowledge of economic principles and a skill in their application of a high order. The quality also of the answering of those whom I have recommended for a Second-class is very satisfactory."

The Examiner in *Commercial Geography and History* regrets being obliged to report that the answers obtained this year were neither so numerous nor so good as could be wished. Only very few papers show satisfactory results. Candidates in the highest division would do well to bear in mind that the award of a First-class is intended to denote at least a liberal knowledge of the Commercial Geography and History of the United Kingdom and of two other countries mentioned in the programme.

The Examiner in *French* says:—"The impression left on my mind by this year's papers is very satisfactory, their quality being, on the average, considerably better than what we have had for the last four or five years. A large proportion of papers bear marks of careful preparation, though too many are still very unsatisfactory in this respect, and these again come mostly in groups. I am able to recommend eleven candidates for First-class certificates, and thirty-three for Second-class. This proportion of altogether successful candidates is, perhaps, rather small, being only 28 per cent. of the whole; but of the 113 that have not passed, no less than 61 have secured upwards of 30 marks, and would, therefore, under the old system, have obtained a Third-class, and that in a more difficult, because, so to speak, a two-fold examination."

The Examiner in *German* says:—"The result of the examination is in so far satisfactory that there have been several excellent candidates for First-class and some very good ones for Second-class. Thirteen failed to satisfy me by their performances, and it seems that many of them merely took up the subject—as is so often the case at examinations—in order to find out practically what the test will consist of, and what amount of preparation they may yet require. Those candidates seemed to be deficient not only in the special branch to which the test refers, but also in a general knowledge of the language. I consider it, therefore, my duty to point out, that in order to be successful at these examinations, it is in the first instance necessary to have a thorough knowledge of the language in general, and then to be fully acquainted with the commercial terminology. A person may have a sound literary knowledge of a language and still be incapable of writing a business-like commercial letter; whilst one who has mastered all the commercial

idioms and phrases of a language will still be unable to compose a connected and intelligible letter, unless he has had considerable practice in German prose composition in general. It is, therefore, obvious that it is necessary to have both a general and special knowledge of the language in order to be a good foreign correspondent. In conclusion, I would advise intending candidates to read the market and trade reports in the German newspapers, and to have as much practice as possible in reading genuine German commercial letters."

The Examiner in *Clothing* says:—"For the first time the papers are not bad, although some have hardly understood the simple questions. Two are most admirable."

A report of the discussion, at the Conference, will appear in the next number of the *Journal*.

MISCELLANEOUS.

THE PHILADELPHIA EXHIBITION.

That each such exhibition should be larger in extent than its predecessor is natural, while the Centennial greatly exceeds the Vienna Exhibition in size, that proposed to be held in Paris in 1878 will, doubtless, as far surpass that of Philadelphia in the same respect. This almost inevitable growth of such undertakings is, to say the least of it, inconvenient, the larger the collection the greater the difficulty in organisation, and the greater the danger of complications; this is shown in the fact, that the idea of having such exhibitions ready, or even nearly so, on the opening day, has been flung aside as chimerical. This is unfortunate, for punctuality in such complicated undertakings gives valuable practice to those engaged in their organisation, and excellent example to the rest of the world.

The space devoted to the exhibition is said to amount to more than two hundred and thirty acres, and the five chief buildings have an area of upwards of forty-eight and a half acres.

Another point, of far more importance than size, is admirably illustrated at Philadelphia, namely, simplicity of plan. The main building resembles in plan the Crystal Palace of 1851 more than any of the intermediate exhibitions, but it is considerably larger, being 1,880 feet long by 464 wide, and this is only one of five large buildings devoted to the exhibition. The American Commission had the judgment to see that there was but one figure suitable for a great exhibition building, namely, the parallelogram; it possesses all the qualifications—simplicity, cheapness, facility in arrangement, and general effect. The central avenue of this building is 1,832 feet long and 120 feet in width, and the two principal side avenues are of the same length by 100 feet in width; between the central and main side avenues are two others 48 feet wide, and, lastly, there are two lateral avenues 24 feet wide. These gigantic dimensions are striking, but they do not make up all the remarkable points to be noted; there is a central transept, as there was in the Crystal Palace, of the same width as the central avenue, two side transepts of the same width as the principal side avenues, and two of 48 feet in width.

The intersection of these avenues and transepts produce nine open spaces free from supporting columns, four of which are 100 feet square, four 100 by 120 feet, and that in the centre 120 feet square; lastly, the height of the building in the centre is 70 feet. All who have seen the exhibition agree that such a magnificent effect has never before been produced. The four great exhibiting nations, the United States and Germany are on one side of the central avenue, and France and England on the other.

The absence of any extraneous ornamentation is remarked upon as a high quality; the building is noticeable as being in good taste and admirably adapted for its intended purpose; the eye is not directed from the real exhibition. The light is obtained entirely from the sides and ends, the roof being of tin laid upon wood, and is abundant although subdued, a very important point which deserves elucidation, as the windows are said to be so ingeniously arranged as not to admit the direct rays of the sun.

The comparative amount of space occupied in this main building, which includes the whole of the classes of mining and metallurgical manufactures, and education and science, as regards the chief exhibiting nations, are:—The United States, 31; Great Britain and her Colonies, 16; France, 7; Germany, 5; and Austria, 3. But even this immense building was not quite sufficient for its purpose, for an annex contains all the carriages, with the exception of those of France.

Another remarkable point which well deserves notice, is the fact that the columns of the building are made use of to indicate the position of the contributions of each exhibitor; the letters A. B. C. to U. designate the successive ranges of columns commencing next the northern wall of the building, and proceeding southward, and figures, 1, 2, 3, &c., the position of the columns in these ranges counting eastwardly from the western wall, the entire length of the building. Thus C 5, is the column in the third range, and the fifth from the west end of the building. This admirable arrangement is the same as that adopted in the street nomenclature of Philadelphia and most of the other large towns of the United States. The affixing to each entry in the catalogue the designation of the column to which the objects are nearest is a triumph of systematic arrangement.

The classification is extremely minute, but this has already been before the world for a long time, so that it is unnecessary to enter into that subject further than as regards the arrangement of the catalogue. The classes are not used as sub-divisions of the catalogue, but what are called departments, with, however, a few divisions; thus all the entries which belong to the first eight classes of the first department, viz., mining and metallurgy, are placed together, then follow metallurgical products including five classes, and mining engineering, composed of the last two classes in the department, but at the end of each entry is the number of the class or classes to which the contributions belong.

The numbering is peculiar; instead of one system running throughout the catalogue and embracing all countries, which was considered an admirable arrangement, not only has each department, but each country and colony exhibiting in that department, its own series of numbers, commencing with No. 1.

The catalogue exhibits evidence of care and business-like notions, and shows that practical men have been selected to superintend it; in fact, all the arrangements connected with the exhibition bear like proof of the presence of business-like capacity. In the front of the catalogue is a table of contents, giving the page of each department and sub-division for each country, and at the end of the volume is a full index of names of exhibitors, a word or two showing what they exhibit, and the page on which their entries will be found.

The *Moniteur Industriel Belge* states that a locomotive without furnace has commenced running in Paris on one of the tramways. It has a reservoir of superheated water, which furnishes a constant supply of steam for moving the vehicle. On another line of tramway an ordinary steam locomotive is at work. It is like a small omnibus in shape and size, containing a boiler. The furnace is out of sight, and fed with coke and charcoal. The draught of the furnace is kept up by a supply of compressed air.

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(Subsidised by Parliament.)

The results, giving important information for public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. Number of visitors for the month of March, 1876. When they are counted by sight the letter "S" is used, when by turnstile the letter "M":—

Institutions.	Amounts voted in 1875.	Number of Visitors in April.	Number of Visitors in May.	How counted.	Remarks.
	£				
1. British Museum	107,471	..	..	S	Return refused. (1)
2. National Gallery, Charing-cross	6,346	92,426	..	S	Open 17 public days. Total of four months, 1876, 253,813. The Gallery is now closed for alterations. (2)
3. Kew Gardens and Museum....	21,257	60,461	49,300	S	Open on Sundays and week days. (3)
4. South Kensington Museum....	39,019	100,740	..	M	Total for year, 839,212. Open daily all the year and in the evening, except Sundays (4)
5. Bethnal-green Museum	7,325	57,421	..	M	Total for year, 522,098. Open daily all the year and in the evening, except Sundays. (5)
6. National Portrait Gallery, South Kensington	1,956	..	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines and Mining Record Office, Geological Museum, Jermyn-street ..	9,070	3,728	..	M	Open daily, except Sundays and Fridays, and in the evenings of Mondays and Saturdays.
8. Patent Office Museum, South Kensington	..	17,677	17,504	M	Open daily, except Sundays. (8)
9. Edinburgh National Gallery ..	2,100	5,382	6,945	M	(9)
10. Edinburgh Museum of Antiquities	..	5,628	7,720	M	(10)
11. Edinburgh Museum of Science and Art	10,509	24,157	17,935	M	(11)
12. Edinburgh Botanic Gardens ..	1,750	5,352	..	M	(12)
13. Dublin Museum of Natural History	1,717	8,057	8,437	M	Open daily, and in the evening. (13
14. Glasnevin Botanical Gardens and Museum............	2,224	23,166	19,935	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland ..	2,389	7,650	6,174	M	(15)
16. Museum of Royal Irish Academy, Dublin........	200	..	..	M	(16)
17. Zoological Gardens, Dublin ..	500	12,837	10,600	M	Open daily, including Sundays. (17)
18. Tower of London............	1,500	26,619	..	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall ..	..	35,129	30,352	S	Open daily, including Sundays. (19
20. Royal Naval Museum, Greenwich	1,190	4,886	5,070	S	Open daily, except Fridays & Saturdays. (20)
21. India Museum, South Kensington	5,883	4,627	4,454	M	Paid for by Indian Government. (21)
22. Hampton Court Palace	3,465	..	..	M	Open on Sundays, and on week days except Fridays. (22)

(1) Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays.
(2) Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays.
(4) (5) Open morning and evening till 10, on Mondays, Tuesdays, and Saturdays. Students' days—Wednesday, Thursday, and Friday, 6d. entrance.
(7) (8) Open till 10 in evenings of Monday, Tuesday, and Saturday.
(9) (10) (12) (15) (16) (20) No information as to opening.
(11) Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days, Monday, Tuesday, and Thursday; admission 6d.; other days, admission free.
(21) Open on Mondays, Tuesdays, Fridays, and Saturdays, 1d. admission; on Wednesday and Thursday, 6d. admission.

NEW TELEGRAPH APPARATUS.

A new apparatus for telegraphic signalling has lately been brought into notice. It is the invention of a Spanish gentleman, and its object is to provide a simple and inexpensive system by which any number of stations—houses, fire-offices, police-stations, &c.—may be able to communicate with a central station by the same wire, yet without interfering with one another. It is obvious that with any system of telegraphy now in use this cannot be done. When, as is frequently the case, there are more than two stations on a line, only two stations can communicate at any one time, all the others being kept waiting till these have done. The operator at any station wishing to send a message has to wait till the line is clear, and he then telegraphs all along it, "calling" the station with which he requires to communicate. The signal is given all along the line, but it is attended to only by the station called. Should any second station attempt to break in before the first has finished, it simply causes confusion and consequent delay. According to the new system

the message may be said to wait on the line till all is clear, and then take its turn to be recorded at the receiving station without any further action on the part of the operator. The apparatus also is intended for use by persons without any knowledge of telegraphy, and can be set in action as readily as an ordinary electric bell. The arrangements by which all this is effected are at once so novel and so ingenious as to deserve notice, though it is but fair to add that—at least in its present state of development—it is not easy to suggest any practical application for the invention. The proposal of the inventor is that by his system all the houses in a town or any district of a town might be put into communication with a central office, so that on any sudden emergency, a message might be despatched giving the locality of the house requiring assistance, and indicating the character of the assistance required. Now, however tempting such a proposal may appear, it is certainly too elaborate, and would require too extensive an organisation, for it ever to be likely to come into practical use, while for any system of communication less extended than this it is a question whether the simpler appliances now in use do not answer almost equally well. For use in large offices, hotels, hospitals, and other places fitted with electrical communicating apparatus, it would offer some advantages, particularly the considerable one of being able to send a variety of signals instead of a single one, but beyond this the practical value of the new system is not at once apparent.

There are, however, many points about the invention which render it interesting to those who have any acquaintance with practical telegraghy, and it may be worth while to try and indicate them, so far as can be done without entering too deeply into technicalities.

The way in which an ordinary telegraph line is arranged is, of course, familiar to most people. The wire connecting the two stations, after passing through the instrument, is at one end connected to the earth, while at the other end it is joined to one pole of the battery, the other pole being connected to the earth, through which, therefore, the electric circle is completed. In small apparatus, for communication within a building, two wires are used, so that the circuit is completed by the second wire instead of by the earth, as is usual in all cases where the distance is at all considerable. The essence of the system under discussion may be said to consist of the use of two independent wires, the earth being in each case used to complete the circuit. Of these one wire serves to carry the message, the other to set the instruments and connections in a condition to carry it. This last may be termed the "starting," the other the "sending" wire. Both wires are led along the street or other main line of communication, and short branch wires connected to them are carried into each house. The battery is placed at the central station, where also is, of course, the receiving instrument. This is a "Morse" instrument, which records on a slip of paper the messages sent through it. In the normal state of the line this instrument is connected with the starting wire, but not with the sending. On a signal being sent through the starting wire, the instrument, previously at rest, is set going, tho connection with the starting wire is broken, connection with the sending wire is made, and the message is received and recorded. The clockwork of the instrument is set to run a sufficient time to receive the message, and it then changes the connection back to the starting wire and stops. We must now go back to the sending apparatus, from which practically two signals are sent, one along the starting wire, and the other—the message itself—along the sending wire. The starting wire may be said to pass through all the instruments, arrangements being made in each instrument for severing the connection there and connecting to a short earth wire. As soon as this is done, all the line beyond is cut off from the central office, and, the electric circuit being now completed through the earth, a current passes along the starting wire, and the receiving instrument is set in action. This being simultaneously disconnected, as above stated, from the starting wire, it cannot be interfered with until the message has been received and the instrument placed in a condition to be started afresh. It now remains to show how the message itself is sent. This is effected as follows:—The electric current, as it passes along the starting wire, is caused to act on a magnet, and thus set in motion a small apparatus on the sending wire. This, by an arrangement of considerable ingenuity, but involving details too technical for description, severs the communication with stations beyond, and completes the circuit on the sending wire by connexion with the earth. The current thus being enabled to pass, a signal is given, after which the instrument returns to its normal state. Thus the operator by one and the same action sends a message along the starting wire, which cuts off all communication between the starting wire and the receiving instrument, throws the receiving instrument into connection with the sending wire, and transmits his message. Nobody can send a message along the sending wire till he has sent one along the starting wire, since it is by the current flowing along the starting wire that his sending instrument is put in action. Nobody can send the requisite starting message while any one else is telegraphing, for during the process the starting wire is disconnected from the receiving instrument. Not only this, but if, while one person is telegraphing, another attempts to do the same, this second person, though he does not actually send his message, yet puts his connections in such a position that, as soon as the instrument at the central station has received the previous message and regained its normal position, the circuit with his instrument will be completed, and his message sent. Thus any number of persons can telegraph simultaneously, and their messages are received at the central office in the order of their position, those nearest the office being taken first. The signals transmitted are capable of considerable variety, according to the complexity of the instrument. They are given by the movement of a pointer hand on a dial. The signals required are marked on the dial face; and on the hand being brought to any given signal, that signal, with the number indicating the house, is recorded at the central office. The receipt of the message is shown by the return of the hand to the zero point. The principal signals suggested are for giving an alarm of fire, summoning the police, or desiring the attendance of a doctor. Street stations might also be arranged, from which a fireman or a police-constable might communicate with the central office.—*Times.*

THE SILVERING OF MIRRORS.

Down to the year 1840, the silvering of mirrors was performed by means of tin covered with mercury in a liquid bath. Such manipulation necessarily exposed the workman to the pernicious influence of mercurial vapours, and many of them met with premature death after long sufferings. In 1840 Drayton conceived the idea of covering mirrors with a thin pellicle of silver, obtained by reducing an ammoniacal solution of nitrate of silver, which moistened the mirror, with essential oils easily oxidised. Petitjean substituted tartaric acid for the various reducing agents previously employed. The mercury bath, with its attendant evils, is now suppressed. Even in point of cost the use of silver is preferable. A mirror is silvered in a few hours, whereas the old tinning process lasted twelve days at least.

Still, silvered mirrors have a yellow tint not met with in tinned ones, which is a serious defect in practical use. Moreover, the adherence of the silver to the glass is not so perfect as might be wished. It often happens that the silver leaf of mirrors exposed to the direct action of the sun's rays comes off the glass here and there. Lastly, the silvering, though covered with a thick var-

nish, gets black in course of time under the influence of hydro-sulphuric emanations. The emanations which rise from the water-hold of ships in the equatorial regions turn the mirrors black that are stowed in them. These defects are more than compensated by the saving of expense and the prevention of tho maladies caused by the use of mercury, but it was desirable that, if possible, they should be avoided, and M. Lenoir has succeeded in correcting them by a simple manipulation which is harmless to the workman.

The mirror, silvered by any process whatever, is first washed, then sprinkled with a diluted solution of cyanide of mercury and cyanide of potassium. The silver displaces part of the mercury and is dissolved. The rest of the silver gives rise to an amalgam whiter and more adherent to the glass than silver itself. This transformation is instantaneous. The proportion of mercury does not exceed five to six per cent. The management of the cyanides, which are very poisonous substances, does not give rise to any danger when they are in very diluted solution. The daily practice of electro-platers, who have used them for more than thirty years in much more concentrated solution than M. Lenoir does, has not occasioned any serious inconvenience.—*Practical Magazine.*

CORRESPONDENCE.

HEALTH AND SEWAGE OF TOWNS.

Sir,—In reply to Dr. Alfred Carpenter's personal attack upon me, contained in the *Journal* of the 16th inst., I would simply say that I wrote my letter, correct ing certain mis-statements in his paper, to elucidate a scientific truth. It is clear that Dr. Carpenter acknowledges the truth of my corrections, as in his letter he does not refer to them in any way, but has chosen the by no means uncommon practice with him of vilifying my professional character, whenever I have felt it my duty to correct his mis-statements.

In explanation to the reference to my forming the Croydon Irrigation and Farming Company to work the Beddington Farm by Dr. Carpenter, I may state that I advised the Croydon Local Board to farm the land themselves, and that they acted so far on my recommendation as to appoint a manager to take charge of the farm, but unfortunately at that time the Board got into difficulties with the ratepayers, and it was to get them out of their difficulties that I undertook the formation of the company with the full consent and knowledge of Dr. Carpenter and other members of the Local Board, and with the full assurance from Dr. Carpenter that he would aid in a material manner to form the company, which promise, by the way, he never redeemed.

The reference made is to my letter in the *Echo* of 29th Sept., 1871, in which it is stated that the capital of the company then called up was £2,028, and that the profits realised in the first year of farming, viz., the year ending 25th March, 1871, was 30 per cent. Does Dr. Carpenter wish to insinuate that the farm did not make this profit? If so, what becomes of his own figures published in your *Journal* of the 19th May, which shows that the profit made on the farm this same year was £1,073, or more than sufficient to pay 50 per cent. on the capital then called up. The statement that the "real capital" of the company as made by Dr. Carpenter was £1,500, I have already shown to be incorrect. The further insinuation in his paper that it was only "sufficient to pay the first quarter's rent" is equally incorrect, as the rent shown by his own figures to have been paid by the Farming Company in the whole of this year was but £1,770. Moreover, the general statement of receipts and expenditure in connection with the Beddington Farm as given by Dr. Carpenter in his paper is unreliable. As an example, in the first year he gives credit for the sale of manure on one side of the account, but omits the cost of production on the other!

With regard to the policy pursued by Dr. Carpenter, I think the term "ruinous" may well be applied to it, seeing that taking the figures given by himself he makes the losses on the Beddington Farm in ten years £5,441 16s. 6d., and he further shows in the same paper that the loss during the last two years, or the term in which he acknowledges he has pursued a wrong policy, is £5,697. All the loss, and something additional, he has clearly shown to have been occasioned by his blundering management. The insinuation that he acquired this same policy from me is as base as it is unfounded. Fortunately, these matters have not been done in Croydon in the dark, and I say that Dr. Carpenter owes his position on the Farm Committee to the strenuous opposition I made to the ruinous policy of the Farm Committee's managing both the Norwood and Beddington Farms of the Croydon Local Board. The figures relating to tho Norwood Farm will show that I had just cause for complaint with the management, and that, by pursuing a rational system of sewage policy, the losses on sewage farming may, to a great extent, be avoided.

Norwood Sewage Farm.—Balance of Account 25th March in each Year.

	Loss.	Profit.
1867 ..	£172 ..	—
1868 ..	95 ..	—
1869 ..	— ..	£150
1870 ..	36 ..	—
1871 ..	274 ..	—
1872 ..	248 ..	—
1873 ..	654 ..	—
1874 ..	620 ..	—
1875 ..	191 ..	—
1876 ..	— ..	122

By referring to the above figures, which are abstracted from the Local Board accounts, it will be seen that in the year 1869 the Norwood Farm showed a profit, and in 1870 a slight loss—which would have been a profit had not the rent of land then under preparation for sewage been charged to the account. Previous to 1869 Norwood Farm was let to a tenant, and subsequently to 1870 has been managed by a committee. As to whether Dr. Carpenter has pursued my policy in sewage farming, I may be allowed to state that the only year I managed the Beddington Farm was the year 1871, which shows a profit according to his own figures. The two years I had sole management of Norwood Farm—1869 and 1870—were likewise profitable years. After 1874, when I pointed out the ruinous policy pursued by the committee of management, the Norwood Committee began to alter the system of cultivation, and in the following year lost a comparatively small sum compared with previous years; but during the last year, since they have entirely pursued the course recommended by me, and moreover put me on the committee, the loss has disappeared, and a profit results. The gross returns at Norwood on the profitable years are by no means so great as the years when the losses have occurred; the system in the profitable years was different, and tho working expenses were reduced; at the same time the means of purifying the sewage have been increased.

The mismanagement of the sewage farms by their committees does not corroborate Dr. Carpenter's assertion as to the wonderful success I must have achieved under the "guidance" of such a Board, but the boot is on the other leg, as the management of the sewage farms clearly shows.

Let it not be for one moment thought that sewage farms cannot, if properly managed, be made to pay; but it is perfectly impossiblo for them to pay if mis-

managed in the way the farms at Croydon have been; the system of cultivation at Croydon being copied in 1871 and 1872 by the Farming Company from Mr. Hope's farm at Romford, with regard to which, from the recent evidence given by this gentleman in a case between himself and the Romford Local Board, we learn that, in the first 52 months he had the farm in hand, paying £385 rent and £600 a year for sewage, with a farm of 120 acres, he lost £8,975 17s. 3d.

When Dr. Carpenter states that "We have unfortunately discovered in Croydon that Mr. Latham is not a safe guide to follow in sanitary work," it would have been well if he had informed your readers who is meant by "We." Surely it cannot be his colleagues at the Local Board whom, during the past year, he has vilified in the public press, and who proposed a few months ago to pass a vote of censure upon him? Is it likely to be the ratepayers of the district who returned me at the last election but one at the head of the poll, and who, a few weeks ago, returned a gentleman at the head of the poll who had only my single nomination? The fact is, it is generally felt in Croydon that Dr. Carpenter has done the greatest possible injury to the place by his public statements, which are of no value whatever in advancing sanitary science, but are simply inflicted on the public for his own glorification. The personal animosity he has manifested towards myself on all occasions when I have differed from him in his opinion is so well known in Croydon, as to need no explanation at my hands for the personal attack made upon me in your columns.—I am, &c.,

Baldwin Latham,
C.E., M.Inst.C.E., F.G.S., &c.

7, Westminster-chambers, S.W.,
20th June, 1876.

GENERAL NOTES.

Brockelbank's Railway Couplings.—An account is given in *Iron* of a trial recently made at the East Goods Yard, Holloway, by permission of the Great Northern Railway, of these couplings, described in the *Journal* for March 24, page 414. There was a great number assembled to witness the performance, among whom were the Earl of Aberdeen and Earl De la Warr, members of the Railway Accident Commission. The engineers from most of the leading lines were also present. Among the tests to which the coupling was put were the following:—A brake carriage was automatically connected, tightened up, loosed and released, at a standstill, and on the run. A mixed train of high and low, old and new, loaded and empty waggons left at different points on a straight road, was connected automatically in one shunt. Vehicles were disengaged without the necessity of men going between from either side, and shunted into various sidings, and the train again made up with a re-assortment of vehicles. Carriages were coupled and uncoupled on sharp curves. A train of waggons ran on a straight road at various speeds. A runaway train was sent down an incline, and an engine sent after it for its recapture. Two waggons connected by centre buffer coupling with the tightening and unloosing gear attached were also shown.

NOTICES.

SUBSCRIPTIONS.

The Lady-day subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

THE LIBRARY.

The following works have been presented to the Library:—

Journal of the Royal Geographical Society. Vol. 45. 1875. Presented by the Society.

The Classed Catalogue of the Educational Division of the South Kensington Museum.

Résumé of the Rights of Literary and Artistic Property in France.

St. James's Magazine, edited by S. R. Townshend Mayer. Vol. 2.

Transactions of the National Association for the Promotion of Social Science, Brighton Meeting, 1875, edited by C. W. Ryalls.

Idioms of the German Language, by J. H. Lloyd, M.A. Presented by the Author.

Systems of Land Tenure in various Counties, edited by J. W. Probyn.

La France Industrielle, par Paul Poiré. Presented by Edward Stanford.

Voyage en Asie, par Théodore Duret. Presented by the Author.

Street Pavements, by G. J. Crosbie Dawson. Presented by the Author.

A Brief Sketch of the Introduction of Railways into this Country, by G. J. Crosbie Dawson. Presented by the Author.

Science Made Easy: a Series of Familiar Sketches on the Elements of Scientific Knowledge most required in Daily Life, by Thomas Twining. Parts 1, 2, and 3. Presented by the Author.

The Annual Report of the Superintendent of Government Farms (Madras Presidency) for the year ending 31st March, 1875.

New System of Town Drainage, by John Towle, J.P. Presented by the Author.

Sewage Disinfecting and Filtration Process, by F. Hillé.

Sewage Turned to Profitable Account, by Robert Pulling.

The Financial Register and Stock Exchange Manual for 1876. Presented by the Publishers, Messrs. Charles and Edwin Layton.

HEALTH AND SEWAGE OF TOWNS.

The Report of the proceedings at the Conference on the Health and Sewage of Towns, held by the Society on May 9th, 10th, and 11th, has been published, and can be had on application at the Society's House. Price 2s. 6d.

MEETINGS FOR THE ENSUING WEEK.

Mon.....Royal Geographical, University of London, W., 8½ p.m. 1. M. Gessi, "Letter from General Stone (Cairo) on the Circumnavigation of Albert Nyanza." 2. Mr. R. B. Shaw, "The Geography of Eastern Turkistan." 3. Capt. J. S. Hay, "The District of Akem, West Africa."

Tues....Statistical, Somerset House, W.C., 7¾ p.m. Annual Meeting.
Anthropological Institute, 4, St. Martin's-place, W.C. 1. Mr. Hyde Clarke, "The Worship of Siva in Central America." 2. Mr. J. Bell, "The Term Mediterranean." 3. Mr. J. Park Harrison, "Chalk Marks at Cissbury." 4. Dr. Gillispie, "Flint Cores." 5. Mr. Kiehl, "The Javanese."

Wed. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Annual Meeting.
Royal Society of Literature, 4, St. Martin's-place, W.C., 8 p.m. Mr. Walter De Gray Birch, "The Seals of King Henry II., and his Son, the so-called Henry III."
Quekett Club, University College, W.C., 8 p.m. Annual Meeting.

Thurs...Antiquaries, Burlington House, W., 8½ p.m.
Society for the Encouragement of the Fine Arts, 9, Conduit-street, W., 8 p.m. Conversazione.

Fri...... Royal Botanic, Inner Circle, Regent's-park, N.W. 4 p.m. Professor Bentley, "The Organs of Nutrition in Plants." (Lecture VIII.)

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,232. Vol. XXIV.

FRIDAY, JUNE 30, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

NATIONAL AID TO PROGRESS IN SCIENCE.

The success of the Science Loan Exhibition is great, and confers honour on his Grace the Duke of Richmond and Gordon, Lord Sandon, and the subordinate officers. It will doubtless lead to the establishment of a Science Museum rivalling the Conservatoire des Arts et Métiers at Paris. On Monday last an important announcement was made of the aid about to be given to scientific research. In addition to the annual grant of £1,000 now made to the Royal Society, £4,000 are to be voted annually to aid research upon the advice of the Presidents of the following Societies:—The Royal Society of London, the Royal Society of Edinburgh, Royal Irish Academy, Royal Astronomical Society, Mathematical Society, Chemical Society, Linnæan Society, Zoological Society, Geological Society, Physical Society, Institution of Civil Engineers, Institute of Mechanical Engineers, General Council of Medical Education and Registration of the United Kingdom, Royal College of Physicians, Royal College of Surgeons, and British Association. The grants will be made through the Science and Art Department.

Again, in the House of Lords, on the 27th of June, there was a discussion upon establishing a Museum of Science and Art in Dublin, which has long been talked about, and it appears that the present Government are disposed to create such a museum, if the local jealousies do not prevent it. No expenditure of national funds promises such profitable results as judicious investments in promoting Science and Art.

It is suggested that school managers should press upon the Education Department the necessity of allowing boys to practice their fingers in needlework, netting, and the like, and encouraging the teaching of these processes by payments. The eminent surgeon, Sir Benjamin Brodie, said, "If I could have my will, I would have all boys taught needlework. Nothing gives such nicety of touch as that, or prepares so well for any kind of handicraft."

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The Annual General Meeting, for receiving the report from the Council and the Treasurers' Statement of Receipts, Payment, and Expenditure during the past year, and also for the Election of Officers, was held, in accordance with the Bye-laws, on Wednesday last, the 28th of June, at four p.m., Lord Alfred S. Churchill, Chairman of the Council, in the Chair.

The notice convening the meeting having been read, the minutes of the last Annual General Meeting, and of the subsequent Special General Meeting, were read and signed.

The Chairman then nominated Dr. W. A. Fitz-Rayne and Mr. Henry Liggins as scrutineers, and declared the ballot open.

The Educational Officer (Mr. C. Critchett) in the unavoidable absence of the Secretary, read the following—

REPORT.

The Council, in accordance with the Bye-laws, present to the members in General Meeting assembled the following report of their proceedings during the year.

National Training School for Music.

This important Institution, so long and so persistently advocated by the Council, has now become an accomplished fact, and the school, opened in May, by H.R.H. the Duke of Edinburgh, is now in actual work. Dr. Arthur Sullivan is the principal, aided by a board consisting of the following distinguished professors: — Herr Pauer, Dr. Stainer, Signor Vizetti, and M. Carrodus, whilst Sir Michael Costa, Sir Julius Benedict, Sir Geo. Elvey, Professors Ella, Charles Hallé, and John Hullah, are the examiners to test the work of the school. It may not be out of place here, though perhaps at the risk of repeating what has appeared, necessarily in a somewhat disconnected form, in former reports of the Council, to give a short resumé of its history. So long ago as 1865 the Council appointed a Committee to inquire and report on the condition of musical education in this country and abroad; the Committee sought and obtained valuable information from leading musical authorities, and through the agency of the Foreign-office received from the various conservatoires abroad full details as to their constitutions and management. In 1866 the Committee issued their report, appended to which was a full statement of all the evidence and information collected. The Committee expressed their opinion that such an institution should afford gratuitous instruction to persons having great musical gifts, and that the establishment of free scholarships was the best form

in which assistance could be given; such scholarships to be obtained by open competition, and to be held by candidates who thus prove that they are endowed with musical abilities. The Committee were further of opinion at that time, that the Royal Academy of Music, with whom they were in communication, would form a fitting basis on which to establish a National Academy of the foregoing character and worthy of the nation, and that like institutions of a kindred nature abroad should be aided by support from the State. The Council contemplated also, that in the event of a satisfactory arrangement being come to for the establishment of a National School on a suitable basis, whether in connection with the Royal Academy or not, to aid in the foundation of four free scholarships. A considerable amount of negotiation and correspondence took place, but it was not until 1871 it was found that the attempt to carry out the undertaking in connection with the Royal Academy must be given up, and it was determined to start the National Training School for music on a thoroughly independent basis. Whilst the Committee was deliberating as to how best to accomplish this aim and procure a suitable building, Mr. C. J. Freake came forward, and most munificently undertook at his own cost to erect the necessary building, the Commissioners for the Exhibition of 1851, providing a site on land adjoining the Royal Albert Hall. The first stone was publicly laid by H.R.H. the Duke of Edinburgh on the 18th December, 1873. In order to carry out the original idea of free scholarships on which the Institution is based, the Council have been engaged for some time past in bringing the question before the public in various localities throughout the kingdom, with a view to obtaining pecuniary aid in the way of scholarships for the benefit of those residing in the localities founding such scholarships, and they have also sought and obtained from individuals promises of a like support. Her Majesty the Queen, His Royal Highness the Prince of Wales, and the Duke and Duchess of Edinburgh have undertaken to establish scholarships, and various private individuals and towns have given their support in a like manner. The Council are happy to report that the school which has just been opened starts with 67 students out of 100 scholarships promised. The Society undertakes to provide four scholarships, and amongst its members two further scholarships have been set on foot. In February last, a competition for these scholarships, as well as for five established by Mrs. Freake, and one by Mr. Frank Morrison, was held. 106 candidates competed and the examination was conducted on the part of the Society by Messrs. Otto Goldschmidt, J. Hullah, and W. G. Cusins. The city of London and several of the city companies have established scholarships, and competitions have been lately held for these scholarships, and the candidates selected; the same course has been already pursued in with localities in the country, and further competitions will shortly take place. Those already selected have commenced their career at the school, and it is hoped that very shortly selected candidates will be found for all the scholarships established. The Council are assured by the Examiners as well as the Professors at the school, that an amount of musical talent has been thus obtained far exceeding any expectations that had been previously formed. The Council trust that the members will come forward and aid the object by assisting in the formation of further free scholarships. If individuals will guarantee the payment of one, two, or three pounds a-year each for five years, and thus form a joint scholarship of £40 a year, they can aid very materially the success of this great experiment. At the end of the five years, it is confidently hoped that the success of the undertaking will be so far assured, that it will be found worthy of national support and taken up as a national establishment. The Council hope to be able to devise a scheme by which the several Institutions in Union may work in connection with the National Training School.

School Drill.

The importance of military drill in schools, a subject in which it will be remembered the Society has long taken a deep interest, has not been lost sight of. The reviews of school drill held with so much success a few years since, in the presence of H.R.H. the Prince of Wales, the Society's president, will be in the recollection of all, and the members will learn with interest that the example set by the Society is about to be taken up on a large scale by the School Board for London, and in the course of the session a public review of the schools under that body will be held in the metropolis. The Society, to encourage emulation and stimulate the movement, have had prepared a handsomely worked and embroidered banner, to be held as a challenge prize by that school which acquits itself best on these occasions. In specifying military drill, the Council is convinced of the value of military drill for those engaged, or hereafter to be engaged, in industrial and handicraft pursuits which cannot be too highly estimated. The habits of obedience, precision, and united action thus gained in youth bear abundant fruit in after life. The Council have had before them the opinions of some of the leading engineers and others engaged in industrial work, who bear their testimony to the great value of military drill in youth. Some go even so far as to say that the labour of well-drilled mechanics may be taken in the proportion of two against three undrilled. It is in the interest of Arts, Manufactures, and Commerce, that the Society places so high a value on the introduction of military drill in schools.

Health and Sewage of Towns.

This subject is at the present time attracting so much consideration, and is of so highly important a character, that the Council have deemed it expedient, in view of eliciting and promulgating useful information in relation to it, to call together Conferences, at which representatives from the principal cities, towns, and other localities might meet and discuss with each other their several experiences and needs. The first of such Conferences has lately been held under the Presidency of the Right Hon. James Stansfeld, M.P., and with a success which well justifies the Council in having convened it, and gives good augury for the utility of

those which are to follow in subsequent years. A full report of the proceedings and the information collected, together with a summary of the results as gathered by the Executive Committee, has already appeared in the Society's *Journal*. The whole of the proceedings have, however, been separately published in a complete form.

Wednesday Evening Meetings.

There have been twenty-four evenings during the past session at which papers on a variety of subjects connected with the progress of Arts, Manufactures, and Commerce, have been read and discussed. The meetings have been well attended, and the interest in their proceedings has been sucessfully maintained.

Indian Section.

This Section has had before it papers of a highly interesting character, and the discussions have in several instances led to adjournments. The reading of Mr. Magniac's paper on the "Suez Canal," and the discussion which ensued, extended over three evenings, and the like was the case with Mr. Seyd's paper and the discussion on the "Silver Question." "The Land Resources of India," by General Marriott; Mr. Thornton's paper on "Irrigation Works;" Captain Douglas Galton's paper on "Sanitary Progress;" and Dr. Birdwood's paper on "Competition and Effects on Education," drew together goodly audiences, and were full of interest. It is apparent that Indian questions are becoming more and more popular, and that the public interest in this vast dominion of the Crown is daily increasing. The visit of the Society's President, H.R.H. the Prince of Wales, is on all hands admitted to have created a deep desire for increased information and knowledge connected with India, and the Council trust that the proceedings of this Section will tend to assist in their extension.

African Section.

The meetings of the African Section this year have been marked by a series of interesting and important communications. At the opening of the Section Vice-Admiral Ommanney—to whom the thanks of the Society are especially due for the enduring interest which he has taken in the proceedings of the Section as its permanent Chairman—gave a brief but comprehensive summary of the recent advances that have been made towards a more competent knowledge of the interior state of the great African Continent. The early history of the Dutch Republics of South Africa was explained by Dr. Mann in reference to the pending consideration of the social conditions of the district, and of the practicability of establishing some more methodical system of cohesion and co-operation amongst the civilised settlements than now attains. An excellent description of the growth of ostrich farming, and of the production of ostrich feathers from the domesticated and artificially fed bird, was then given by Mr. Simmonds. A graphic and somewhat brilliant account of the Great African Diamond Fields was contributed by Mr. J. B. Currey, who had for some time acted as secretary of the Government of the diamond yielding province of Griqua Land West, and who was, therefore, intimately acquainted with the various social and physical peculiarities of the place. Mr. J. B. Glanville gave an eloquent address upon the industrial enterprise of South Africa; he dwelt especially upon the employment by the Kaffirs of the plough, the acquisition and feeding of woolled sheep, the adoption of civilised habits of clothing, and the construction of square houses with windows and doors by these races. The Section was further indebted to Mr. R. B. N. Walker for an altogether exhaustive statement of the condition and prospects of the province of Gaboon.

In the last communication of this Section, Mr. Edward Hutchinson gave a very clear and interesting account of the general state of the district of Africa lying to the east of Zanzibar, and in the broad track of territory which intervenes between Lake Nyassa and the Victoria Nyanza, and which is most immediately concerned with commercial and social improvements in Zanzibar. Mr. Hutchinson contended—with a very exact knowledge of circumstances, and with cogent reasons drawn from them—that the Zambesi and Zanzibar, and not the Nile and Egypt, are the natural inlets of civilisation and prosperity for this part of Africa.

Chemical Section.

The Chemical Section has in no way fallen off in interest during this session, and the meetings have been well attended.

The past year has not witnessed any very remarkable triumphs of technical chemistry, the tendency being rather towards the more complete development of already introduced processes, many of which have been more widely adopted.

During the session six meetings of the Chemical Section have been held, at which papers have been read from subjects connected with the application of chemistry to industrial art. These papers have been followed by discussions, which it is hoped will be of service in spreading information.

Mr. Sparke Evans, of Bristol, brought forward the subject of "Leather Tanning." In the course of the discussion upon this paper, a matter not connected directly with the application of chemistry, but of great importance, was referred to; this is the cruel and wasteful practice which is in vogue in South America, of so branding or burning the cattle that the impression of the brand is found to completely penetrate the hide even in its thickest part. Mr. Evans estimates the annual loss from this source alone, on account of the deterioration of the leather, at £300,000.

Mr. J. A. Phillips's paper upon recent "Metallurgical Processes," was an account of the methods which have been introduced by M. Claudet for the extraction of the precious metals from the burnt pyrites of the sulphuric acid manufacture. This process may be regarded as typical of many of the chemical improvements of recent date. A waste product occurring annually to the extent of about 365,000 tons, previously of little or no value, has become of some considerable importance, on account of the present possibility of extracting from it the small amount of gold and silver which it contains.

An evening was occupied by Mr. Robert Warington, in giving an account of the tartaric and citric acid manufacture. This industry, though

small, is steadily increasing; the processes employed are very simple, and appear to have undergone little alteration since their first introduction.

The experimental researches of Messrs. O'Sulivan and Valentin, upon the constitution of malt, detailed in Mr. Valentin's paper on dextrine-maltose, have established the existence of a new sugar which has been named maltose. The fact that this sugar is the active fermenting principal of malt, and the possibility of producing it artificially, have led these gentlemen to a series of investigations, the result of which Mr. Valentin brought before this Section in an elaborate paper. The process which it is proposed to adopt, in order to prepare this artificial material which is intended to be used as a substitute for malt in brewing, is to boil together for a short time, rice meal, and dilute sulphuric acid. When a chemical change takes place, the starch of the rice being partially converted into the substance maltose, the product is then evaporated, at first in an open, and, afterwards, in a vacuum pan, to a viscid consistency, and afterwards cast in moulds, into blocks and slabs; in this state it is intended to send the material into the market.

The large field covered by the processes concerned in the manufacture of coal gas offers great inducements to those who turn their attention to this subject. Although considerable improvements have been made and adopted, there is still great room for advance in the mode of production, purification, and estimation of illuminating power and purity. Mr. Vernon Harcourt, one of the metropolitan gas referees, is already associated with one or two schemes for the better carrying out of some of these matters, and in the paper with which he favoured this Section, he gave an account of some of them. His attention has been specially directed to the purification of gas from bi-sulphide of carbon, which at present finds its way into the purified gas, and the estimation of its illuminating power.

The last paper read before the Chemical Section was by Mr. Morrison, upon a new process for the preparation of salt-cake, known by the name of its inventors, Messrs. Hargreaves and Robinson. Should this process become a success, which seems probable at the present time, it will in many respects revolutionise the alkali manufacture, by abolishing entirely the present costly and bulky process for the manufacture of sulphuric acid. This process proposes to treat common salt directly with sulphurous acid gas and steam in iron cylinders, and in this manner to obtain salt-cake, the first step towards the preparation of soda ash, and carbonate of soda. Plant has been laid down on a large scale for carrying it out in one or two places, and the result of these manufacturing experiments will be awaited with interest.

Food Committee.

This Committee has had before it a variety of methods proposed for the preservation of meat, but none of them have been of a character which would justify the Committee in recommending their adoption. It is true that in most instances the meat was no doubt preserved in a sound and sweet condition, but in every case the quality of the meat was so changed, either in appearance or flavour, that it would not be likely to find favour with the consumer. They however had before them some meat, forming part of a cargo of fifty tons, sent over from New York, packed in canvas, and as the Committee were informed, hung up in store rooms on board the ship, and kept cool by a current of air passing over ice, and driven through the rooms by a fan. This meat, a specimen of which the Secretary purchased of the consignee in the Central Meat Market was pronounced to be not only of excellent quality, but in perfect condition as regards soundness and flavour. Several cargoes it is understood have been sent in this way to Liverpool, and thence to London, all in an equally good condition. These importations, however, took place in the spring, and the question arises how far it is possible to continue this proceeding satisfactorily during the hot weather. At all events, the experiment has up to the present time been successful.

Mr. Mort, to whose proceedings and experiments in a like direction the Council adverted in their former report, is, with the assistance of a number of public-spirited gentlemen in Australia, raising funds to send over 500 tons from those colonies, in the full confidence that he can accomplish the object in view, and at a price which will render the adventure a commercial success. Monsieur Tellier, in Paris, who has long devoted himself to the solution of this problem, has fitted out a ship, the *Frigorifique*, which is to make the voyage out to the coast of South America laden with meat and vegetables as an experiment, and with the intention of bringing back a similar cargo.

Last year the Committee had before them specimens of pilchards preserved in oil, after the manner of the French sardine; but, although the Committee were then most favourably impressed with the undertaking, they did not consider it sufficiently advanced to warrant them in recommending the Society's medal in respect of it. A year's further trial has shown that the process can be carried out successfully. and after testing further specimens and learning that the trade is actually established on a commercial footing, have recommended the Council to award to Mr. C. G. Fryer the Society's medal for his valuable exertions in establishing a new industry in this country. This fish, which is taken so abundantly on the coast of Cornwall as frequently to be used as manure, is, by the process of preservation adopted by Mr. Fryer, made available as an additional source of food supply to the country.

Cantor Lectures.

This session the Council thought it right that some portion of the series should be devoted to subjects in connection with the Society's Technological Examinations, and two courses were arranged specially with this object, viz.:—On "Iron and Steel Manufacture," by Mr. W. Mattieu Williams, and on "Wool Dyeing," by George Jarmain, Esq.

The other course was by Dr. Thudichum, on "The Labours and Researches of Justus von Liebig," to whom a few years since the Society awarded the Albert Medal.

The lectures for the coming year have been arranged as follows:—

The first will consist of five lectures on "Coach Building," by Mr. Thrupp.

The second course will consist of six lectures on the "Chemistry of Gas Making," by Mr. A. Vernon Harcourt.

Both these courses, though adapted to a general audience, also have especial value for those interested in the Society's Technological Examinations.

The third course will consist of six lectures by Mr. Sidney Colvin, Slade Professor in the University of Cambridge, and will deal with the connection of Greek and Roman Art with the teaching of the Classics, and the Council will endeavour to obtain models of ancient buildings and diagrams to illustrate the lectures.

Unhealthy Trades.

The subject of unhealthy trades has at various times of the Society's career been brought under its consideration, and aided by a donation from Mr. Benjamin Shaw, the Council engaged the services of Dr. Richardson to enter on an investigation of this character, and to deliver a course of lectures, by way of reports, on his researches. These lectures have been delivered, and they form a very valuable contribution to the knowledge of this important subject.

Memorial Tablets.

During the year seven tablets have been erected, viz. :—

Samuel Johnson—17, Gough-square, Fleet-street.
Edmund Burke—37, Gerrard-street, Soho.
George Canning—37, Conduit-street.
Michael Faraday—2, Blandford-street, Portman-square.
David Garrick—5, Adelphi-terrace.
Horatio Nelson—147, New Bond-street.
Mrs. Siddons—27, Upper Baker-street.

The following is a list of tablets previously erected :—

John Dryden—43, Gerrard-street, Soho.
John Flaxman—7, Buckingham-street, Fitzroy-square.
George Handel—25, Brook-street.
Benjamin Franklin—7, Craven-street.
Sir Joshua Reynolds—47, Leicester-square.
Lord Byron—16, Holles-street, Cavendish-square.
Napoleon III.—3a, King-street, St. James.

Leave has been obtained for six more tablets, which will be put up as soon as they are received from the maker.

Medals.

The Albert Medal for "distinguished merit in promoting Arts, Manufactures, and Commerce," has this year been unanimously awarded to Sir George B. Airy, K.C.B., the Astronomer Royal, for "Eminent Services rendered to Commerce by his Researches in Nautical Astronomy, and in Magnetism, and by his Improvements in the Application of the Mariner's Compass to the Navigation of Iron Ships."

A prize of a Gold Medal was offered by this Society for the best "Revolution Indicator," which should accurately inform the officer on deck, and the engineer in charge of the engine, what are the number of revolutions of the paddles or screw per minute without the necessity of counting them. The following were the conditions :—1. Simple in construction. 2. Not easily disarranged, and easily refitted in case of accident. 3. Accuracy not depending upon the heel or steadiness of the ship. 4. To indicate to the officer on deck in charge of the ship, and to the engineer in the engine-room, the revolutions per minute at all times, by night and day, immediately by simple inspection, without the necessity of counting, or the use of a watch. 5. It is desirable that the error should not exceed 2 per cent. 6. Moderate in first cost and expense of fitting. Cost to be stated. There were 86 competitors, and a selected number of them having been practically tested by the Committee on board H.M. gunboat *Arrow*, kindly lent to the Society for the purpose by the Lords of the Admiralty, Mr. Hearson's was chosen as that which best fulfilled all the conditions laid down in the offer, and the Gold Medal has therefore been awarded to that gentleman.

On the recommendation of the Food Committee, the Council have awarded the Society's Medal to Mr. C. E. Fryer, for the establishment in this country of a new industry, whereby the pilchard, so abundantly taken off the coast of Cornwall, is preserved in oil, after the manner of the French sardine, which is now admitted by our best naturalists to be identical with the pilchard. Both the small and the larger pilchards are thus treated, and have been pronounced by the Food Committee as quite equal to the French sardines.

For Papers read before the Society Medals have been awarded as follows :—

To Clements Markham, C.B., for his paper "On the Cultivation of Caoutchouc-yielding Trees."
To W. T. Thornton, Esq., for his paper "On Irrigation Works in India."
To E. Hutchinson, Esq., for his paper "On the Development of Central Africa."
To W. Valentin, Esq., for his paper "On Dextrine-Maltose, and its use in Brewing."

Valuable papers were also read by Mr. Bramwell and Captain Douglas Galton, but these gentlemen, being members of the Council, are ineligible to receive medals.

The Council passed a special vote of thanks to Mr. H. T. Wood, the Assistant Secretary, for his valuable paper on "Trade Marks," which led to the appointment of a committee, who entered carefully into the subject, and communicated their conclusions to the Lord Chancellor during the progress of the "Trade Marks Bill" in the House of Lords.

Honorary Life Members.

The Council, acting under the provisions of Bye-law 66, empowering them to admit in each year five persons eminent in Arts, Manufactures, and Commerce, or in the application of abstract science thereto, as Honorary Life Members of the Society, have this year placed the following distinguished men upon its list of Members :—

Dr. C. H. D. Buys Ballot.—For his meteorological researches.
Lieut. V. Lovett Cameron, C.B.—For his energy in exploring and laying open to commerce districts of Equatorial Africa hitherto absolutely unknown.
Cyrus Field.—For his valuable services in connection with the promotion of electric communication between England and America.
Professor Joseph Henry.—For his researches in light, heat, electricity, and magnetism, applied to the telegraph and lighthouses.
General Morin.—For his researches in relation to the principles in warming and ventilation.

Union of Institutions and Examinations.

The Examinations this year, with the exception of the Technological, have been conducted in accordance with the changes determined upon at the commencement of last year, and with a success which fully justifies the changes. Looking at what the Government and other bodies are doing, it was felt that the Society would no longer be justified in maintaining a system of Examinations which, however important at the time of their establishment (some twenty years ago), are no longer needed. The Council determined so to mould their system as to cover ground which at present is unoccupied, and with this view set on foot the Commercial Examinations, suited especially for clerks and others engaged in commercial pursuits. The subjects comprised in these examinations are—Arithmetic, English (composition and correspondence, extra marks being given for précis writing), Book-keeping, Commercial Geography and History, Shorthand, Political Economy, French, German, Italian, and Spanish. It is, however, made a condition that no certificate is issued unless a candidate passes in three of the foregoing subjects at least, and that of these English and arithmetic are indispensable..

The Council also established examinations in Domestic Economy, under which title are comprehended—(1.) Clothing and its Materials; (2.) Health; (3.) Housekeeping and Thrift; (4.) Cookery. This subject is now encouraged by the Education Department for girls. A practical knowledge of almost all the subjects is equally useful to boys. The Council are considering how the teaching may be promoted among adults in institutions of all kinds. Four free teacherships of cookery have been founded by the Council at the National Training School for Cookery.

A further subject of examination was added, viz.—Fine Arts applied to Industries.

This examination is intended to apply to subjects which are not at present included in the general Art Examinations of the Science and Art Department, and especially to test a literary knowledge of the decorative arts.

The examination papers comprise subjects adapted to two classes of certificates. Candidates must possess the power of illustrating the answers by diagrams drawn from memory, and show a knowledge of styles of all nations.

The subjects of examination have reference to Fine Art applied to some useful objects, such as furniture, dress, utensils, &c., or to well known public buildings, museums, &c.

The details and results of these several examinations will be found in the Educational Officer's report laid before the Conference of the Institutions held on Friday, the 23rd of June, and published in last week's *Journal*. The Conference this year was held under the chairmanship of Sir Henry Cole, and had reference especially to the means of advancing adult education. Valuable papers illustrative of the present condition of this subject in connection with Government and the Universities were read and discussed. A full report of the proceedings at the Conference is published in the present *Journal*.

Patent Laws.

The Government have this year reintroduced the Bill relating to Letters Patent for Inventions, which was dropped last session. The present Bill, though somewhat modified from that of last year, embodies practically the same provisions, and the Council have considered it their duty to present a Petition to the House of Commons of the same character as that of last year, pointing out such parts as they deem objectionable. The Petition has been printed in the *Journal* (p. 654.)

Soane Museum.

Under the provisions of the Act of Parliament, 3 William IV., c. 4, intituled "An Act for Settling and Preserving Sir *John Soane's* Museum, Library, and Works of Art in *Lincoln's Inn Fields*, in the County of *Middlesex*, for the Benefit of the Public, and for Establishing a sufficient Endowment for the due maintenance of the same," the Society has the privilege of appointing a Trustee of that Museum, and last year Mr. Samuel Redgrave was appointed to that office at the Annual General Meeting. During the year Mr. Redgrave has died, and it becomes the duty of the meeting to elect another trustee in his stead. The Council have placed on the balloting list the name of Mr. Alan S. Cole to fill the vacancy.

Finance.

On this head the Council refer with confidence to the balance-sheet, appended hereto, and published in last week's *Journal*, as showing the continued prosperous advance of the Society. There is no special feature which needs reference or explanation. The number of members on the books at the present time shows a considerable increase upon that at the corresponding period last year. The Council, however, cannot leave this subject without some notice of the loss they and the Society sustained at the commencement of the year by the death of their old esteemed officer, Mr. S. T. Davenport, who so long was chief of this important department of the Society's work. A record has already appeared in the Society's *Journal* of his services and his worth, but the Council feel that they should ill-discharge their duty if they allowed the present annual meeting of the members to pass over without expressing their hearty recognition of the valuable aid he was ever ready to give to the Society, and their high estimation of his earnestness and integrity. His successor, Mr. H. H. Room, has long been in the service of the Society, and the Council have had much pleasure in appointing him to the post.

Mr. B. F. Cobb moved, and Mr. T. Hilton seconded, the adoption of the report.

Mr. Hale commented upon the names put forward in the balloting list for the ensuing year, and expressed his general satisfaction at the selection; and referred to the visit of His Royal Highness the President to India. He was glad to observe that the financial position of the Society was so flourishing, but suggested that several matters to which he had previously drawn attention should be dealt with by the Council for the better accommodation of the members. He advocated the preparation of a printed catalogue of the library, increased accommodation in the reading-room and lavatory, and questioned the policy of not stitching the *Journal*. He thought some of the funded property of the Society might well be

expended on these objects. He also thought the papers read might occasionally be of a political nature.

Mr. Hilton begged leave to remind Mr. Hale that the bulk of the Society's funded property was trust money. He thought that members should bear in mind that the Society's object was not their amusement or even their convenience, but the promotion of Arts, Manufactures, and Commerce, and that the income should mainly be expended in the furtherance of this object; failing which, the work of the Society would be unsatisfactory.

Mr. David Chadwick, M.P., considered that members received a very adequate return for their subscriptions, and he had much pleasure in expressing his opinion, as an old member of the Society, that though the Society had met with a severe loss through the death of their able officer, Mr. Davenport, the members must congratulate the Council for having certainly kept up the prestige of the Society during the past session, and having done much good and important work.

The Chairman, in putting the vote for the adoption of the report to the meeting, wished to remark that it was most undesirable to introduce political topics into the Society's discussions. As to the question of stitching the Society's *Journal*, it was one of serious cost in postage, and he would certainly prefer to see the *Journal* in its present increasing importance in value, through so much instructive matter appearing in its columns, than to curtail its usefulness so as to bring it within the lowest limit of the book-post rate. As regarded the library it was more a library of reference than for general literature, hence the Council did not deem it expedient to issue a printed catalogue. He, however, assured Mr. Hale that his suggestions should be duly considered.

The vote was then put to the meeting, and unanimously carried.

Mr. Hilton wished to inquire upon what basis the asset of subscriptions in arrear was calculated?

Mr. Seymour Teulon explained that the arrears of two or three years were included as possible assets, and a deduction made to bring the amount to such a sum as might fairly be expected to be realised.

The meeting then proceeded to ballot for the election of the candidates for membership, and they were duly elected members of the Society:—

Adye, Major-General Sir John Miller, R.A., K.C.B., Royal Military Academy, Woolwich, S.E.
Batten, William, C.E., 150, Lozells-road, Handsworth, near Birmingham.
Brittain, Frederick, St. George's Works, Sheffield.
Carpenter, Alfred, M.D., Croydon.
Cresswell, Charles Neve, 1, Hare-court, Temple, E.C.
Dawbarn, William, Elmswood-hall, Aigburth, Liverpool.
Dunn, Andrew, Millbrooke-villa, Guildford-road, S.W.
Field, Rogers, 5, Cannon-row, Westminster, S.W.
FitzGerald, John F. Vesey, 131, St. George's-road, S.W.
Flower, Captain Lamorock, Lee Conservancy Board, 199, Gresham-house, Old Broad-street, E.C.
Gill, George, M.R.C.S. Lond., 21, Abercromby-square, Liverpool.
Gregson, S. Leigh, Aigburth-road, Liverpool.
Grey, Albert, St. James's-palace, S.W.
Hawes, James C., Derby-house, Mallinson-road, Wandsworth-common, S.W.
Heckler, Rev. Professor W. H., Temple Club, W.C.
Hibberd, James Shirley, Bridge-house, Stoke Newington, N.
Hicks, George Matthew, 51, Rutland-gate, S.W.
Hill, Alsager Hay, 15, Russell-street, Covent-garden, W.C.
Holden, James, 64, Cross-street, Manchester.
Jones, Lieut.-Col. Alfred Stowell, V.C., A. Inst. C.E., Hafod-y-Wern Farm, Wrexham.
Kennedy, Lady Gilbert, 76, Eaton-square, S.W.
Kittoe, Rev. Edward Hooper, Boldmere Vicarage, Birmingham.
Leveaux, Edward H., 5, Westminster-chambers, S.W.
Lewis, John, 3, Elgin-road, Maida-vale, W.
Love, John Henry, M.R.C.S., L.S.A., 43, Queen-street, Wolverhampton.
Lyon, John Andrew, St. Mary-le-Strand-house, Old Kent-road, S.E.
Maclean, Andrew Hislop, 13, Grosvenor-terrace, Glasgow.
Merino, Lorenzo, Wool Exchange-buildings, Coleman-street, E.C.
Midwood, George Harrison, 55, Faulkner-street, Manchester.
Morrison, Alfred, 13, Carlton-house-terrace, S.W.
Morrison, Frank, 8, Cromwell-houses, South Kensington, S.W.
Morrison, Mrs. Frank, 8, Cromwell-houses, South Kensington, S.W.
Mothersill, Robert, 3, Redcliffe-villas, Surbiton, Surrey.
Naismith, John, 87, St. Vincent-street, and 2, Belgrave-terrace, Glasgow.
Nixon, Brinsley De Courcey, Athenæum Club, S.W.
Oliver, Russell, 107, Queen Victoria-street, E.C.
Ottley, Rev. T. A., B.A., St. John's, Portland, Dorset.
Peirce, John Sampson, 21, John-street, Adelphi, W.C.
Pinches, John, 27, Oxenden-street, W.
Pullar, Robert, Perth.
Randolph, Charles, 14, Park-terrace, Glasgow.
Saville-Kent, William, Royal Aquarium, Westminster, S.W.
Scott, Adam, 14, Cloudesley-street, N.
Simons, William, Gwainvarren, near Merthyr Tydfil.
Spalding, Samuel, 147, Drury-lane, W.C.
Sutton, John Maule, M.D., M.R.C.P. Lond., 244, Great Clowes-street, Higher Broughton, Manchester.
Swann, Captain John Sackville, F.G.S., F.S.A. (Mayor of Honiton), Holyshute, Honiton.
Taylor, John Stopford, M.D., 1, Springfield, Liverpool.
Viley, Frederick Thomas, Chelmsford, Essex.
Waller, Thomas, 47, Fish-street-hill, E.C.
Westgarth, William, 28, Cornhill, E.C.
Whewell, Louis, Midland Goods Station, St. Pancras, N.W.
Wright, James Baird, 3, Great St. Helen's, E.C., and 23, Camden-square, N.W.
Wright, William, 3, Great St. Helen's, E.C., and 434, Camden-road, N.W.

The ballot having remained open one hour, and the scrutineers having reported, the Chairman declared that the following had been elected to fill the several offices. The names in *Italics* are those of members who have not, during the past year, filled the offices to which they have been elected:—

PRESIDENT.

H.R.H. the Prince of Wales, K.G.

VICE-PRESIDENTS.

H.R.H. the Duke of Edinburgh, K.G.
F. A. Abel, F.R.S.
The Lord Aberdare.
Sir George Campbell, M.P., K.C.S.I.
A. Cassels.
Lord Alfred Churchill.
Hyde Clarke.
Sir Henry Cole, K.C.B.
Major Donnelly, R.E.
Major-General F. Eardley-Wilmot, R.A., F.R.S.
C. J. Freake.
Captain Douglas Galton, R.E., C.B., F.R.S.
The Earl Granville.
The Right Hon. Lord Hampton, F.R.S.
Wm. Hawes, F.G.S.
Sir John Lubbock, Bart., M.P.
Vice-Admiral Erasmus Ommanney, C.B., F.R.S.
Adml. the Right Hon. Lord Clarence Paget, K.C.B.
E. Carleton Tufnell.
The Duke of Westminster.

ORDINARY MEMBERS OF COUNCIL.

J. Lowthian Bell, F.R.S., M.P.	Hon. Dudley Fortescue.
F. J. Bramwell, F.R.S.	*Col. Lane Fox, F.R.S.*
J. Brunlees.	Peter Graham.
Major-General Fred. C. Cotton.	James Heywood, F.R.S.
Col. du Cane, R.E., C.B.	Edwin Lawrence.
	Sir C. Nicholson, Bart.
	T. R. Tufnell

TREASURERS.

Ed. Brooke. | H. Reader Lack.

SECRETARY.

P. Le Neve Foster.

SOANE TRUSTEE.

Alan S. Cole.

The Chairman then proposed a vote of thanks to the scrutineers, which was carried.

Mr. David Chadwick, M.P., proposed a vote of thanks to Lord Alfred Churchill for presiding, and for his able services to the Society.

Mr. Liggins had much pleasure in seconding the motion.

Mr. Teulon wished to remark that few of the members were aware of the very energetic manner in which the Chairman had devoted his time to the interests of the Society. He (the Chairman) had within the last few days been present at the opening of the Brussels Exhibition, where he had ably represented the Society of Arts, and he had hastened his return in order to preside at this meeting.

Sir Henry Cole, K.C.B., said he was glad to find that the members felt that they obtained their money's worth for their subscriptions. The objects of this Society were broad, and clear of prejudices, and it gave a fair hearing to any one who had anything to say worth saying. He saw a gentleman in the room who, as an eminent mechanical engineer, wished to ventilate a subject with which he was conversant, and he appeared to prefer bringing it before an audience here to one elsewhere. He considered that the Society of Arts, especially during the last twenty-five years, had done much valuable work, and he had much pleasure in putting to the meeting the vote of thanks to the Chairman.

The vote was unanimously carried.

The Chairman, in responding, thought that the success of the Society was mainly due to the Council and the officers, and he proposed a vote of thanks to Mr. Le Neve Foster and the other officers of the Society for the energy they had displayed in carrying out the Society's work.

The vote was carried, and responded to by Mr. Critchett.

ANNUAL EDUCATIONAL CONFERENCE.

This Conference, which, with the view of giving special interest to it this year, the Council decided should deal with the subject of Adult Education, was held on Friday, 23rd June, at 11 a.m. Sir Henry Cole, K.C.B., presided.

The discussion was taken under the following heads:—

1. Adult education as now conducted in literary and mechanics' institutes, workmen's colleges, clubs, &c., night classes, public elementary schools, &c.
2. Aid to adult education given by the Education Department.
3. Aid to adult education given by the Science and Art Department.
4. Aid given by the Universities of Oxford, Cambridge, London, &c., in examinations, lectures, and otherwise.
5. Aid obtainable from the surplus of the Exhibition of 1851, held by the Commissioners.
6. Subjects which it is especially desirable to promote in adult education, such as laws of health and cleanliness, household economy, food, music, &c.
7. Annual report on the Union of Institutions, and suggestions for improving the Examinations of the Society of Arts.

Several papers referring to these subjects were laid before the Conference, and appeared in last week's *Journal.*

In opening the proceedings:—

The Chairman said it would be convenient to adhere as closely as possible to the programme laid down, though it would be seen that the different divisions of the subject necessarily, more or less, overlapped each other. It was very difficult, for instance, to define exactly what was adult education. According to the definition of the Education Department, adult education began at 13 years of age, and elementary education was supposed to go on until 21 years of age. In the Science and Art Department, however, no limitation of age was fixed. He had seen old gentlemen of 60 and 70 taking advantage of the Science Schools, as well as of the Art Drawing Schools. However, the first subject for discussion was Adult Education, and he would, after reading a short paper upon some general points, invite a general discussion:—

ADULT EDUCATION.

By Sir Henry Cole, K.C.B.

1. Great changes have taken place in promoting the education of adults since the Marquis of Lansdowne, a Lord President of the Council, presided in 1852 in this room, over the first Conference of the Union of Institutes with the Society of Arts. These changes have induced the Council to enlarge the basis of the Conference on this occasion, which is not limited as formerly to merely discuss the views of representatives of institutions.

2. The adoption of public elementary education as a national duty by Mr. Forster's great Act in 1870, and the annual issue of the Education Codes; the extensive working of the Department of Science and Art since 1853; the examinations so liberally instituted by both Universities and thrown open to the whole country; the recent institution of admirable lectures by the University of Cambridge offered to adults in every local centre; the formation of workmen's colleges and clubs, free libraries and similar aids to education have all powerfully aided "in the cultivation of Literature, Science and Art, and the Fine Arts, and in the diffusion of useful knowledge;" objects which Harry Chester specified in the first resolution passed to establish that Union of Institutions with the Society of which Union he was the founder.

3. In 1853, I occupied this chair at the second Conference, and the subjects we then met to discuss strike me as comparing rather oddly with those in to-day's programme. We discussed (1) How to obtain Parliamentary papers for nothing. (2) How to get cheaply, books, maps, apparatus, &c. (3) The fiscal restrictions on advertisements, newspapers, and foreign books, as they retarded the progress of reading-rooms. (4) How to get lectures. (5) How to organise class instruction. (6) Statistics; and (7) and lastly, the legal posi-

tion of institutions. The changes I have glanced at have enlarged and even altered the field for examination by this Conference.

4. I must call your attention to another contrast between 1852 and 1876, showing how Parliament has responded to the popular demand for Education, Science, and Art, and how great the growth of this demand has been. In 1852, the annual vote for public education in England was only £160,000. For the present year it is £1,707,055. In 1853, the votes for Science and Art (including Jermyn-street) were £44,476, now they are £297,673. In 1852, the total vote for Education, Science, and Art, in the United Kingdom, was £470,762, now it is £3,278,039.

5. This last statement of facts may help us to consider Adult Education as at present conducted in all kinds of institutions, Literary and Mechanics' Institutes, Workmen's Clubs, Working Men's Colleges, Free Libraries, Night Classes under the Education Department for adults not exceeding 21 years of age, and Schools and Night Classes for Science and Art under the Science and Art Department open to all ages. I have tried to make out the numbers of these several institutions now in action, but the materials cannot be collected with accuracy. The work of getting these statistics for Adult Education and Secondary Education would appear to come especially within the province of the Science and Art Department. They would be very useful. That department already has schools and classes at work in all parts of the United Kingdom, numbering about 2,000. I put down the number of Mechanics' and Literary Institutions at between 600 and 700. Great results must follow from the scheme of University lectures established and to be established. I find in the *Workmen's Club Journal* an enumeration of some 685 Working Men's Clubs in England, Scotland, and Ireland. Then there are Co-operative Libraries and Reading-rooms as at Rochdale, institutions well worthy the attention of statesmen who watch the forces silently in motion among the best artisans in the kingdom. Free Libraries have increased but slowly, but I venture to infer from what Lord Sandon said last autumn, that we shall soon see a sort of Free Library connected with Board Schools. Excepting at a few schools like Faversham, which Members of Parliament should study, the means of Secondary Education are too much mixed up with Adult Education. It is to be hoped that the attention of Parliament will not continue to be exclusively confined to Primary or Elementary Education, but will call for a Ministry of Public Education to take a comprehensive survey, and superintendence of all direct education, Elementary, Secondary, and Adult.

Having read the above paper,

The Chairman said they were not going to discuss elementary education on the present occasion, but it so happened that the Education Department had night classes for elementary subjects. Mr. Fitch's paper raised the practical question whether the aid which came from the Department was sufficient, and perhaps it would be well to call upon that gentleman first.

Mr. J. G. Fitch said he had not intended to do more than read the paper, and as it had already been printed, he need not detain the Conference by speaking at length. (See last *Journal*, page 763.) It would be observed that the object of the Education Department had always been to secure, if possible, the connection of the evening classes with a regularly organised public elementary school, and to secure also the services of a regularly certified teacher; because it was found quite impossible to carry on these classes with the needful efficiency by means of voluntary teachers who had obtained no certificate of qualification, and who were under no obligation to attend regularly. After referring to the statistics given in his paper, he said the Parliamentary grant for public education was given for a very distinctly defined and limited purpose; it was not applicable to secondary education, nor generally speaking to adults. It was a grant for the elementary education of the children of the poor, and though it went a little beyond that range, he believed its present application to older scholars might be regarded as temporary. No doubt if the time came, as he hoped it would come rapidly, when every child under 13 would receive the rudiments of a sensible useful education, the application of this grant to scholars above that age would cease altogether, unless, of course, Parliament thought it its duty to encourage higher education in evening schools, and to make specific grants for that purpose. But this would be to make a considerable change in the whole scope and intention of the public grant; and he regarded such a change as in the highest degree improbable.

Mr. Ellis A. Davidson was glad to have the opportunity of speaking on this subject under the presidency of Sir Henry Cole, to whom the country owed so much in the matter of education. He himself was one of the earliest pioneers sent out by Mr. Cole in the provinces, and he well remembered how, when he asked what he was to do to make the thing succeed, Mr. Cole told him that was exactly what he had to find out, and report upon his success, so that improvements might be made. It seemed to him that the two first questions on the programme in some degree merged into one. Speaking as a practical teacher of 25 years, the great obstruction he found to adult education was the very poor education, looked at in a practical point of view, which the children received in the elementary schools. The working man who attended a night school wanted to get information which he could apply in the workshop the next morning; but the teacher found he had to detain him over preliminary elements which he ought to have learnt as a boy. Not long ago, when engaged on a little book for Weale's series on painting and graining, he found, having everything done specially under his own eye, that a grainer would bring him a specimen of work, and when asked what it represented, said satin wood, and when told it was not correct, tried pollard oak, and then birch, not having the slightest knowledge of the growth of the different kinds of woods, or the development of the grain or knots. And so it was in all branches of trade. The men picked up their knowledge by rule of thumb, and when they came to the night schools it was almost too late in the day to teach them. Schools could not of course be conducted without money, but he must say most distinctly, that if they wanted to spread this mode of education they must see to it that the education they gave to working men was of the kind calculated to be of use to them. It had been made so in some schools. At this moment he knew men, managers, superintendents, and workmen in some of the largest firms in London who, some years ago, were pupils in the school in a country town to which he had been appointed by the Science and Art Department. What they did in the beginning in the schools ought thus to fructify in the end in the life of the working men. It was not enough to merely teach art as art, and science as science, in mechanics' institutes. They were teaching art and science, and teaching it well and thoroughly, but he was not aware of any mechanics' or literary institutions—except, perhaps, some in Staffordshire—where definite subjects, required by the special industries of the neighbourhood, were taught. The men were taught the abstract sciences upon which, if

they were men of education, they would see that their trades were based; but they were not men of education, and therefore were not able to draw these practical inferences. He knew of no school in which, for instance. a carpenter received instruction in all the specialties of his calling—materials, construction, form, style, tools, and manipulative skill. He was taught the science of building construction, but that was a different thing. This was the practical point which he wished to urge, that they should give to working men the instruction useful to them, if they wanted to make up for past deficiencies. This was done in other countries, and such instruction as was given in France and Germany must be given in this country.

Mr. Frank Curzon (Yorkshire Union of Mechanics' Institutions) said he did not wonder that so little money was required from Government when so little pains seemed to be taken to reach the class for whom the money was required, for there seemed to be no organisation at work to reach the great body of men in this country. From a very large area of personal inquiry he had arrived at what he believed to be the fact that at least one-half of the working men and women could not read, and at least one-fourth could not write, and you could not get these people into the schools unless there were some mode of visiting them at their homes. The next best step would be to form working men's classes, conducted by working men themselves, until they had mastered the first steps of reading and writing, and then it would not be difficult to draft them into the institutions and bring them within the scope of the Government organisation. He knew a district in Yorkshire, thirty miles in extent, without a single night school, and where it was impossible to have one, because it would not pay to conduct one, unless the limit of age was further extended. Last year the concession was made from 18 to 21, but it must be remembered that in education these people were still children; it was not a question of age; they were as much children at 50 or 60 as at 15, and unless Government recognised that fact it could not expect any positive result. The next subject he thought would have to be dealt with more practically than Mr. Fitch supposed. He seemed to be looking forward to a millennium when night schools would not be wanted, when children would be well taught before the age of 13, and that this work would entirely cease. Unfortunately it did cease at 13, and practically they did not get hold of 5 per cent. of the population from the age of 13 to 21, but the difficulty really began at the point where the night school took up the work; and unless the Government did as the Chairman had wisely suggested, and dealt with the question of national education as a whole, from birth to death, primary, secondary, and technical, it would never do any practical work at all. He had tabulated in connection with one of the largest institutions, that at Huddersfield, about 15,000 entries, of 11,000 pupils, and he found that from 13 to 17 or 18 they had no intermediate education whatever. They left the primary school, and at 16 or 17 entered a mechanics' institute, by which time they had forgotten nearly all they had learned; and Government, carrying out a cast-iron theory, said—you passed in a certain standard in 1872, you must pass in the next standard in 1876, although for four years the boy had been inside no school at all. Unless the teachers were rewarded in such a way that they could make their schools pay, and unless there were power in small villages to accept the services, not merely of certified masters, but of good men who had had no opportunity of doing more than help those around them, they could never reach the point which was aimed at. A wider scheme would have to be adopted. They must take care that at 13 the State did not lose hold of the pupils, but they must be carried forward through the night school system, and must proceed step by step until the great gap between Whitehall and South Kensington was filled up much better than at present. In Leeds, although they had 10,000 or 12,000 in the day schools they had not as many hundreds in the night schools; Bradford would show the same; and so would other large centres.

Mr. W. H. Baker (St. Stephen's, Westminster), as the representative of one of the largest night schools in the kingdom, did not think the time referred to in the last part of Mr. Fitch's paper, when evening schools would be superfluous, was likely to arrive for many years; not indeed, until direct compulsion was carried out in all elementary schools. Children left these schools quite unfitted for the technical instruction given under the auspices of the Science and Art Department; but there were a very large number who did not even attend these elementary day schools. Until attendance in primary schools was more regular, they could not present the children for secondary instruction. It was not only technical instruction which was required, but also commercial instruction; but the Education Department gave no aid whatever for book-keeping, French, shorthand, and similar subjects. In his own school they had an average attendance five years ago of 87, and out of 76 presented in arithmetic 67 passed, but in the present year under the new Code there was a great difference. The average attendance was 75 between 13 and 21—it would be increased by about 30 per cent. including those over that age—71 were presented in arithmetic and only 28 passed. That was not the fault of the teachers, for Mr. Matthew Arnold said the school continued to be most vigorously and excellently worked, more than half those presented being in Standard V., and the work being very creditably done. What then was the cause of this falling off in the number of passes in arithmetic? In 1872 the pupils were allowed to be presented in the same standard as the one in which they were presented in the day school, or even in a lower one, but under the present system they must be presented in a higher standard every year. Now this was almost impossible. They attended a minimum number of times, and the lessons being of a short duration owing to the number of subjects, it was impossible to prepare the pupils in the higher rules of arithmetic which the Department required. The consequence was there was a great falling off in the grant, but evening schools could not be worked without some aid from the Education Department, the expenses being even greater in proportion than in day schools. There was extra expenditure for gas, and very often for rent, and yet Government only paid about 60 per cent. as much for the results as for day schools. His experience was that voluntary teachers could not be depended upon; they came when they liked, and of course they stopped away when they liked. In consequence the amount paid for teaching must be larger than in day schools because you could not employ pupil teachers. What then could they ask Government to do to encourage elementary night schools? In the first place they might ask for a larger sum on the average attendance, but then they must give something additional for it. Under the new Code the Department only examined in reading, writing, and arithmetic, but if they increased the grant for average attendance, the same amount as that given to day schools, they might examine in grammar, geography, and history also; or even add such subjects as French and literature. At one time the Department would only allow a maximum of 15s. per head on the average attendance, including the day and night schools, but last year that was suspended, and there was a considerable loss in consequence to the night schools.

Mr. Fitch said, in reply to the remarks of a previous speaker as to the parsimony and insufficiency of the education grant, the Conference would not fail to observe that 7s. 9d. per head upon the scholars in average attendance at night schools was a far larger grant, relatively to the expense of carrying on such schools, than 12s. 7d. per head upon day scholars. Whether it

should be more or less was another question; but it must be remembered that so long as 40 attendances were sufficient to make a claim for a night school, whereas in a day-school 250 were required, the sum granted per head was a very substantial aid indeed. He had been referred to as having spoken of a time when night schools would become superfluous, but he was very far from saying that. He did not look forward to such a result for a long while; and he hoped that, whether Government maintained night schools or not, evening classes which contemplated the prolongation of elementary instruction into higher subjects would, under some name or other, not merely be continued but extended. There would always be need for such agencies. What he had said was, that for the limited purpose of giving instruction in elementary subjects of the same kind as that which children received before the age of 13, it might be reasonably expected that, ere long, the Parliamentary grant and the operation of the Education Department for evening schools would become superfluous and die a natural death.

The Rev. Dr. Irons thought it would be better not to dwell too much on details, over which they might spend several days and gain nothing very practical, but deal rather with the general principles. He had had some little experience in the matter, which had left in his mind certain conclusions which he was quite willing to mention. The first was, that there was a certain class of adults about whom it was almost superfluous to busy themselves very much; those who had grown up to 21 without being able to read or write were pretty nearly a hopeless class to deal with, unless the machinery were much more extensive and the aid given far more liberal than could be dreamed of at present. What was wanted with these people was a strong motive, and they would find it was quite necessary they should be able to read and write in order to get on in life, and he thought the best plan would be to make it constantly known that by attending classes for a given time and giving their attention, they might learn to read and write. What was wanted was to put before them a definite object, and then instruction should be provided gratuitously. At present his experience was that many of this class who were so deeply ignorant would be wholly disheartened, because what they would acquire was of such a fragmentary kind, they would drop their attendance for want of encouragement; but there was a considerable class of more educated mechanics who could read and write, and who wanted that improvement which would come from the use of their faculties which were then beginning to develop. Before them also certain definite things should be set which might be taught them within a given time. For example, he was for some years at the head of a working man's institution for self-improvement, numbering about eighty members. Unfortunately there was a little political policy set up by some of the more ignorant members, who thought they ought to manage the affair themselves; he gave way to them, and though he paid all the expenses, and gave them the gas, he allowed them to work it entirely by themselves. But really, when they met together they were like a set of children, and broke down actually for want of knowing how to do their own work; and from the political element being introduced by two or three individuals, the thing eventually was wholly destroyed. He thus learnt this practical lesson for himself, that you must treat these men to a large extent as children; and at the expense of being thought tyrannical, must do them good for a time even against their own will. In that institution he learnt what subjects would tell and what would not. For instance, he started a class of about twenty members who said they would like to learn shorthand. They could all read and write pretty fairly, and he told them he would teach them shorthand in a certain limited time, allowing a fair margin, considering the class of men, provided they would give so much time to it. He took them in hand for about six weeks, and at the end of that time about half wrote it well and about a quarter rapidly. If gentleman would undertake to go through a subject and teach it without fixing a limit of time, and saying if you would only attend steadily for so many hours for so many weeks you will really acquire such and such a subject up to a certain point, then you would have a fair attendance of the men and would obtain practical results. It might, however, be difficult to get volunteers for such classes unless you conld find a clergyman with a little time on his hands, and therefore the teachers ought to be paid. The main thing, however, was to take a definite thing within a definite time, and if you had a class of 20 working men of average brains a certain amount of success could be depended upon. The mechanics' institutions had been at work for two generations but had proved a failure; financially they were failures, and as a general rule it was not too much to say that they were actually, thus far, failures. This arose, he believed, to a great extent from the custom of leaving the thing all a sprawl, instead of concentrating the attention of the workmen upon definite things and seeing that they were fairly carried out. They must not expect too much from the pupils, because they must remember Mr. Carlyle's saying that the population consisted of 30 millions, mostly "fules." It was the lazy, moon-shiney way in which all these institutions were conducted which disheartened the working men in the long run.

Mr. Whitlock (South London Working Man's Institute), having had some experience in these matters, could not agree that working men's institutions had been a failure. They had been so to some extent, and had not realised all that had been expected of them by enthusiasts; but he could speak from experience that they had done an immense amount of good. No doubt Dr. Irons would know the institutions he referred to, when he said that the Rev. Charles Mackenzie began about the year 1849 to form classes in various parts of the metropolis, some of which he (Mr. Whitlock) joined and received great benefit therefrom. These classes ultimately developed into the City of London College, which was doing an immense deal of good, and so were many other institutions. A large amount of instruction was still being given in them, even without any aid from Government at all.

Rev. Dr. Irons said he referred to mechanics' institutions.

Mr. Whitlock said that was what he was referring to. There was a gentleman near him who worked very hard in the Walworth Institute, to which he was greatly indebted many years ago. With reference to adult education in evening schools, he could quite agree with the remarks made, that that would have to be continued for a long time yet to come; his experience was that it would be many years before all children were so well educated by 13 that they would require no further instruction, even if the principle of compulsion were carried out to the fullest extent. Unless you took the children, and clothed and fed them as well as taught them, a large number would be missing. A friend of his told him that he knew many cases in which, when the School Board officer called, the mother would say, "Here are the children; they do not go to school; you may take them if you like, but you will have to put clothes upon them;" the fact being they were in such a ragged condition that they were not fit to go to school. He had had some experience in evening classes, having had one under his charge for four years, numbering about 150, and the ages ranging from 13 up to 40 and 50. Not being qualified to receive a Government grant, he had no examination, but he was much indebted to volunteer assistance, some of the gentlemen attending with the greatest possible regularity. Of that 150 there was not one who understood anything at all of the rule of three, and therefore highly qualified teachers were not

required. Still, a great deal of gratitude had been expressed for the instruction which had been there given, and he knew some who by the slight foundation there given had been enabled to rise considerably.

Mr. George Howell said Dr. Irons had touched on some of the points why mechanics' institutions had failed, but he could quite understand, if they were taught after the style adopted by that gentleman's address that morning, political difficulties would soon exist. If Dr. Irons, or others with him, tried to cram their politics down working men's throats, he fancied working men would try to cram their views down the throats of their teachers.

Dr. Irons said he had been misunderstood; there were no politics at all.

Mr. Howell said he so understood.

Dr. Irons said there was not one single word of politics in the teaching, but there were political persons who had an idea that they ought to have the working of the thing in their own hands, and not be dictated to by another class.

Mr. Howell did not see how a thing of that kind could very easily crop up in any number of classes for giving elementary or other instruction to adults unless it took some kind of political turn from the teachers. He had no experience as a teacher, but he had had considerable experience as a scholar in literary and mechanics' institutions all over the country and knew something of their working, and he knew very well how these elements cropped up from time to time, and how working men became disgusted with them. Another cause of failure was if teachers took it for granted that when an adult came to school he was simply a fool, and ought to be dealt with as a fool. When a child went to school the teacher did not understand him to be a fool, and the same with an adult; you might teach him as a child, as he was in education, but he was certainly not to be treated as a fool, for working men, however ignorant they might be with regard to the elements of reading, writing, and arithmetic, had some kind of sense, or they would not carry on the work of this country in the manner they did. He deprecated, therefore, any such method of dealing with working men. Passing from that point, which was rather a painful one, the views he had on this subject were set forth in the paper which was printed in the *Journal* (see p. 775), and he was much gratified to find how much those views were concurred in by other gentlemen who had spoken. He must say there was not so much fault on the part of working men as some gentlemen supposed. For instance, Mr. Fitch spoke about the number of attendances required in a year being only 40; but, perhaps, few there knew the difficulty of attending classes regularly. When he came to London, having attended institutions in different parts of the country, he was anxious to continue the course of instruction he had laid out for himself. He joined several classes, paid his money, and made up his mind to attend them, but sometimes after having paid for a quarter's instruction he only got one or two lessons, not for want of desire to attend the class, but because he might be sent to another part of the country, and have to leave the class behind him. And even when in town a working man living at a great distance and working at a great distance had not always the opportunity of making himself clean and respectable in time to attend the classes in the evening. Therefore 40 attendances during the year, although they might seem very few, represented a good deal, especially when you took out all that period of the year when very few attended classes at all. He did not see how this difficulty was to be remedied to any considerable extent. One means would be to institute classes amongst working men's homes, and another would be to induce them by every means to attend the classes regularly. He must say it required a great amount of pluck, and those only who had tried it would thoroughly understand what he meant, for a man after having got up at five o'clock in the morning, remained at work until five or six in the evening, then walked home and got a little refreshment, to dress himself and trot off to a night school. He quite agreed with what that gentleman had said, that men must be treated as children; they must be encouraged, and everything done to induce them to attend, and the instruction given should be as easy as possible. They must strive to bring home to the minds of the men the great advantage which would accrue to them in their own trades from this kind of instruction. Sometimes working men got frightened at the programme put before them, and really thought it was much more difficult than it was to pass an examination. He had come across men of first-rate abilities who knew all the details of their trade, and the application of the sciences and arts to it, but yet they had not the courage to sit down and qualify themselves to pass an examination. With such a class of men, you wanted to show them how little elementary instruction they required in order to enable them to pass the examination with credit to themselves and to their teachers.

Mr. Hodgson Pratt said the difficulties which had been alluded to were those which were always spoken of in discussions of this kind, and they arose, he believed, principally from a cause which he had not yet heard referred to, namely, the waste of opportunity at the best part of working men's lives—the part which intervened between the day when they left the elementary schools and the day when they were grown up. It was to the apprenticeship period that especial attention should be turned, for, during that time, greater progress could be made than at any subsequent period of life, when the habit of mental application had been lost, and when much of the teaching acquired in the elementary school had been forgotten. One of their main objects should be to supplement the teaching of the elementary school by what were called, on the Continent, supplementary schools, while the habits and facts derived from elementary instruction were still fresh and vigorous. That opened up a most difficult question, upon which they were now bound to enter—the whole question of apprenticeship to trades. Workmen would tell you that the old system under which a master was bound to give his apprentice a proper training had more or less entirely broken down, not only in this country, but throughout the Continent. In the latter those who studied the question of education, finding it essential that it should go on after elementary school was over, not only for the general training of a man as a man, but also for his work in life, had endeavoured to compensate for the loss of the apprenticeship system by carrying out on a larger scale these complementary or supplementary schools. Now that educationists in Switzerland, Holland, Germany, and France, had admitted this principle, it was time for England to consider it. So deeply had that been felt in that working class country, called Switzerland, that during the last 20 years there had been ever increasing attempts to compel the apprentices to give more and more of their time to education, and secondary education had been made compulsory as well as primary, and now in the most advanced cantons they had got a step further, and not being satisfied with evening schools, because they found that the young men were to some extent tired after the day's work, they were now insisting that the apprentices should have this secondary training in the morning hours. It was made compulsory alike on the parents and the masters to see that the apprentices got that instruction. If this were carried out universally, there would be no difficulty in filling the mechanics' institutions. Under the present system working men came to the classes with the best will to learn, but the teachers used phrases which were a

mystery to them, and many of the elementary facts they had acquired at school they had forgotten, the link had been lost, as well as the habit of mental application, which was, of course, of immense importance. If this training went on during those intervening years, the most important of a man's life in all classes of society, the time when the habits and the will were being formed, they might hope to derive immense benefit from evening classes. It was no fault of the men that they were discouraged and discontinued their attendance. It was the fault of the educated and governing classes who had not seen that this supplementary instruction was provided. He had very recently visited schools founded for such apprentices, particularly one in Paris, where the municipality had a school of a high class under the supervision of the Prefect, where 300 lads were taught the various trades connected with the use of wood and iron, headwork and handwork going together, a certain number of hours being given to each. During the first year they had to obtain an insight into the general principles applicable to the various handicrafts, either in iron or wood; in the second year, they chose that particular department to which they were to devote themselves; and in the third year they entered on the actual execution of work for sale. Educationists in Paris were now quite unanimous as to the good that school was doing. That brought up another question, which he had only just time to allude to, the question of wedding mental training to handicraft training. It had been pointed out over and over again that, if the two went together, the application of the principles of science and art to production would throw a light on those principles, whilst the study of the principles would also throw a light on the handicraft, the different kinds of faculties being called into play simultaneously, which would enable both to be more fully developed and lead to better results. One of the main questions which educationists should now turn their attention to was, how could the youths and apprentices of this country best utilise the time between leaving school and that at which they entered on the practical business of life, for their own benefit and that of the country.

Dr. Yeats (Examiner in Commercial Geography and History), said he wished to direct the attention of the Conference to the desirability of promoting better technical training, and particularly commercial training, among adults and apprentices, by means of supplementary instruction on the raw materials of industry, and the various uses to which these are or may be applied. He thought that liberal provision had been made for such instruction in existing minutes of the Science and Art Department, though never rendered available, because perhaps not sufficiently understood; and that ample facilities might be found in or near London for the formation of trade museums, combined with direct, oral, technical instruction upon their contents. Technical instruction was that practical instruction which prepared a man for business, and business might be subdivided into production and distribution. For production the Government seemed to have done a great deal by the Science and Art Department, but he submitted they had done less hitherto for the science of distribution—he used the term advisably—as understood by a writer of old, who said—

> "One faith, one weight, one measure, and one coin,
> Would all the world in harmony conjoin."

He had lived as a teacher four years in Holland, and nearly the same time in Switzerland, in the midst of *fortbildung-schulen*, *gewerbeschulen*, and special schools. There were weaving schools, watch-making schools, silk spinning schools, and in short schools applicable to nearly every branch of industry. He knew their value, and he was as convinced as he was that 2 and 2 make 4, that unless England adopted something of the kind, we must in matters of business to which technical instruction applied fall behind other countries, which had for so long a time been turning attention to these matters. After preparatory instruction which fitted a lad for going into such higher institutions, attendance at them was made compulsory. Every year the compulsion became more and more rigid, and the advantage was proportionately extended. Now, what had our Government done in that direction? You had all the materials, and only wanted a little extension of the machinery. His own conviction was that to the Science and Art Department should be added a Department for Trade and Commerce, and that provision for object-teaching on raw materials and their uses should be made in primary and secondary schools. He was quite satisfied that the Chairman had had this subject in view. He had not forgotten the distributors, those who aimed at putting the right thing in the right place, who saw that everything was prepared according to the demand for it, and then carried where it was wanted, from the place where it had become a superfluity to the place in which it was needed. A minute of the Science and Art Department, No. 446, appeared to him to contain one of the wisest things which the Government had ever done, a thing which would make efficient preparation for these supplementary and technical schools. It provided for that graduated course of culture which was generally wanted, and gave more and more continuity to instruction; it would, therefore, improve common school attendance. It applied to secondary day schools for the young as well as to night schools for adults, and promised a bounty of 10s. per head for each pupil who passed through each of the three divisions, or 30s. to the teacher who could retain in his school a science pupil through the complete three years course. Bearing in mind this provision for night schools for adults, he would recommend that it be brought to bear on one special subject, the one with which the Society of Arts had entrusted him, Commercial Geography and History. How could this provision apply to it? They wanted young men intended for business either as manufacturers, or commercial clerks, or as sailors, to be assisted to a knowledge of raw materials, if needs be, independent of the aid or the patronage of brokers, who too often dislike entertaining a consideration of new substances. Now, in London there was perhaps the finest collection of raw materials in the world. When he was a student in Holland and wanting special information, he had to go to the Natural History Museum at Leyden, but there was one at Kew Gardens, and a handbook so excellent in its nature, so indicative of the scientific nature and uses of each portion of the vegetable world that he knew of nothing comparable to it at the price. Then coming to the animal kingdom, there was an admirable collection at the Bethnal-green Museum, and catalogues also issued at a very low price. If you required the raw materials of the mineral world, you could go to Jermyn-street. You had everything requisite in London for a complete study of raw materials, but they were not sufficiently utilised. It occurred to him that that Society, which had so long fostered commerce, might now extend its circle of operations beyond establishing an African or an Indian Section. Would it not be possible, at any rate in the course of years, to get every country with which we traded represented? Men in business knew that the main part of our commerce was with five great countries; could not these be taken up in succession, a paper being read on each, and at the same time specimens of their raw products exhibited? Then could not these papers be reproduced in the different centres of production throughout the country, and duplicates of the specimens be prepared for the use of itinerant lecturers, in the same way as Dr. Forbes Watson had proposed should be done for India? That gentleman wanted to make all the world acquainted with India, and he was quite right. But how did he do it? If you went to the India Museum you saw there beautiful relief models of India, with illustrations of all its chief products, really an epitome of the country. Now, what w-

wanted was an epitome of every country with which our trade was carried on. One great, if not the chief qualification of the wonderful man who held the leadership of the German armies in France was minute geographical knowledge. Herr Moltke had been a teacher of geography, and a writer upon it; and had insisted on the study of it in all its applications. If time permitted he could show that in Germany instruction in commercial geography was being made wider and being thoroughly conveyed to sailors and all who were interested in maritime matters. He was very anxious that the Society of Arts should extend its sphere of operations so as to select from and make use of the valuable materials and observations collected at Kew, Bethnal-green, and Jermyn-street. This was a practical matter, and he thought it might fairly come within the scope of the Society.

Mr. J. C. Buckmaster said the question before the meeting was how to make secondary means of education more effectual for those who had left elementary schools. He would mention what appeared to him the chief difficulty in the way. It was his misfortune to be, for six or seven years, a churchwarden, and holding that office he was trustee of a fund for the apprenticeship of poor boys. He thought this would give him an opportunity of introducing this kind of educational compulsion, which was now becoming rather popular, though he could well recollect the time when the mention of compulsion in that room would scarcely be listened to. There was scarcely any difference of opinion now, however, as to the application of the principle to elementary education, and it was now even hinted at with reference to secondary education and apprentices. Now, out of the fund of which he was trustee, a sum was to be paid for the apprenticeship of six boys. The matter was submitted to Sir Henry Cole, and there was a sort of draft agreed to, one clause of which made the attendance of the apprentice in a night school for drawing compulsory during the whole period of his service. The parents of the boys came and implored them to relax that clause, saying the poor boys were so hard worked, and had so much to do when they came home, and that the clause would be inoperative even if it were inserted in the indentures. Then the masters came too, and they were as much opposed to it as the parents, or even more. And this was the point which had to be considered in dealing with this question, namely, the public feeling with regard to it; and not only with regard to elementary education, but this more advanced education also. Was it not the fact that in almost every parish in London where the Free Libraries Act had been suggested, they had been rejected? Did not that indicate something of the state of public feeling with reference to secondary education? Well, with regard to this scheme of his, the parents did not like it; of course, the boys were not very anxious about it; and the masters in some cases positively objected to it. His colleague, who was rather more nervous on the subject than himself, said they would get into a row, and they had better drop it. His reply was that it was not the first row he had been in, and he was prepared to abide by the scheme if his colleague would do so. Then there was a difficulty as to how the teachers were to be paid. He said they must pay them out of the fund, as there was plenty of money in hand, but his colleague said they could not do so, and they would have to go the Charity Commissioners. His reply was, they would pay the money first and go to the Commissioners afterwards. Ultimately, after a great deal of trouble, he persuaded his colleague to leave the matter in his hands, on the understanding that he would not get him into a law suit if he could help it. He enforced those clauses, and as long as he remained churchwarden, and looked after the boys and paid the teachers, it went on. The Charity Commissioners wrote to him about it, asking what authority he had for so doing, and a correspondence went on for some time, but ultimately it fell through, and he was quite certain they could have continued paying the money without any difficulty, but when he ceased to be churchwarden other men came in who said they had nothing to do with technical education. They simply had to apprentice boys, and they must look after their own education as best they could, and so the matter fell through. That was only a specimen. With vestries electing men who met about five or six times a-year, and four times out of six made all sorts of frantic speeches about school boards and the expenditure for the public education, how could you expect to do much? It was a question of far greater difficulty than appeared at first sight. With reference to the secondary schools in connection with the Science and Art Department referred to by Dr. Yeats, although he had advocated, in every possible way, the desirability of establishing these schools, and even utilising for that purpose some of the denominational schools, there were at the present time not more than four or five in different parts of the country receiving the aid and assistance from the Department which Dr. Yeats had indicated. What was wanted was a healthier public opinion on this question, and until this was obtained all their efforts and resolutions would be comparatively useless. If it had not been for the assistance and stimulus given by the Science and Art Department in promoting the establishment of classes for instruction in drawing and elementary science, during the winter, he doubted very much whether secondary education, bad as it was, would not have been much worse. He spoke strongly, because he felt how great the difficulties were in the way. They were all pretty much united there, but nothing they could say would influence the great mass of public opinion outside. Seven or eight years ago, when in the north of England, he attended large meetings of working men, and he found on all sides what they asked for was a reduction in the hours of labour; they said they were so exhausted by their physical toil that they were incapable of benefiting as much as they desired from the classes which it was proposed to establish. This reduction in the hours of labour had taken place to a considerable extent, but it was not found that it had added a single pupil to the classes. He did find, however, that those who were in the habit of going before were more regular in their attendance and more frequent. This only showed the necessity of creating as far as possible in all large centres a more active desire, a deeper conviction, and a firmer faith in this question of education, and until this was done all their efforts would be comparatively unavailing.

Mr. Traice (Manchester) said the Chairman's opening remarks reminded him of the time when the Union of Institutions was first formed, and when a deputation waited on the Prince Consort on the subject. The Prince Consort wanted to know what was the work the Institutions were doing, and he, in reply, representing one of the largest of them, used the same terms which he had often repeated since, that the object was to take up the lads at the period when they left the day school and carry them on until they commenced the actual business of life. The work which the Society of Arts began in 1856, of testing anything which could be termed advanced education, was incalculable in value, and a great part of the work for which they were indebted to the Government sprang immediately out of the stimulus thus given, and from the knowledge thus obtained of their shortcomings. He remembered, when discussing the question of examinations in institutions, the whole idea was that they should examine in science, and he said he doubted very much whether any pupils would be found to be examined, except one here and there. More than 20 years had since passed, and he now found, from Mr. Fitch's interesting paper, that some 43,000 persons between the age of 13 and 20 were still learning the three R's; so that, though much had been done, a great deal yet remained to be done. His impression was that the time was rapidly approaching when Government would be entitled to say it would leave the elementary

education of those who had been neglected in childhood to the benevolence of the locality, and that, having educated children in elementary knowledge up to the age of 13, its business beyond that point was simply to carry them forward. One thing struck him very forcibly in Mr. Fitch's paper, viz., that there was a variety of educational forces, all travelling in parallel directions, and that they sadly wanted something to bring them all into harmony. The necessity referred to by the Chairman of a Ministry of Education, which should bring all the educational forces of the State under one establishment, was obvious for this purpose. Referring to the alleged failure of mechanics' institutes, there was no doubt that they had nearly all failed *qua* institute, but yet it would be found in almost every locality, that there were leading men who would get up at a public meeting and say they owed all the knowledge they possessed, and which had been most valuable to them in life, to one or other of these institutions. Some short time ago he was at the anniversary of the Bolton Institution, when the Mayor of Salford, formerly Mayor of Bolton, who was in the chair, spoke in this way of that institution. Another important matter, to which the Chairman had referred was the necessity for the statistics of adult education. He had acted as special local secretary at Manchester for the science examinations, and though he thought he knew something of the state of science education there, he was astonished and ashamed to find how great his ignorance was. Yet, he did not believe anyone in the locality knew more, or so much, excepting his own clerk, who happened to have been working at the matter continuously for some years. There were now young men's Christian associations, and similar societies, working men's clubs, and so on, taking amusement and sociality as one element, and a certain fragment more or less—generally rather less than more—of instruction, all of these were doing a certain amount of work, and exercising a certain amount of energy, and the problem was to find some means of concentrating them. Some three years ago the Yorkshire Union made a suggestion that the one thing wanted was a little more organisation, and this was easily illustrated. In one street there would be a science class, say on chemistry, with only a few students, and two or three streets off another, the teachers of both complaining of the meagre attendance and hardly having the heart to carry them on at all. One teacher might be a thoroughly competent and excellent man well fitted to bring on his pupils, and the other might be one who had just managed to slip through and acquire a certificate. What an economy there would be if two such classes could be combined, so that one good man would have a chance of being fairly paid. He did not see why something of this sort should not be done; there would be no serious difficulty about it, because there could be no religious element concerned in the teaching of science, and it did not matter in what buildings or under what auspices the instruction was given. Another point was with regard to the three years' course to which Dr. Yeats referred, and to which he had himself called attention in a paper read at Ripon three years ago. It frequently happened that the lads would not enter upon a rigid course for three years in certain subjects, but would choose certain classes which they thought would be most useful to them. They would not say anything to mathematics until they found the want of it in machine construction. One point in connection with secondary education had not been touched upon, and that was the desirability of giving encouragement in the shape of scholarships and exhibitions to the most industrious and successful pupils. The scholarships already established in conection with the Education Act were proving invaluable at Manchester, as testified by the School Board officers, and another class of exhibition which they were also finding very useful were three years' exhibitions to local colleges of £10 a year. He knew an instance of a working man at Accrington who found it worth while to come to Manchester by the 3rd class train to attend the Owens College; he went through his course diligently, and Professor Greenwood gave him an excellent certificate. With regard to the connection of science and technical work, he was afraid they were not yet sufficiently advanced for it, because they could not go too far ahead of public opinion. With regard to the three years' course, he thought it would be well for a dozen gentlemen to meet together and try to draw up a scheme, somewhat more elastic, which would enable the Government to assist secondary education more efficiently. His own experience was that the large manufacturers, while they liked very well to have men capable of doing everything they wanted, did not see their way to assist this so-called technical training, or if they did, the notion with many of them was, that they would like to pay for a boy to go to an Art school two or three years, and then take the place of a designer to whom they were paying £500 a year. In conclusion he would repeat that the main thing wanted at present was to utilise all the agencies they already possessed.

Mr. G. M. Norris (Birkbeck Institution) desired to oppose some of the principles which underlay the speeches of many of the gentlemen, who seemed to desire to crush out all the manliness and independence of Englishmen. One desired the Government to teach shorthand, another that it should teach French, another book-keeping, and so on, and they had spoken a great deal about the failure of mechanics' institutions. He could show them one which had not been a failure, and which now numbered over 3,000 members, and gave instruction in about fifty different subjects, an institution which did not possess a billiard-room, and yet was crowded from the ground-floor to the ceiling, the staircase being rendered impassable by the students. But one gentleman said mechanics' institutions were a failure, and another said that there were public men in all localities who attributed all the education they had obtained to these institutions. They could not therefore be a failure, but must have done a great work. It was true that they had not done all that was anticipated, and the reason was plain, because working men had not the necessary primary instruction. But if they had not taken the lowest stratum of working men, they had certainly taken the higher section of them, and the lower section of the middle class, and many of these might truly be called working men, so that mechanics' institutions had done, and were doing, a great work. They could do all that the rev. Doctor desired them to do, whilst he said they must have in night schools, Government teachers of shorthand, French, and other things.

The Rev. Dr. Irons said he had been quite misunderstood; he said nothing of the kind.

The Chairman thought Mr. Norris was rather exaggerating the view that had been expressed. The idea was that the Government should only encourage these things, not do them directly.

Mr. Norris was opposed to Government doing anything of the kind. If a man desired to learn French let him spend the 2s. or 3s. necessary in order to attend the French classes which existed in London and elsewhere. Let them calculate more on the manly independence of Englishmen. Another gentleman said he wanted Government to take up the pupils from their birth to their death, following the wake of another who wanted to clothe and feed them. It was simply absurd to talk in this way; Government had wisely determined that beyond the age of 21 it would have nothing to do with primary education. There were many advantages now existing in this country for young men when they reached the age of 21, and it was their own fault if they did not make use of them, and Government ought not to step in to sup-

ply the deficiency. This discussion would be published, and would, no doubt, be seen by the authorities at Whitehall, and therefore he for one wished to prevent them imagining that the Conference was of such an opinion. One gentleman complained that when a pupil had passed in one standard one year, he had to pass in a higher one the next year; but a new regulation had been introduced, by which, if a candidate failed in two subjects, he might come up again in the same subject, but, if passed in two subjects, why should he waste his time another year just because the manager of the school desired to get 2s. or 3s. by his passing the examination again. The same gentleman spoke of the great expense in connection with the night schools, and how much larger it was in proportion than in the day schools; but the night school had to meet 40 times, and the day school 400, and yet he said the expenses of the night schools were so much greater.

Mr. Baker said 40 attendances was the minimum.

The Chairman thought this controversy about details was unimportant to the main object of the Conference. Any information as to the progress of the Birkbeck Institution might throw some light on the question before them.

Mr. Curzon said he had not interrupted the gentleman before, but certainly two or three things which he had said had been twisted in a most extraordinary way.

Mr. Norris said he was somewhat surprised to hear gentlemen who had the practical experience of many in that room making statements which, read in the light of Whitehall, were simply absurd. They must have a little more manly independence. These institutions, if properly managed, would do their work well. At the Birkbeck Institution they had classes for physical science, for ancient and modern languages, and in other subjects, and if others would follow their example it would not be necessary to come down there and complain that Government ought to do this, that, and the other.

Mr. Buckmaster said he was not going to make a speech, but he was going to ask a plain question—Would Mr. Norris be kind enough to tell him the number of pupils attending the evening classes at the Birkbeck before the passing of the science minute of 1859, and also what sums of money had been received since that time for teaching science and drawing? That would show how far it was a voluntary institution.

No answer being given,

The Chairman said he did not suppose Mr. Norris was prepared to give the information off-hand, but he had a report before him, from which he could see the particulars of this institution, in 1874, which they all greatly respected, because they all liked manly independence. He found last year that this institution had under the inspection of the Science and Art Department 427 people of some kind or other learning various sciences which they studied. Just to show what that manly independence meant, he would give the number: 27 pupils in plane and solid geometry, 41 in machine construction, 15 in building construction, 122 in pure mathematics, 20 in applied mathematics, 61 in theoretical mechanics, 60 in animal mechanics, 7 in acoustics, 7 in light, 85 in magnetism and electricity, 65 in inorganic chemistry, 39 in geology, 5 in mineralogy, 46 in animal physiology, 30 in elementary botany, 12 in biology, 2 in navigation, 48 in steam, and 12 in physical geography, so that it appeared that the manly independence of these people was considerably aided by the Government.

Mr. Norris said the figures referred to were for the previous year, and did not represent anything like the number of individual students attending the classes. He thought, however, the numbers given would about come to 300 in the whole, which deducted from the 3,000 on their books, would give 2,700 manly independent students, and he might say further that if the grant were withdrawn to-morrow, such fees would be introduced as would make the classes pay their way, and they would not fear the necessity of having to close one of them.

The Chairman said Mr. Hodgson Pratt wished him to ask if Mr. Norris could give him the proportionate numbers of artisans, of clerks, and of students in shops.

Mr. Norris said he could only do so roughly. He should think the artisans, including the higher class of them, would be about one-fifth; clerks, and so on, would be something like three-fifths; and the remainder would be governesses and teachers of various kinds.

Mr. Curzon said it was not, then, really a mechanics' institution at all: it was, therefore, very different from those which they had to deal with in the North.

Mr. Norris said he had yet to understand that a clerk, who had to make a respectable appearance on a small salary, was better able to pay fees for his instruction than a working man who received good wages. In reply to a further question, he said they had no endowment of any kind.

Mr. Baker asked if there were not considerable receipts from the entertainments of the Elocution Class, &c.

Mr. Norris said the money received from those entertainments did not pay their expenses.

Mr. Buckmaster asked if Mr. Norris was prepared to deny that the institution had received £3,000 from the Government within the last seven years?

Mr. Norris replied that if the Government aid were withdrawn entirely the classes would still be continued.

Mr. Buckmaster said in that case they had no right to receive it.

Mr. Whitlock desired to explain that he had not advocated the feeding and clothing of children by Government, but he had only said it would be necessary if compulsion were to be fully carried out.

The Chairman said before they adjourned for luncheon, he would read a note which he had received from a member of the Council, Mr. Hyde Clarke:—"I hope you will urge the study of modern European and Oriental languages, for commercial, political, and educational purposes. There should be colloquial as well as literary instruction and examination. We want greatly, as in Paris, a high school of languages, and there should be the like in Liverpool, Manchester, Glasgow, &c. Such an institution would be very cheap. It would not want much room; and the professors would be at first paid by fees. We are cut out by Germans and others, not from want of linguistic aptitude, but from want of ordinary facilities and organisation."

The Chairman said as this country was a great factory of human beings as well as of machinery and manufactures for the whole world, it was especially desirable that languages should be cultivated. No matter in what relation of life a man stood he was all the better for knowing French, and still more so if he knew German also. The Society was now pressing the question of commercial examinations, and he hoped it would continue them next year. Another member of the Council, Mr. Twining, who had spent a great deal of time and money in promoting technical education, wished it to be stated that he would be happy to send a certain number of copies of his book on technical training to which any delegates representing large centres would be welcome.

(The Conference then adjourned for luncheon.)

On re-assembling,

The Chairman said the next subject was the aid given by the Universities in examinations, lecturers, and otherwise, and it was one rather for information than discus-

sion. He would now call on Mr. Leaf, who had been so kind as to prepare a paper on the subject.

Mr. Walter Leaf said he could hardly say how much he regretted that Professor Stuart could not be present to explain his scheme, which was essentially his own, and for which the Midland and Northern Counties of England had to thank him so much. He would, however, refer them to page 770 of the last *Journal*, paragraph 5, where he had quoted a few paragraphs from the regulations laid down by the Cambridge Syndicate. Professor Stuart said he considered the syllabus and questions the real backbone of the system. It was started some five or six years ago in the provinces, and it had made great progress, a large number of pupils of both sexes, and of various classes of society, having taken advantage of the arrangements. This great success of the Cambridge system led to a request from the Birkbeck Institution, about this time last year, to the Cambridge Syndicate, asking them to send lecturers on the same system. The Cambridge Syndicate, however, said they could hardly deal with a single institution in such a vast place as London, and they would rather have a requisition which could fairly claim to represent the feeling of the metropolis. Accordingly, meetings were held, first at the Royal Institution, and afterwards at the Mansion-house, which resulted in the appointment of a committee, under the presidency of Mr. Goschen, which drew up a scheme for the establishment of a society in order to carry out the system in London, with several additions which appeared necessary. In the first place, it was thought advisable to ask both the London and Oxford Universities to join, and also that a council should be formed, in a more permanent way than the smaller local committees which had worked the scheme in connection with Cambridge. Finally, it was proposed that a regular system of local committees should be formed in different parts of London to work the scheme, each in its own district, using the central council as an intermediary between themselves and the Universities. The object of the council was to secure the co-operation of the Universities, by the appointment of a general board, which should be their general educational adviser, and should have the special work of appointing examiners and lecturers. A requisition was made to the Universities that they should appoint this general board, but he was sorry to say that Oxford had preferred not to nominate the three members, and Cambridge having taken the first step in the movement, quite justifiably determined that they could not do any more until the consent of Oxford had been obtained, although the council were extremely favourable, and the London University had consented to join the movement. This implied a considerable hitch in the movement, inasmuch as Oxford, although the request had been before them nearly a term, had only voted on that day fortnight, but still they intended to go on with the scheme, and though they had not the official aid of the Universities, he did not think that would be any serious impediment to the scheme if they should ultimately get their authority. What they aimed at getting was very much what the last speaker before the adjournment mentioned. They had very much more faith in the classes who wanted education than many previous speakers. They did not go on the assumption that the overwhelming majority either of British workmen, or of the British lower middle-classes were fools—they believed that there was both amongst artisans, shopkeepers, and clerks a real *élite* who were anxious to get a higher education, who had already bridged over the chasm which separated their first start in life from the primary schools, and wished to get on further, who were anxious to know something about history, political economy, and science. It was only because they believed there was a real demand for this education that they started such a scheme, and they had ground for this belief. In the first place, the scheme as set on foot by Cambridge had already been received with enthusiasm in the provinces. In a note to Professor Stuart's paper, it would be seen that most munificent donations had been given to establish the system permanently both in Sheffield and Nottingham, the Town Council of the latter place having voted £40,000 for the erection of a building to include lecture-rooms, a free library, and accommodation for the science and art classes; and the lectures had been endowed with a munificent gift of £10,000 from an anonymous donor. In Sheffield also, Mr. Mark Firth, late mayor, had signified his intention of presenting to the town a building, to be erected in a central situation, for the accommodation of the University lectures, to which there was also an indication that certain endowments would be attached. It was entirely with this faith in the real demand for higher education, which faith they had strengthened by inquiries in various parts of London, that the scheme was founded, and if this desire existed there was a solid foundation upon which to work, independently of any questions as to the assent or dissent of the Universities.

The Chairman said the subject now before them might be said to be more particularly connected with London; but as there were representatives from other parts of the country, he should like to ask their opinion as to how far the localities they represented had taken advantage of this offer of lectures, &c., of the Cambridge University.

Mr. Traice said his experience was that they had been taken up in a few instances in this way. He would often hear in a large gathering connected with literary institutions, the nobleman who occupied the chair, and some other gentlemen who (without any disrespect) did not know much about the subject, declaring that the institution had spent a good deal of time on lectures which were found to be utterly useless, and therefore they were discontinued. It was quite true that they discontinued them, because generally speaking they were a tax upon their resources which was much larger than the result warranted; besides which, a large portion of the money of those institutions which kept up the lectures was expended with a view to its productiveness, and therefore the more entertaining a lecture, the more easy was it to justify its being given. Thus a musical lecture would not only frequently pay the lecturer, but leave a margin in its favour, whereas when one was given on some branch of science, it was considered a mark of favour to get an audience to listen to it. From time to time it had come to his knowledge that gentlemen had complained that they wanted a course of scientific lectures, such as was given in former times by Dr. Lardner, and other eminent men, who gave a good general idea of some branch of science. The first lectures were given for the higher education of ladies; subsequently they were open to both sexes, and were intended especially for the middle and upper classes. When these Cambridge University lectures were first started they grew, as nearly all things of the kind grew, out of those lectures that were given to ladies, in order that ladies should have the advantage of some of that knowledge which men either did or ought to possess. It was then suggested that the same thing might be extended in Lancashire, and they had been adopted in four or five places, though not yet in Manchester. They had been taken advantage of by the middle classes, and to some extent also by the working classes, and there was no doubt they had been for adults very useful. But one thing he should like to say about them, which was this, that it presented another of those cases where they had two or three bodies doing the same work. If he might say so without any danger of interfering with that independence of the British public so far as science was concerned, it was largely provided for by the Science and Art Department, and at present he saw nothing in this so-called University system to supersede it or come near it. It was now giving, in every centre of any activity throughout England, Ireland, and

Scotland, instruction in science to any one who wished to take advantage of it, and many had so far availed themselves of these classes as to become fitted to be good teachers of working men, and he might say, that none could teach working men better than those who had themselves obtained their knowledge by self instruction. It had supplied them with teachers in every locality who were contented with a moderate sum for their work, many being engaged in other pursuits during the day, and, therefore, he had always felt that this University scheme, as far as science was concerned, was rather interfering with than adding to that which was now working very nicely, and upon which they ought to concentrate all their attention. His feeling of course on all these matters was something like that of Nelson, when a captain asked him what he should do if his exact instructions were not available; the Admiral told him that "if he only lay alongside the enemy's ship and poured a broadside into her he could not make a mistake." And so, if they were doing anything to invade the great citadel of ignorance and error, he scarcely cared where the weapon came from, and whether it was a rightful piece of ordnance or not. He thanked Mr. Stuart and the Cambridge Syndicate for entering upon this work, which had attracted the attention of a large number of more or less educated people to their own wants and the wants of others, and that was one of the most necessary steps preliminary to doing something more. At the same time his opinion was that it would be much better if they would concentrate their attention upon that second class of subjects to which Dr. Yeats had referred in the morning, such as literature, history, and geography, which at present was not and could not be very well looked after by the Government, leaving science to be dealt with by the Department. The question of independence he considered to be out of court altogether. They were told that those "independents," for instance, at Nottingham, were to be maintained by an endowment of £10,000.

Mr. Curzon said that having been requested to act as a member of the University Extension Committee, both at Sheffield, Halifax, Wakefield, and other towns, which had now adopted this scheme, he could not help being pleased at the results. They owed the work in the first instance entirely to the ladies of Leeds, who for some four or five years had been advantaged by these lectures. The work was now being carried forward through the working and middle classes, and in Leeds, preliminary to the lectures, the University Extension Union met, consisting of 300 or 400 members, for the purpose of preparing for the subjects which the lecturers were going to deal with. In his opinion the great value of those lectures lay in their giving, what he might call a soul to science, robbing it of its drier aspect, and presenting it in a much more attractive and admirable view to the student. They were doing much the same thing for literature—without stripping it of its bare facts they were investing the subject with an interest which the working men of Leeds and Sheffield, at any rate, were thoroughly delighted with. He might also say that the professors while teaching were also learning something, because they were coming, in many cases, amongst people more vigorous than themselves; and with reference to political economy they were enabled to see the application of the theories they were laying down in the actual business of every day life. After their lectures they permitted discussions on the subjects, and he had been very much pleased to see the practical turn those discussions had taken from the questions of working men. He had no doubt that this scheme if carried forward in the North would be fruitful of good, the only difficulty which arose being the want of preliminary culture which had been spoken of in the morning. With regard to independence, they were all mutually dependent on each other, and only too glad to be so. The Birkbeck Institution, of which he spoke with the most profound respect, had been historically benefited by subscriptions, and had even been petrified by an application for Government aid, but it had arisen out of all this and now it appeared was going to live a free and a clean life, and to take no more Government money, and probably was about to return the money it had received for so many years past. If that were the case he should hope the Government would hand it over to those institutions which could not be so self-sacrificing, and they should put in a claim on behalf of Lancashire and Yorkshire for a share of it. One gentleman said that he was for Government doing everything for a man from birth to death. But was it not so, that it allowed human beings to be born in cellars, kept them in squalor, pinched them as wrongdoers, confined them as paupers, and hung them; and, if it did all those things, why on earth did it not do something for them in the way of culture? All he asked was, that the same pains it took to restrain, to torture, and to annoy, should be used for the purpose of raising and cultivating the people.

Dr. Yeats said he did not in the morning, for want of time, go into the question of the great demand for that instruction of which he spoke; but in Liverpool, and also in London and other places, he knew of sailors having come ashore with new produce wanting to know what it was and where it came from, and what use it was. The question was, how were they to get that information?

The Chairman said the next subject for discussion was, the aid obtainable from the surplus of the Exhibition of 1851. They would recollect that a statement had recently been issued by the Commissioners, the pith of which was that they had resolved to realise some of their landed property, and had shadowed forth some of the objects to which they were going to apply it. The facts given in the *Journal* with reference to this subject were stated more fully in the *Times* of the 27th May last, from which it appeared that the Commissioners intended to realise £350,000 out of their land, and stated that they were going to strengthen the machinery of education in science and art. They had schemes for founding scholarships liberally endowed in connection with the School of Science and Art, and if they could find out some improvement on what the Department was already doing, no doubt their work in that respect would be acceptable and meritorious. In addition to the facts stated in the *Journal*, a still more authoritative statement would be found in the *Times* of that day, and possibly in other newspapers, from which it appeared that they proposed to spend a further sum in establishing scholarships to give the more promising students of provincial institutions and of colleges of science and art, the benefit of study in the science and art classes at South Kensington. He had nothing to say against that proposition, because it stood plainly for everyone to judge for themselves, but if he had been consulted in making this announcement he might perhaps have suggested that promising students in provincial institutions and colleges might better receive the benefit of assistance in science and art classes in local centres. The Science and Art Department offered very liberal inducements already to come up to South Kensington in training their teachers, and he should have liked to have heard a word said referring to Leeds and Manchester, and other centres which had some modes of teaching quite as good as South Kensington. There were other subjects which bore largely on science and art, and he believed there was a lady present who had something to say with regard to her demands upon this surplus. She was well known as an important missionary from her own sex at the present time, having done a great deal to establish better schools for girls than had ever existed before. He believed she wished to claim some of this money for the purpose of training classes for teachers for higher schools and for secondary instruction.

Mrs. Grey said the support she wished was not only for classes for training teachers, but for a society which

was about to be founded by the Women's Education Union for the training and registration of teachers in schools above the elementary class. It was not solely for the training of female teachers, although probably its first work would be to start an institution for the training of women, inasmuch as women had not the opportunity of obtaining the knowledge of the subjects to be taught at the Universities. Their great object, however, was to obtain an examination of a higher authority, which should give certificates to those higher class teachers. At present everybody must be aware that there was no training for female teachers of higher grades in England, and for testing their qualifications, and this was the only country in Europe which professed to have an interest in education, which did not provide some public guarantee that those who professed to teach were qualified by a knowledge of subject, and also by a training in the method and art of teaching. One of the previous speakers mentioned a technical school in France for workers in wood and iron, where a three years' course was required; yet no training at all was required here for that higher class of knowledge which was necessary for training men and women. If, therefore, an institution were started to train teachers for higher grade schools, if it were possible to offer them instruction in the mode of teaching, it would be a fair thing to ask for aid from such a fund as this. In time, they hoped, the institution would be self-supporting, and every effort would be used to make it so ultimately, but to start a thing of this kind there must be some assistance given, and this sum, or a portion of it, she thought might be fairly asked for from the Commissioners of the Exhibition of 1861. They could not give a fair start to an institution of such a kind without a contribution of at least £2,000 down, and £2,000 more to draw upon in the course of the three years during which the experiment might be tried. If, at the end of that time, it was not self-supporting, it would follow that the country was not ripe for it, and it might fairly be dropped, but it was of vital interest to the country that the experiment should be fairly tried.

The Chairman thought that such an object was fairly within the scope of adult education, and within the objects of the Commissioners.

Mrs. Grey said it would be strictly for adult education, because no student would be admitted under 18. It was to be confined to the completion of education after school days were over; in fact, to take the place of the University course, from 18 to 21.

Mr. Traice confessed to having a strong feeling, after reading what had transpired in the House last night, that the scheme proposed by the Commissioners, was something like "feeding the fat sow;" inasmuch as they were going to assist the Government in their promotion of science and art. It seemed to him that there was a field quite sufficiently large, as yet wholly unoccupied, in which these funds might be applied, and with a certain relation to the source from which they were derived. There was a table printed, in which the principal contributions to the original fund in 1851 were set down, namely, Manchester, £4,000; Glasgow, £2,483; Leeds, £1,600; Bradford, £1,100; and so on. He thought the Commissioners were bound in equity, to some extent, to take this into consideration. It was quite possible to do that and at the same time to give the whole country the advantage. It did seem to him that there were three or four ways in which it might be possible for this fund to be applied so as to cover hitherto unoccupied ground. His only objection to Mrs. Grey's suggestion, in whose scheme he entirely concurred, was that, unless the Commissioners organised a scheme of this kind, they could scarcely deal with it until it was established. His own impression was that the policy of the Commissioners should be to hold this sum in hand for some time, as available for supporting various things which might appear desirable. Many objects, for instance, were very useful for a short time, but subsequently took another form and became transformed into something else; and it was most desirable that the Commissioners should not commit the whole of this money to any specific purpose too hurriedly. They had been told that morning that the country was not yet ripe for dealing with the question of technical education, but it struck him that a great deal might be done in that direction by the aid of this fund. If they could not establish schools—and they certainly were not prepared for that—they might give a number of prizes, in the form of scholarships, expressly applied to technical purposes, which would give a direct stimulus, and do a great deal. He had been surprised to find how much young men were in the habit of going in for examinations, not for any particular practical results, because they were beginning to see now that a man might have almost all the knowledge under the sun without being a shilling the better for it, but on account of the honour to be obtained and the prizes which were given. He knew a young man, the only one in Manchester who had gone in for the technological examination on cotton. He had already taken, perhaps, £12 or £15 in various prizes; he felt he was enriching his mind, and he took a pleasure in pursuing his studies further. If the Commissioners would carefully consider this question, and take practical men into consultation with them, he thought great good might be done. The Government felt that at present they could not aid anything except what was called science; but there was a vast range of knowledge which required cultivation outside the sphere of physical science, such as geography, history, literature, philosophy, and the familiar use of language. Some years ago they started in Manchester the colloquial examinations suggested by Mr. Hyde Clarke, and, though they had had French classes going on for 50 or 60 years, they were only able to get together a very few for this colloquial examination, and that could hardly have been done but for the encouragement given by the late Mr. Callender offering a prize. His feeling was that the Commissioners ought to aid those objects which were most desirable to promote, and which were not covered by other agencies; such, for instance, as the scheme suggested by Mrs. Grey, only it must be in existence first.

Mr. Whitlock said it was very desirable in connection with this surplus fund that it should not be too much concentrated in one locality. He only spoke for the metropolis, leaving other gentlemen to speak for the country, but he thought it would be quite as well if it were not all concentrated at South Kensington.

Mr. Traice wished to add that he thought it most important for the Commissioners to take into account the great colleges and schools which existed in Manchester, Leeds, and other places.

The Chairman suggested they should now pass to No. 6 of the programme, namely, "Subjects which it is especially desirable to promote in Adult Education such as the Laws of Health and Cleanliness, Household Economy, Food, Music, &c." There was a particularly valuable paper contributed to the *Journal* by Dr. Bond, on this question, but he should like to know whether the Birkbeck Institution had classes on the subject of the laws of health.

Mr. Norris said that would naturally be taught in connection with the physiological classes. The lecturer would of course mention all those things which were prejudicial to health.

The Chairman asked how many females attended the classes?

Mr. Norris said he thought about 70 or 80.

The Chairman asked Mr. Norris whether he really believed they were influencing the habits of the mem-

bers of the institution with reference to the laws of health and cleanliness?

Mr. Norris said there was no doubt a great deal even now to be done, and he should be very pleased for the Society of Arts to include this subject in the list of their examinations. One of their young ladies had taken the prize in clothing, which was a practical proof that the Birkbeck Institution was not behind in this point. Another point was household economy, and a member of the committee, feeling the importance of the subject, had been kind enough to give a five guinea prize to be competed for in that subject. With regard to music, they had probably the largest class in London; there was a class in the theory of music, and although the Society had struck it out of the examinations, an examination was held by Professor Hullah, and all who presented themselves last year, with the exception of two, obtained first-class certificates representing 70 per cent. of marks. He should be very pleased if the Society would re-introduce the examination in music, because he was convinced that it had a vast influence for good.

Mrs. Grey said that in almost all schools of the Girls' Public Day School Company there were classes for physiology, and it was taught carefully. The Women's Education Union also started a class under Miss McCornish, one of Prof. Huxley's best pupils, which had been very well attended, and very satisfactory results had been obtained. This would show that the subject of the laws of health was not neglected in their schools, which now numbered 11 at Norwich and different parts.

The Chairman asked if they taught needlework.

Mrs. Grey said it was on the programme, but they did not profess to teach needlework in that class of schools where the attendance was only four hours a-day for five days in a week. There was a difference of opinion on the Council with regard to needlework, and she was against teaching it at all in the schools, considering it technical work which ought to be taught the girls at home. Twenty hours of instruction per week in schools left no time for teaching needlework as it ought to be taught; and she spoke with some knowledge of the subject, because she believed in her youth she could have passed a competitive examination in it with any one.

The Chairman said he had been told that morning by a lady that if you went to every house in South Kensington, you would not find one of the servants who could sew on a button properly, and still less one of the ladies.

Mrs. Grey thought the ladies knew more about it than the servants, and it must be remembered that the servants were taught in the elementary schools, where needlework was supposed to be taught, and the ladies were not. The best needlewoman she knew was an earl's daughter, who made all her own dresses.

Mr. Curzon said it was now twenty years since he got a resolution passed at the Society of Arts for examination in physiology, and so little were people prepared for it, a gentleman of position in Leeds wrote a pamphlet against it, as being likely to prove exceedingly dangerous. He was happy to say now that things were very much changed, and that in Leeds there were ladies who had classes of 30 and 40 women meeting twice or thrice a week to study these subjects, and one of them in particular had published a little book on physiology, which was very popular. This lady had for three or four years devoted herself to visiting the homes of the working women, and teaching them how to cook, to wash, to keep their rooms healthy, how to dress their children, and so on; and another lady had been still longer engaged in the same work. They had a school of cookery in Leeds, perhaps the first in the kingdom. A number of ladies went there to be taught, and they cooked so well that their husbands came to get their luncheons, whilst the working women came at night to learn how to utilise much that was wasted in their own homes. This year they had extended examinations to needlework, and he was glad to say they had a number of candidates, and he believed it was doing practical service.

Mr. Whitlock also spoke of the great importance of this subject to the working classes, who witnessed the great deal of discomfort and wretchedness arising from the want of knowledge amongst the working population. The knowledge of cookery was one of the most important things in a working man's wife.

Mr. Noldwritt (Walworth Institution) said important as this subject was, it was not paid much attention to, for, about twelve months ago, being on the committee of a national school, he proposed to offer a prize for cookery, but it was refused. He believed the strongest objection came from the mistress, and perhaps it was because she herself did not know how to cook.

Mr. Traice said they had been teaching physiology for some time, but that did not necessarily involve much knowledge of the laws of health. Domestic economy and all that related to health covered a wide field, in which physiology, chemistry, the proper use of money, and commercial questions, all came in. Where it happened, as at Leeds, that they had a number of ladies well-educated, and what was still more important, with hearts full of sympathy, and a desire to help their fellow-creatures, a great deal might be done; though sometimes he feared these ladies were prone to be too scientific. A little book had been referred to, which was no doubt a most excellent one, but the authoress thought it necessary to tell the people a great deal about points on which he was quite satisfied she was not very perfectly informed herself, and some of the information conveyed was rather calculated to mislead than otherwise. One of the most important defects in connection with these matters in the education of women, was that they were taught everything but arithmetic, and an immense amount of wastefulness ensued, not only in the working-class homes, but in those of the middle classes. He believed the amount of loss, simply from ignorance of arithmetic, was almost incalculable.

Mr. Noldwritt remarked that the school to which he had just alluded, where a prize for cookery was refused, also showed great deficiency in arithmetic.

Mr. Norris said that the teaching of the laws of health would naturally come under the head of physiology, although he quite agreed with Mr. Traice that the physiological teacher could not afford to give as much time to it as was desirable, and he suggested that it would be well if the Society would introduce examinations in this subject, as by that means they would create more interest in it. Since sitting there he had also determined to institute a class for that very subject next year.

The Chairman remarked that what was called domestic economy might be divided into seven or eight subjects. It was somewhat astonishing to find that in the code of regulations of the Education Department domestic economy was applied only to girls, whereas it was notorious boys wanted it quite as much. Sir Benjamin Brodie had lately made a statement which had gone the round of the papers, that the best thing you could do with a boy was to teach him how to sew; but this part of a boy's education seemed to be very generally neglected. In his opinion elementary education had been too much governed by abstract theories carried out by senior wranglers — people who had had little experience of the wants of the toiling millions of this country. According to the regulations of the Department, this subject was thus treated:—Food and its preparation; clothing materials; those two things were to be taken up in the first year.

It was no use taking them up unless the pupil passed the 4th Standard, but in point of fact domestic economy might come in after the 2nd Standard. Why should food and its preparation be coupled with clothing and its materials? After the second year you came to warming, cleaning, ventilation, washing materials, and so on, a vast number of subjects mingled together. That was not a very practical way of dealing with it. In the third year, you came to rules for health, management of a sick room, cottage income, expenditure, and earnings. Why, it must be the work of a life almost to get up those subjects. He thought the influence of institutes might perhaps be brought to advise the Education Department to improve their programme a little in this respect. He should like to ask if the Birkbeck Institution taught cookery?

Mr. Norris said it had been proposed, but they had no room which could be fitted up as a kitchen, or else it would have been introduced some little time ago. One member of the committee offered to give a sum of ten guineas towards the expenses.

Mr. Pearsall asked if it would not be possible for the institution to be allowed to use the cooking apparatus belonging to the Society or to the South Kensington Museum, where cooking was taught.

Mr. Curzon said if they wrote to Leeds they could get information as to how an entire range could be fitted up and worked for about £30 a year.

The Chairman said they would now consider No. 7 on the programme. The annual report on the Union of Institutions and suggestions for improving the examinations.

Mr. Norris said there was a very practical subject which he wished to bring forward. Some time ago they introduced a high examination, and made three subjects necessary before the students were allowed to take up the higher branches which would qualify them to take the certificate, and as his institution had taken very much the same course, he could not find any fault with the determination to which the Society arrived. But they found great difficulty this year in reference to the time-table, and he thought by a simple transposition of the subjects, it could be made acceptable to everyone. The principle upon which he proceeded was this, that the necessary subjects should be put down for those evenings on which the candidates would be examined in subjects, a knowlege of which, could not be acquired within the one year; but in accordance with the present timetable, it was necessary for a candidate to take two years in doing that which might be very well done in one. He would hand in the scheme he had sketched out, under which, by a simple transposition, it would be possible for a man to complete his examination in three different ways in one year. This would make the examination more popular, and enable the Society to do better work.

The Chairman said the suggestion would receive due attention.

Mr. Gibbs (Halifax) wished to call the attention of the Council to the fact, that, owing to this change of system, their institution had suffered very much indeed; last year they sent in about 33 candidates, whilst this year there were only three. The reason was this, that young men would not tie themselves down to take three subjects before they got a certificate. If a young fellow wanted to go in for one subject he should be allowed to do so, without being compelled to pass in any other. They had hitherto looked on the Society of Arts examination as their "little go," but they now said they had to take the great go and the little go at once, which they objected to. He believed the experience in Huddersfield was the same, and if the matter could be reconsidered he should be very glad.

The Chairman said when the Council looked into the question they thought that to give a certificate for one small subject would act as a deterrent in others, and prevent young men coming up for the larger ones afterwards.

Mr. Gibbs thought it would draw them. They said if they could not get a certificate on one subject what was the use of going in. His suggestion was that they should take one subject at a time, and get a certificate for it, but should not get their diploma until they had taken the three. The great mass would not tie themselves down to take so much work all at once.

Mr. Critchett said the names of those who passed were printed in the Society's *Journal*, which was to all intents and purposes as good as a certificate.

Mr. Gibbs said it was not considered so. They took the certificates with them when applying for a situation, and found them useful.

Mr. Curzon said in the Yorkshire Union they gave certificates for separate subjects, and then gave the Society of Arts certificate for combined subjects.

Mr. Gibbs said they had given private certificates for the last twenty years, but they were not looked upon with anything like the esteem that the Society's certificate was.

Mr. Foster said those who went to the University were quite content with having their names recorded in the University Calendar as having obtained such and such honours during the year; they did not ask to have a paper showing the position they held.

Mr. Gibbs said there was this great difference—that all their friends saw their names in the honour lists, but the Society of Arts' *Journal* was very little seen by the great mass of the people.

Dr. Yeats had great pleasure in seconding the proposed alteration of the time-table suggested by Mr. Norris.

Mr. Whitlock bore testimony to the value put upon the certificates by young men who passed the examinations. They liked to have something to show.

Mr. Noldwritt said in the suburbs of London generally the new regulation had been a source of great disappointment, and it was hoped the Society would next year reconsider what they had been doing.

The Chairman said it was possible the Council might have jumped to a conclusion somewhat too hastily, and the representations made would, no doubt, receive full consideration.

Mr. Gibbs said he pressed it all the more because he had now been connected with the Working Men's College for 18 years, and had seen the immense value which the Society of Arts examinations had been.

The Chairman said there was one subject with regard to the omission of which he must stand in penance before the representatives, and that was music. When the question was discussed, how he could have recommended that it should not be continued was a mystery to him, but he was told he did so, and of course he believed it. He saw no reason for omitting it, but, on the contrary, he thought it ought to be still more encouraged, not only the theory, but the practice of music than it was at present. So far as his vote went, therefore, it would be for restoring the subject.

Mr. Curzon said he was desired to submit one or two suggestions coming from their examiners with reference to the elementary examinations. They rather objected to the vagueness of some of the questions, as for instance when the students were desired to write an account of the French Revolution. They should be glad to know which of the French Revolutions. Then, again, a question which appeared a little difficult for a lad of thirteen,

was to draw a map showing all the railways passed over, and the principal stations on those railways, from Aberdeen to London, because nothing but a well-digested knowledge of Bradshaw would meet the difficulty. There were several other suggestions which he would hand in, rather than occupy time by mentioning. He might say to those who thought that mechanics' institutions were a failure, that he had in his charge 173 institutions, with 35,000 members, and having 13,000 pupils in the evening classes. He thought if the Society of Arts would be kind enough to add two or three subjects to the elementary examination, and a special examination in commercial pursuits, and domestic economy, it would be a great improvement. He might mention one or two things they required of their pupils, such as to draw an invoice with a letter of advice, and to prepare a commercial letter complete ready for post. These seemed very simple things, but they would be astonished to find how very few boys and girls could do it. Another question was the use of a year's wages, and the result of savings in a penny bank, in a building society, in a sick club, or in life insurance. The penny bank was an institution scarcely known in London, but in the county of Yorkshire there was one which did £450,000 worth of business a year, had 383 branches, that had never lost a shilling from the commencement.

The Chairman said he must inform Mr. Curzon that a penny bank had been established in London called the National Penny Bank, which, within the last four months, had met with such great success that some of the officials in the Post-office were quite alarmed, and had actually suggested that an Act of Parliament should be passed to put it down.

Mr. Noldwritt said there was one point which he wished to mention with regard to the Union of Institutions. He recollected when they first met in 1852 they said all sorts of complimentary things to one another, they all agreed to be friends, and there was to be every facility for freedom of intercourse. He was sorry to say that this had gradually dwindled down until, in many cases, it had reached an entire neglect of the common courtesies of life; for there were many institutions, both in London and in the country, which never had the grace to return a copy of their syllabus in exchange for the one which was sent out from his institution every session. There were 45 metropolitan institutions, to each of which a syllabus was sent, with a request that they would send one of theirs in exchange, but only 23 were returned; and out of 30 provincial ones only 12 were returned. Amongst other defaulters was the one represented by Mr. Curzon.

Mr. Curzon said they had no syllabus, but they published an annual report, of which some thousands were circulated, not only throughout the kingdom, but on the Continent, at the cost of 3d. or 4d. in each case. A considerable number were sent to the Working Men's Club and Institute Union, where Mr. Noldwritt could at any time obtain one.

The Chairman thought they ought perhaps to have begun with this subject. There were movements constantly going on in the world, which somehow or other seemed not to have greatly advantaged mechanics' institutes and the like. He did not believe adult education had gone back in any degree since 1852, quite the contrary, but it had gone on in a different kind of way, and instead of the 300 institutes which originally joined the institution he was afraid to say what was the number at present on the list. It might be they could invent some mode of reviving the interest in these institutions, for he believed if they could get at the statistics the number must be more like 3,000 than 300. It was with a desire to excite more interest than had for some time existed that the Council had somewhat enlarged the scope of the discussion that day, and on the whole he believed there had been an improvement, and perhaps next year they might be able to take up a few of the hints which had been given, and see whether they could revive this union of institutes.

Mr. Norris suggested that that should be put down as a subject for the next Conference. He then begged leave to move a hearty vote of thanks to the Chairman for the able manner in which he had conducted the business. They all owed a great deal to him for his efforts in the cause of education; he trusted that his life would long be spared, and at the close of it he would be able to look back on a vast amount of valuable work, whilst his name would ever stand amongst the foremost of those who had done what they could to advance the interests of their fellow creatures.

Mr. Curzon, in seconding the motion, said they owed a deep debt of gratitude to Sir Henry Cole for all the services he had rendered. He had visited all parts of the country, and attended crowded conferences of delegates, where he had given counsel and afforded encouragement which they had received from no other quarter, and although there was, perhaps, no part of England where they looked with more impatience than they did in the north upon all that was still being done at South Kensington, they knew that there lay their great reservoir, from which must be obtained the tributary streams of knowledge to run through the country. But for Sir Henry Cole the glories of that grand achievement could never have been reached at all; for to his tact and energy, and almost diplomatic finesse in some instances, they owed in a great measure that magnificent collection; and no one could pass through it without thinking gratefully of the mind which had controlled and guided the work from the beginning to the end. They rejoiced to see him there that day, presiding over their councils, and he looked to that day as an epoch from which might date the revival of the great work which the Society of Arts commenced when it united the institutions of England together. He hoped when they met next year that some hundreds would be present from different parts of the country; and he could only say, for the part he represented, that any exchange of courtesies and sympathies would always be met in the most willing spirit. The way in which they had been received today showed that the heart was, at any rate, sound, and the limbs ought to be sound also, and surely that heart would never pulse with greater truthfulness than when it throbbed in the heart of one, who like the chairman presided over the meeting with such thorough geniality. He, therefore, had the greatest pleasure in seconding the vote of thanks.

The resolution was passed by acclamation.

The Chairman, in reply, said he always found it very difficult to return thanks for such an expression of thanks. He did not know whether he was going into some ancient theory or not, but he felt himself a sort of old instrument which had very little will of its own. Some people said the contrary, but he felt that he did things he could not help, and therefore that he was not deserving of any credit for what he had done. He had re-appeared now, after nearly a quarter of a century, at one of these meetings, being moved to do so because he thought he could stir up some things a little now, and the Council kindly consented to his suggestion. There was one great fallacy he saw still prevalent, which it was to be hoped was nearly worn out. But going back fifty years it was much stronger. It was the dread of Government. Fifty years ago we were governed through rotten boroughs, and the country stirred itself up and said it would have rotten boroughs no longer, just as it said a long time before that it would not have monasteries. Of course in the days of rotten boroughs there was nothing more incapable scarcely than the Government, and therefore the feeling was very natural that Govern-

ment was to be repudiated, and people were to do things for themselves. But for people to say that they would not have a Government when they had one to their mind, and were able to make that Government responsive to their wants, seemed to him to be going backward in political sagacity. You might as well say you would have a manly independence of the sun; you would not have a centralised thing like the sun, but everybody should find his own farthing rushlight. At the present time, considering the weakness of human nature, and how imperfect all instruments were, he must say that, whatever Government they had, it did in the main respond to the wishes of the country at large. On the whole, the public now wanted to be educated, and they could only obtain it by centralisation. After all, Government was nothing more than a co-operative society in which every one united—more or less voluntarily, but everybody united to get that which they could not get without it. As civilisation advanced there were heaps of questions cropping up, such for instance as the pollution of rivers, which could only be dealt with by the Government. The instinct of everybody was to send his filth to his neighbour, but if everybody was entitled to do that the rivers could never be cleansed. Manly independence was very well, but you must have that hateful thing called centralisation if you wanted cleanliness; you must have a despotism running from the source of the stream to the bottom. They had the machinery of Government, and the best thing they could do with it, was to make it do all that was wanted for human progress.

CONVERSAZIONE.

The Society's Conversazione was held on Friday evening last, June 23rd, at South Kensington Museum, by permission of the Lords of the Council on Education. The Reception was held in the South Court by Lord Alfred S. Churchill, Chairman, assisted by the following Vice-Presidents, members of the Council, &c.:—Sir George Campbell, K.C.S.I., M.P., Andrew Cassels, J. Oldfield Chadwick, Hyde Clarke, Benjamin Francis Cobb, Sir Henry Cole, K.C.B., Major-General F. Eardley-Wilmot, R.A., F.R.S., C. J. Freake, Wm. Hawes, F.G.S., Edwin Lawrence, LL.B., Vice-Admiral Erasmus Ommanney, C.B., F.R.S., and Robert Rawlinson, C.B.

A vocal concert, consisting of glees, by the London Glee and Madrigal Union, directed by Mr. Land, was given from 9 to 11 o'clock, with intervals, in the Lecture Theatre.

PROGRAMME.

From 9 to 9.30.

1. Glee (5 voices) .... "O Bird of Eve" (Lord Mornington)
2. Glee (male voices) .... "My dear Mistress had a heart" (Spofforth)
3. Glee (5 voices)............... "When winds breathe soft" (S. Webbe)
4. Madrigal (male voices)... "We happy shepherd swains" (Netherclift)
5. Part-Song.................... "O hills! O vales of pleasure" (Mendelssohn)

From 9.45 to 10.15.

1. Glee (male voices) .... "Under the greenwood tree" (Arne and Bishop)
2. Glee............................ "Once upon my cheek they said the lilies grew" (Dr. Callcott)
3. Part-Song ...."I know a maiden" (J. L. Hatton)
4. Madrigalian Dialogue ..."In the merry spring (A.D. 1561) (Ravenscroft)

From 10.30 to 10.45.

1. Part-Song (male voices) .. "Spring's delights" (Muller)
2. Glee .... "Here in cool grot" (Lord Mornington)
3. Glee ...."Hail, smiling morn" (Spofforth)

Finale, Madrigal..................."O who will o'er the downs?" (R. L. Pearsall)

A Promenade Concert was given by the Band of the Coldstream Guards (Conductor, Mr. Fred Godfrey) in the North Court.

PROGRAMME.

Overture......................... "Mirella" (Gounod)
Waltz .... "Bien Aimés" (Waldtenfel)
(Dedicated to their Royal Highnesses the Prince and Princess of Wales.)

Selection .... "Trial by Jury" (Sullivan)
With Solos for the Principal Performers.

Cornert Solo .... (Cody)
Mr. Cody

Grand National Fantasia ... "England" (Fred Godfrey)
Introducing the following National Songs and Dances:—"Down among the Dead Men," "A Lullaby," "A Morris Dance," "Barbara Allen," "Sally in our Alley," "Sir Roger de Coverley," "Hope the Hermit," "Tom Bowling," "The Keel Row," "Home, Sweet Home," "The Bay of Biscay," "Rule Britannia," &c.

Fantasia .... "La Jolie Parfumeuse" (Offenbach)
Russian Dance..."Pas des Patineurs" (Arranged by Fred Godfrey)
Piccolo Obligato, Mr. Nice.

Grand National Fantasia ... "Scotland" (Fred Godfrey)
(Dedicated by permission to H R H. the Duke of Edinburgh.)
Introducing the following Scotch National Songs and Dances:—"Scots wha hae," "Auld Robin Gray," "Highland Laddie," "The Campbells are comin," "The White Cockade," "John Anderson my Jo," "Logie o' Buchan," "Green grow the Rushes O," "The Braes o' Auchterader," "Annie Laurie," "Within a Mile o' Edinburgh," "Blue Bonnets," "The Blue Bells of Scotland," "Tullochgorum," "Auld Lang Syne," &c., with Solos for the principal Performers.

Waltz .... "Brise des Nuits" (Lamothe)
Gavotte .... "La Woffington" (M. Ball)
Selection .... "Chilpéric" (Hervé)
With Solos for Euphonium and Cornet, Messrs. Darnley and Cody.
Galop .... "Bruder Lustig" (Budik)
"God Save the Queen."

MISCELLANEOUS.

THE EXHIBITION OF 1851.

In the House of Commons, on Thursday,

Mr. R. Yorke asked the Secretary of State for the Home Department whether he could inform the House of the financial position of the Commissioners for the Great Exhibition of 1851, or of the prospect of making the large funds in their hands available for the promotion of science and art; and whether the Commissioners had made any Report to Her Majesty since that of the 15th of August, 1867; and, if so, whether he had any objection to lay it upon the table of the House.

Mr. Cross—As the subject is one which naturally excites some interest, perhaps the House will allow me to read a short statement which I have received from the Commissioners with respect to it. They say:—"The property of the Commissioners for the Exhibition of 1851 consists of land returning no income, of exhibition galleries leased or lent to the Government, of land let on building leases, and of house property. Their available income at the present time is about £2,000 per annum. Their financial position will depend upon the mode in which the land now returning no income is dealt with, that is to say, whether let on building leases or reserved for public purposes. The Commissioners have lately determined to sell on building leases some of the outlying portions of the estate, and to employ £100,000 of the money thus obtained in erecting on their estate a building for a museum of scientific instruments, for a library

of works on science for the use of the students at South Kensington, and for public examination rooms, which are much needed. The building would also be available for other objects of scientific education. An offer to this effect has been recently made to Her Majesty's Government, and the matter is now under consideration. The Commissioners propose to expend a further sum in establishing scholarships to give the more promising students of provincial institutions and colleges of science and art the benefit of study in the science and art classes at South Kensington. The Commissioners made a report of the annual International Exhibitions from the 1st of May, 1871, to the 31st of October, 1874, which has been laid before Her Majesty." I have no objection to lay that report upon the table of the House.

BRUSSELS INTERNATIONAL EXHIBITION.

(FROM A CORRESPONDENT.)

The International Exhibition of Objects of Health and Public Safety was opened last Monday. Of the English Committee there were present, among others, Lord Alfred Churchill (Chairman of the London Committee), Mr. P. De Keyser, Sir Antonio Brady, Major Burgess (Hon. Secretary to the London Committee), and Mr. E. A. Gruning. After a short opening ceremony, which included the pscsentation of an address to the King, and his reply, his Majesty paid a short visit of inspection to the different parts of the Exhibition, and went away expressing himself highly pleased with all he had seen, and especially with the British Section. The Exhibition was then opened to the public, but neither on the first nor following days was the attendance very large.

The building, which is in the park of Brussels, is necessarily of a rather straggling character. It is formed of a number of long galleries or passages extending in different directions and meeting at different angles. This is caused by the fact that the building follows the lines of some of the *allées* of the park, so that when it is removed it may not leave behind it any traces of injury to the park or its fine trees. An entire gallery is allotted to England, certainly one of the best parts of the Exhibition. The other countries which exhibit on the largest scale are Belgium, Germany, France, and Russia, the amount of space occupied by each being proportionately in the order named. The other countries represented, but less extensively, are Austria, Hungary, Italy, Holland, Switzerland, Denmark, Norway, and Sweden. In each country the exhibits are arranged in each country in ten classes, dealing respectively with, (1) the Preservation of Life from Fire; (2) the Prevention of Accidents on the Water; (3) the Prevention of Accidents on Railways, Roads, &c.; (4) Aid to the Wounded in War; (5) Public Health; (6) Industrial Hygiene and Safety; (7) Domestic and Personal Hygiene; (8) Medicine and Surgery; (9) Societies for Improving the Condition of the Working Classes; (10) Agricultural Hygiene and Safety.

The class which seems to be the best represented throughout the Exhibition is No. 4, that devoted to objects connected with aid to the wounded in war, many of the exhibits in this class being of a most complete and elaborate character. There is, for instance, a complete railway train for the conveyance and succour of the wounded, shown by the "Ordre Souverain des Chevaliers de Malte," which has its head quarters at Vienna. This is the most remarkable object in the class, and perhaps in the whole Exhibition, but there are many others not quite so extensive, but illustrating just as well the methods employed, or proposed to be employed, for this humanitarian purpose. Next to this come classes 1 and 2, which are fully represented in all the countries.

RESOURCES OF THE PROVINCE OF SHANTUNG.

A report on the geography and natural history of the province of Shantung has recently been published in Hong Kong. The writer first describes the different kinds of fish which are found more or less abundantly in the waters of this part of China. A kind of carp and a fish called the Si-yu are very plentiful, and with the eel and other kinds are sold in the markets by the pound, being kept alive in shallow tubs. One fish, known as the Huang-kee, is remarkable on account of its having yellow bones, the skin is also described as being yellowish, and devoid of scales, while the dorsal and two pectoral fins are each provided with a long sharp spine, having a line of acute teeth, giving it the appearance of a saw. Another very curious kind is found in the waters of the Huai-ho, and in a spring on the Tai-shan. If we can believe the statement of respectable Chinamen, this fish has no bones; some pretend that it is sent alive to the Emperor, when he prays for rain, and they even go so far as to say that after the sacrifice to heaven it has to be returned to its native waters; perhaps, this may be the reason why this is called the dragon fish. Many varieties of the gold fish, are found, some, contrary to their name, being of a fine velvety black; a large number of species are found in the markets, being edible, at least to the Chinese, who readily swallow the cuttle and jelly fish. Star fish of all hues and shapes are found on the beach, and at low water the rocks are adorned with beautiful sea anemones, and the Beche de Mer, which is very common, and constitutes one of the greatest delicacies of a Chinese table. Amongst birds may be enumerated the red-legged partridge, the pheasant, snipe, woodcock, wild duck, wild pigeon, wild swan, &c.

On the Fu-shau-hien river wild geese and wild turkeys and some turkey buzzards are seen, but these birds are very wild, and it is difficult to come within range of them; they are, moreover, tough, and cannot be considered good eating. Sheep are fed in large numbers on the immense plains of the western boundary, together with oxen and horses.

The province, in the plains and valleys, is very fertile; the hills are cultivated to the extreme limit of available soil, but they are generally barren, with the exception of a dwarf kind of pine, very seldom reaching more than 10 feet in height. Some of the mountains bear names indicating that at a certain period there must have been some trees upon them. For instance, in the high range of the Saw Teetto Mountains, on the road from Chefoo to Lay Yung, there is a summit called the Elm Peak, upon which, however, no such tree as an elm exists; a few dwarf oaks, the leaves of which are eaten by silkworms, is apparently the only vegetation there. In the ravines or stony valleys there is a larger kind of pine, flat-headed, and resembling the Italian pine when the Chinese allow it to grow to its full size. Large trees in the plains are not very common, but on the high road to Chi-nan Fu, and near Lay Yung, are some poplars remarkable for their large size, silver-white bark, and contorted branches. There are two kinds, one with large, and the other with small leaves; both furnish a light and excellent timber for carving and junk building.

A kind of catalpa, bearing the name of the great naturalist Bunge, is very common in Shantung, and decorates the gardens of Chefoo; its wood is used for making musical instruments, chess-men, chess-tables, and weighing-rods. The ailanthus, or Chinese varnish-tree, is not only useful for feeding silkworms, but its roots furnish an exceedingly useful drug, for use in dysentery; this remedy, long known to the Chinese, has been experimented with successfully on Europeans during the last two years, and is proved to be one of the most powerful astringents known. The *Cedrela odorata*, a tree closely allied to the mahogany, also grows in

Shantung; the wood is of a reddish colour; the fruit is astringent, and is used in cases of ophthalmia. The young shoots are described as having an onion-like taste, and they are boiled and eaten by the Chinese.

The huai shu (*Sophora japonica*) is a very common tree, and is often found of great size and age, when they take the fantastical shapes the Chinese love so much. The veneration they have for old trees is a great incitement to preserving them from destruction. They support the long branches with poles or pillars, carefully patching the holes of the trunk with bricks and mortar, and often building a little chapel or niche at the foot of the tree, generally dedicated to the Tu-lao-ye, or god of agriculture, when not dedicated to the tree itself, which they call lao-ye. The flowers of this tree are used in China as a yellow dye, for dyeing the silk of which the garments of the mandarins are made. Very large quantities of these flowers are thus consumed, and the tree is largely cultivated for the purpose, not only in Shantung, but also in Tokien and Honan, from whence they are sent in sacks to other parts of China. Small quantities occasionally reach this country, but they have never yet become an established article of commerce.

The Chinese persimmon (*Diospyros kaki*) is very common in Shantung. The fruit is sometimes known as the Chinese date-plum; it is of a bright red colour, about the size of an ordinary apple, and the pulp, which somewhat resembles that of a plum, is yellowish transparent. These fruits are sometimes dried and candied; but both in their fresh and preserved states they are very delicious. Considering the ease with which they might be sent, preserved in tins or earthenware jars, it is surprising we do not often see them in the European markets. It seems however, that they are largely exported to Chili. The only uses to which the fruits of the elegant Gingko, or maidenhair tree (*Salisburia adiantifolia*) are put, are for making soups, and as an astringent medicine. A large article of export, known as red and black dates, are the fruits of two very common shrubs, one of which is *Rhamnus utilis*, and the other probably *R. chlorophorus*. The former grows extensively on the mountains, and furnishes the well-known dye known as Chinese green indigo, and by the Chinese as lu-kao. It is prepared by chopping the twigs in small pieces and boiling them in water, to which a certain quantity of alum is added for fixing the colour. This dye has been imported in considerable quantities into France, chiefly to the silk weaving districts about Lyons, for dyeing some of the more beautiful shades of green. The fruit-bearing trees of Shantung are somewhat limited. The vines are plentiful, and give two or three kinds of grapes, which are not so sweet as the cultivated grapes of Europe. Good wine is nevertheless made from them in Pekin by the French missionaries. A celebrated fruit of the province is the Shantung pear, which is largely exported.

From the seeds of the millet (*Setaria* species) the Chinese make a fermented beverage in the following manner:—The seeds are boiled till they burst; they are then spread out on a table and mixed with a small quantity of leaves from wheat; the whole is then put into a large leather jar, where it is left to ferment from one to four weeks. It is then placed in linen and pressed with stones, and the liquid so extracted forms huang chin, or yellow wine. Besides this, a kind of brandy or spirit is prepared from viro, sweet potatoes, persimmon fruits, &c. The bean cheese or bean curd, so common in many parts of China, is made from white and yellow beans (*soja hispida*) steeped in cold water till they are soft, when they are deprived of their skin by pressing them between the fingers, after which they are reduced to pulp by pounding them in a mortar or pressing them under a millstone; the pulp is passed through a sieve and then some *lu-shui*—the residuum of sea-salt or nitre, or a gypsum solution is added, which coagulates the albumen; the water is taken off by pressure in a linen cloth loaded with stones; this liquid is carefully thrown away, being said to be poisonous. The cake so obtained is salted and sold fresh in the streets, or dried to the consistency of a hard cheese. Flour for food is also made from these beans, as well as a sauce or soy. This sauce, now extensively used in this country and in America, is prepared by steeping the beans in water for one hour; they are then half-dried in the sun and mixed with wheat flour and allowed to ferment, being placed for that purpose in a hot damp place. The mould which develops itself in abundance on the beans is scraped off, the beans are then dried and put in salted water, which has been properly boiled and cooled (to expel the air). The brown and black colour of the sauce so obtained is supposed to be produced by a microscopic fungus resembling the ergot of rye, whose properties the soy is said to possess. These kinds of beans are very extensively used in the manufacture of the now famous bean cake. The Customs returns give but a small idea of the enormous export of these cakes; for, if thousands are sent to the southern ports in foreign bottoms, the many millions which have found their way in junks it is impossible even to guess at. The beans being thoroughly crushed under heavy stone wheels turned by mules, are heated under water and the cakes compressed between iron hoops. The pressure is slowly and gradually increased by driving the wedges with an enormous stone suspended as a pendulum and acting as a ram. The oil, which runs from them into a kind of well, is black and very dense; it has a disagreeable smell, and is used for illuminating purposes, and for caulking boats, and being mixed with lime it makes a kind of putty. A foreign firm in Nenchavang, some time ago tried to extract oil from the beans by the more powerful and expeditious means of a hydraulic press, but the reaction to a sudden pressure was so great that hardly any oil could be obtained.

The other oil-producing plants of Shantung are *Sesamum orientale*, *Arachis hypogaea*, *Cannabis sativa*, *Ricinus communis*. Some of these oils are exported to Canton to be purified and clarified there, and come back to Chefoo under the pompous but false name of tea-oil. The castor-oil plant is often cultivated in the form of hedges, being considered an effective barrier against the intrusion of animals.

The Shantung province is also very rich in medicinal plants. A kind of native ginseng found in sandy plains, and accordingly called sha-sen, is exported in quantities. The roots of the *Libanotis* and the fruit of the *Aristolochiga* are famous drugs, while the leaves of the *Artemisia* are used as Moxa.

The products here mentioned are only a few of those constituting the natural resources of the province of Shantung.

The *Commission de Geographie Commerciale* has appointed a Committee of Initiative, with the object of forming an international society for a final and complete exploration of the Isthmus of Panama, to determine the best course of the canal. M. Ferdinand de Lesseps is nominated President, and the Vice-Presidents are Admiral La Roncière Le Noury, President of the Société de Geographie, and M. Mensand, of the Ministry of Foreign Affairs and President of the *Commission de Geographie Commerciale;* and the Secretary is M. Léon Drouillet, engineer.

The *Moniteur Industriel Belge* states that a premium of £2,000 is offered by the authorities of Reggio-Calabria, to whoever will supply the best appliance for extracting the essence of bergamot. The conditions are severe, as the appliance must not be expensive, and must yield the greatest quantity of the essence in the shortest space of time, without affecting its purity, the colour, or the odour.

The Government of India, says *Engineering*, has made a proposal to the guaranteed Indian railway companies with the view of acquiring possession of their telegraph lines, which will be brought into combination with the general system of telegraphs throughout India. The telegraphs of India, like the telegraphs of Great Britain, will thus be wholly in the hands of the Government.

UTILISATION OF URINE.

In connection with the recent Sewage Conference, some account of the method by which MM. Müntz and Ramspacher propose to deal with the urine of large towns may not prove uninteresting. The calculations are based upon Paris, with its 1,900,000 inhabitants, a urinal arranged according to this method having been used at the Conservatoire des Arts et Métiers for six weeks with satisfactory results.

The authors observe that in large centres of population the public urinals receive daily considerable quantities of urine; and, as the inhabitants of towns are fed for the most part on highly nitrogenised food, the urine is very rich in urea, which, as is well known, becomes transformed into carbonate of ammonia by the putrefaction of the urine. In Paris, the fresh urine contains, in the state of urea, about 20 lbs. of nitrogen per cubic yard, capable of yielding 32 lbs. of ammonia, from which may be made 1 cwt. of sulphate of ammonia.

Now, in Paris, where active measures are being taken to turn excrementitious matters to account in agriculture, there exists no practical method for collecting the urine of public urinals. This abundant substance, so rich in fertilising elements, is, therefore, almost entirely lost. In fact, after being considerably diluted with the water which secures the cleanliness of the urinals, it becomes mixed with the sewer water. Although a small portion of the latter is now utilised, that which runs into the Seine renders the water of this river unwholesome, a state of things to which the urine greatly contributes. Besides, at certain seasons of the year, notwithstanding the use of water and disinfectants, the urinals now existing evolve a very disagreeable effluvium. The urinals now in use have, in fact, the following drawbacks:—(1) The waste of the whole of the urine; (2) considerable expense in water and disinfectants; (3) unhealthiness through bad odours in summer; and, (4) the introduction into the river of a considerable quantity of nitrogenised matter, which considerably increases the elements of putrifaction.

Messrs. Müntz and Ramspacher claim, however, after experiments extending over several years, to have devised a system which obviates these difficulties, and, indeed, secures the advantages of (1) collecting the whole of the urine of the public urinals, and in a natural state, not diluted with water, thus permitting the useful substance—nitrogen—to be extracted with slight expense; (2) completely superseding the use of water or disinfectants analogous to chloride of lime, whereby a considerable saving is effected; (3) preventing all smell, even during hot weather, by at once arresting the decomposition of urine; and (4) avoiding the introduction into the river of any substance rich in elements of putrefaction.

It has been noticed that a considerable number of oily substances, lighter than urine, such as spirit of turpentine, petroleum, &c., prevent, or, at any rate, retard, the decomposition of this substance when brought into contact with it. Thus, some urine, to which a few drops of spirit of turpentine have been added, has remained for three years completely unchanged, entirely owing to the presence of this oily matter. By establishing a system of urinals in which the preservative substances above mentioned suffice to prevent any smell of putrifying urine, this liquid may be collected without the intervention of water. An arrangement approaching that of the appliance known as a Florentine receiver, or any other arrangement permitting of the flow of the preserving liquid, attains the desired end. By thus modifying the basin of urinals, and maintaining therein a super-natant layer of suitable oily liquid, the following result is achieved: the urine, constantly isolated from the air by this substance, which acts partly as a cover and partly as a disinfector, runs away without communicating any effluvium to the atmosphere, and without the presence of water. A special system of drains would conduct the urine out of the town to the works for the extraction of the ammonia.

It is reckoned that one-eighth part of the whole quantity of urine might be collected in the manner described, and, as $2\frac{1}{4}$ pints is about the daily average for each individual, this gives, for a population of 1,900,000, about 400 cubic yards; but, taking only 392 cubic yards, this figure, at 12 parts of nitrogen per thousand, gives $3\frac{1}{2}$ tons of nitrogen, capable of producing 3 tons 15 cwt. of ammonia, from which $14\frac{1}{2}$ tons of sulphate of ammonia may be made daily. This represents a yearly value of £103,376; and, if the system were applied in all the great centres of population, a considerable quantity of nitrogen which is now completely wasted, would be restored to the soil.

M. Bonneau, attached to the French Ministry of Public Works, has made an estimate of the first cost and yearly expense of utilising the urine of Paris, from which, and the incomings given above, it appears that a profit of 73 per cent. may be realised on the necessary capital.

GENERAL NOTES.

Indian and Colonial Museum.—The Chancellor of the Exchequer, in answer to Mr. Fawcett, in the House of Commons, said he had heard from time to time, suggestions for the erection of an Indian and Colonial Museum, and among other plans, of one to erect a building for the purpose on the Thames Embankment. No definite proposal had, however, been submitted to the Government on the subject, nor was there one at present under their consideration. He could, therefore, give the hon. gentleman no information as to the probable cost of erecting and maintaining such museums, or as to the sources from which the necessary expenditure would be defrayed.

NOTICES.

SUBSCRIPTIONS.

The Midsummer subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

EXAMINATIONS.

In List of Prizes in the *Journal* for the 16th inst., the second prize of £3 for English is stated to be awarded to

No. 587. Houghton, John W., 19, Liverpool Inst., clerk.

It should stand as follows:—

No. 587. Hudson, William C., 21, Liverpool Inst., clerk.

MEETINGS FOR THE ENSUING WEEK.

Mon.....Royal Institution, Albemarle-street, W., 2 p.m. Monthly Meeting.
Asiatic, 22, Albemarle-street, W., 3 p.m.
Victoria Institute, 10, Adelphi-terrace, Strand, W.C., 8 p.m. Extra Meeting, to consider the Rev. Prebendary Irons's paper, "An Examination of a Work Entitled, 'The Unseen Universe.'"

Wed. ...Entomological, 11, Chandos-street, W., 7 p.m.
Obstetrical, 53, Berners-street, W., 8 p.m.
Royal Horticultural, South Kensington, 1 p.m.

Fri.......Geologists' Association, University College, W.C., 8 p.m.
Archaeological Institute, 16, New Burlington-street, W., 4 p.m.

Sat.......Royal Botanic, Inner Circle, Regent's-park, N.W., $3\frac{3}{4}$ p.m.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

BRUSSELS INTERNATIONAL EXHIBITION.

[FROM A CORRESPONDENT.]

Before proceeding to any notice of the objects contained in the Exhibition, it may be as well to review briefly the origin of the scheme, and the intentions of its promoters. Some information on many of these points has already been given in previous numbers of the *Journal*, but even if there is a little repetition it will doubtless be pardoned.

In 1871 the Société des Sauveteurs de Belgique, of which General Renard, the King's aide-de-camp, was then and still is president, suggested the holding at Brussels of an exhibition of objects connected with health and public safety. The Société des Sauveteurs combines in itself the functions in this country divided among the Royal Humane Society, the National Lifeboat Institution, the Society for the Protection of Life from Fire, and other like institutions. It was, therefore, excellently suited to carry out the idea of an exhibition dealing with the means used to protect and prolong human life. Various circumstances, principally the Vienna Exhibition of 1874, delayed the fulfilment of the scheme until the present year, but since its first conception its originators have not failed to use their best endeavours to secure its ultimate success. At the end of 1874 the Société des Sauveteurs issued a circular, appealing for help to carry out the proposal. A subscription list was opened, and headed by the names of the King of the Belgians and the Comte de Flandre; a capital of 600,000 francs (£24,000) was subscribed, and, for certain legal reasons, a Société Anonyme was duly constituted to carry out the Exhibition. Committees were then formed for the various classes, and also for the different countries represented. Besides these, local Belgian Committees were nominated, and a special committee for the management of the Congress, which is expected to be one of the great features of the Exhibition.

The names of the countries exhibiting were given in last week's *Journal*. Several others declined to take part on account of the Philadelphia Centennial, amongst them the United States, Spain, and Portugal. Some even of the countries which do exhibit would certainly have been more fully represented had not the two exhibitions unfortunately clashed. In England, for example, there are many well-known exhibitors who would probably not have been absent had they not shrunk from the double expense and trouble of sending both to Philadelphia and Brussels.

Still, the Central Committee have succeeded in collecting together a very creditable and satisfactory show. They have been largely assisted by municipalities and associations of various kinds, and these more than supply any deficiency among private exhibitors. In most cases Government departments lending their property have also defrayed the cost of its transmission, but with our own Government this has not been the case. The Admiralty and the War-office have, indeed, placed the articles required at the disposal of the Exhibition Executive, but they have left the English Committee to bear all charges connected with them. It is no secret that this will fall heavily upon certain liberal-minded members of the committee who have undertaken to bear the risk.

It will be remembered that the Exhibition was to be confined strictly to matters coming within its special range, and bearing, more or less directly, on the subjects comprised in the classification, an abstract of which was given in last week's *Journal*. The committees of the different countries have, apparently, interpreted the rules with varying degrees of stringency, for in some of the sections the exhibits are of a much more diversified character than in others. In the English Section the greatest latitude seems to have been permitted, but even here there is very little which cannot fairly be regarded as having a just claim. One advantage resulting from this slight elasticity is that as the exhibits are more varied, so the collection is more generally interesting; and after making all allowance for national prejudices, it may fairly be said that the British gallery is the most important part of the Exhibition. This is the more creditable when it is remembered that in the rest of the Exhibition the principal exhibits are those of Government departments and official bodies, while in our own section this class of exhibits bears but a very small proportion to those contributed by private firms or individuals.

The British Committee was originally formed at the Mansion-house, under the chairmanship of the Lord Mayor, but on the election of Alderman Cotton as Lord Mayor he declined to continue the work begun by his predecessor. Lord Alfred Churchill was then elected chairman, and by permission of the Council all further meetings of the Committee were held in the Society's House. The Society has thus become more intimately connected with the Exhibition than it was at its first conception, and it is for this reason that arrangements were made to provide a somewhat detailed account of its contents.

It is intended to award prize medals and diplomas, and each exhibitor will also receive a commemorative medal and a diploma. As all the exhibits have had to be passed by one of the committees, it is considered that this will be in itself some testimonial as to their character.

Having premised thus much as to the general arrangements of the Exhibition, it may be as well to pass on to notice some of the principal objects shown, beginning with the British Section. For convenience sake, it is proposed to follow the order of classification as given in the catalogue. It happens occasionally that one exhibitor shows in several classes, but places all his exhibits together,

and it is therefore impossible that the objects themselves should be arranged under their respective classes. The small space, however, occupied by each country as compared with former international exhibitions renders this a matter of no great consequence.

Class I., Saving Life from Fire, is in many respects less fully represented in the British than in several other Sections, in which some magnificent fire-engines and other appliances are shown. This fact has given rise to the freely-expressed opinion that in the matter of the best method of dealing with conflagrations England is behind her neighbours. The conclusion, whether correct or not, is hardly justified by the premises, the fact merely being that there are scarcely any specimens of English apparatus with which to institute a comparison. Hydes and Wigfull, of Sheffield, send some small hand-engines, but there are no specimens of any of the fine engines used by our own Metropolitan Fire Brigade, to show foreigners that, even if our cities are less fully protected against fire than some of theirs, we are at least nothing behindhand, either in our mechanical appliances or our organisation, so far as it goes. The Society for the Protection of Life from Fire shows one of their ordinary fire-escapes, of the type familiar to Londoners. One or two firms show specimens of hose, &c.; and two, Messrs. Gibbs and Co., and Price's Candle Co., show plans and drawings of the means adopted in their factories to prevent the spread of fire. Homan and Rodgers exhibit specimens of their fire-proof floors, girders, &c. These, as is well known, are composed of iron and cement, combined in such a way that the iron resists the tensional strain, while the cement offers the required resistance to any forces tending to compress and crush the structure. There are also other exhibits of fire-proof building appliances. Messrs. Frost Bros. send some very fine specimens of cordage, which appear in this and several other classes, according to the special purposes for which they are to be applied. Automatic fire alarms and extinguishers are represented, the principal being those of Messrs. Sanderson and Proctor, and Julius Hall. The former of these employ steam, and propose to use their apparatus only where steam is available. The heat of the fire acts on an apparatus which, by means of an electrical connection, opens a valve in the boiler, and fills with steam the place where the fire is. At the same time an alarm is sounded in any suitable position. In Mr. Hall's apparatus, a system of perforated pipes is fitted up through the warehouse or other place to be protected, and on a fire breaking out, water is turned on through these, and the place flooded. In the same class, Messrs. Newall show a fine collection of lightning conductors. These include specimens of the copper wire rope and other conductors, with the different ornamental and other points used, including platinum points, and a new infusible point recommended for its greater cheapness and higher conducting power, as compared with platinum. There are also ribbon conductors, and nickel plated rope conductors, for chimney shafts. The usual method of affixing the conductors (without insulators) is exemplified by means of a tall wooden shaft, and also by several models, in one of which a very complicated system of conductors is attached to a model of a house, with numerous projecting spires and cables. In this case all the different parts of the system are in connection, so that the whole building is, so to speak, covered with a complete net of conducting material in perfect connection with the ground. The important point of securing complete earth contact is illustrated by specimens of some of the different methods used. Some lightning conductors are also shown by Sanderson and Proctor, and by J. Shaw, of Sheffield.

In Class II., the British Section is without question *facile princeps* in the Exhibition. This is indeed only natural, but it is satisfactory that our superiority as a sea-faring nation should be so plainly shown in this special department of the Exhibition. Among the contributors are the Admiralty, the Board of Trade, the Trinity House, the Royal Humane Society, and the National Lifeboat Institution, and all these bodies contribute very largely. The Admiralty collection consists of models and specimens from the museum of the Royal Naval College at Greenwich, and some of the exhibits are of great historical interest. Among them are models of the earliest life-boats built, including the Shields life-boat, the first ever used in England. This boat was built by Henry Greathead; she was first tried in 1790, and was in use up to 1820. The inventor received the Society of Arts Medal in 1802, and was afterwards rewarded by a grant from Parliament of £1,200. She rowed ten oars, double-banked, and had a cork lining 16 inches thick. There was no provision for freeing herself of water, or righting if upset. There are also models of other early lifeboats. A life-raft, invented by Mr. Fonteneau in 1862, is shown in model. It is composed of spars lashed on either side of a tier of empty casks, the object being to show how to turn to the best advantage the materials at hand in case of wreck. A seamen's bath, suggested by the Duke of Edinburgh for use in places where the presence of sharks renders bathing impossible outside the ship, is also shown. Gresham's "Patent Record Buoy" is intended to contain documents, and to be thrown overboard in the last extremity. It is constructed so as to be as conspicuous as possible from a distance. The remaining exhibits include plans for ventilation, leak-stoppers, anchors, jury rudders, &c. A model of Kynaston's well-known boat-lowering apparatus is also shown.

The most important portion of the Board of Trade collection consists of an entire set of life-saving apparatus for use in wrecks. The whole equipment of a rocket station is exhibited, with rockets, firing apparatus, lines coiled in their box ready to run out freely, and all the other appliances, with the cart in which they are conveyed. These rockets have superseded the old mortars brought into use by Captain Manby in 1808, and long employed at some stations, though others have always used the rocket, which indeed was applied to make connection with a wrecked ship almost simultaneously with the mortar. Captain Manby also received a Society of Arts Medal in 1808. Until 1855 these stations were not under Government control, although the apparatus was worked by the Coast Guard, and recognised by the Government. They were established and supervised by the National

Life-boat Institution (then the Institution for Saving Life from Shipwreck) and other societies. In the year named (1855), there was a large number of rocket and mortar stations, some of which were supplied both with rockets and mortars. In order to improve the service, Colonel Boxer was appointed to experiment with both, and he succeeded in effecting considerable improvements, both in the mortar and the rocket apparatus, the latter especially. The apparatus now in use, as shown in the Exhibition, is used as follows:—As soon as a line has been thrown over the stranded vessel, the crew haul on it, and thus bring on board a whip (endless rope) rove through a block. The block is made fast to a mast or other point, and as soon as this is done, those on shore send off a hawser by means of the whip. This in its turn is made fast on board, and then a buoy, travelling along the hawser, can be hauled to and fro between the shore and the wreck by means of the whip. This method of communication obviously presupposes a knowledge among those on board of the plan of working, and indeed cases have occurred when it has failed for want of such knowledge, chiefly, though not always, in foreign ships. To get over this difficulty, the Board of Trade have had constructed a number of enamelled iron plates, giving instructions for wrecked crews, and these they give to any shipowner who will have them conspicuously fixed up in his ship. Besides this, other means are taken to disseminate as widely as possible a knowledge of the proper method of working the apparatus.

The Board of Trade also shows a set of models used in their examinations of masters and mates for certificates, a set of signal flags, and some charts, tables, &c. Next comes the collection lent by the Trinity House, which includes models and drawings of several lighthouses, and a floating lighthouse apparatus. The Royal Humane Society send models of the apparatus used for rescue in cases of accidents by water. The objects represented by models are as follows:—(1) A folding ice ladder, extending to 48 feet in length; (2) a hand ladder ten or twelve feet long, intended to be laid down on the ice, so that a man can creep along it to get near the immersed person; (3) a hand line about six fathoms long, fitted with corks at one end, which is thrown to the person in the water, the other end being held in the hand; (4) a pole drag 16 feet long; (5) a rope drag for deep water; (6) a cork circular life buoy with loops of cord at the side; (7) a cork life-belt, formed of narrow pieces sewn on a canvas belt in two rows, one above and one below the waist. Besides supporting the body, this belt serves as a protection from blows, and to retain warmth; (8) an unsinkable boat, capable of supporting twelve persons even when full of water. Next comes the Royal National Life-boat Institution, which contributes one of the most striking objects, not only in the British Section, but even in the whole Exhibition. This is a full-sized life-boat, fully equipped, with her sails set and mounted on her carriage ready for launching. This is a specimen of the most perfect class of life-boat which modern ingenuity has been able to construct, and as such it has deservedly attracted a very great deal of attention. Besides this there are models of life-buoys, life-barges, cork belts, a large wreck chart of the British Isles, drawings of boats, &c., and of Mr. C. H. Cooke's life-boat houses erected at all the stations of the institution, specimens of the institution's medals, &c.

This concludes the list of the contributions in this class made by Government departments and societies. The objects lent by Government were all brought over at the charges of the London Committee, the Treasury having declined to be at any expense whatever for the purpose. Amongst the exhibits shown by private individuals or firms, the principal is certainly the "Triple Flashing Light," shown by Chance, Bros. The object of this system is to provide a distinct and easily recognisable light without the necessity of using coloured lights, interposing long intervals between the flashes, or employing so many flashes of different lengths as to require a considerable time before the signal is complete, and the observer consequently enabled to be certain of his position. This latest novelty in lighthouse illumination consists of an arrangement by which each face of the light is caused, instead of one flash, to give two or (as in the example exhibited) three flashes, with much shorter intervals than those between every two groups of flashes. Thus, for instance, if a group of three flashes were to be exhibited every half-minute, each flash would last nearly two seconds, and the dark intervals between them three seconds; then would come a period of darkness lasting eighteen seconds, and the flashes would be repeated. It is considered that, for all nautical purposes, three such short flashes, following in rapid succession, are equivalent to one flash lasting the time of the three, viz., twelve seconds, while the distinctive character of the light is greatly increased. The flashes can also be made to correspond with the sound of a fog signal stationed at the same spot. The light shown is a nine-sided one, giving a group of three flashes with a period of one minute. It is to be erected on the Casquet Rocks, in the English Channel.

Mr. J. W. Wood's leak-stopper has already been described in the *Journal*.* An iron bolt has a short cross-bar pivotted to its end in such a way that the bolt can be thrust outwards through the hole to be stopped, but the bar then swings downward, and by catching against the sides of the hole, prevents withdrawal; a felt pad is then placed against the side of the ship, over the hole, an iron disc placed over this again, and the whole tightened up by a nut screwed on the bolt. The pad is thus held tight in its place between the disc inside and the cross-bar without, thus filling the hole and stopping the leak. As shown in the Exhibition, the apparatus is fitted either for stopping a large hole, such as made by a shot, or a small hole caused by the loss of a rivet. It can be used for boilers, as well as on board ship, Among the other exhibits are several life-saving jackets of various construction, ventilators (by Howorth, of Manchester), safety cleats, boat-lowering apparatus (Hill and Clark), &c. Several collapsible boats are shown, one large one by Wihl, of Manchester, and one of rather a remarkable nature by W. R. Gade. This is a "life-saving trunk," which when opened forms a life-boat. Parratt's "deck seat life-raft" is also exhibited in this section.

In Class III., the committee have been

* See *Journal* for December 10, 1875, p. 64 of the present volume.

somewhat liberal in their admissions. It is only by a considerable stretch of courtesy that Messrs. Pooley's excellent weighing machines can be said to be useful in preventing accidents. Their railway weigh-bridge indeed contains provisions for this purpose, but that seems the only one of their exhibits which has much claim to be included in the class. It is hardly necessary to say, that no reflection whatever is intended on the machines themselves, which are apparently admirably adapted for their purpose—that purpose being weighing, not the prevention of accidents. Messrs. Saxby and Farmer's beautiful and elaborate model is quite the most attractive object in the class. It shows in the greatest detail the various applications of their interlocking points and signals. Almost every possible combination of railway lines seems to be given on it, with all the requisite points and signals, The model is the same as that shown at the Vienna Exhibition, with a few slight additions. To describe it at length would occupy too large a space, and anything less than this would be of little use. Suffice it to say, that nearly all the appliances of this class described by Mr. Bramwell in his recent lecture before the Society are here exemplified, down to even the latest modification, the locking of the signal levers by the movement of the spring catch of the point lever, instead of the lever itself. Mr. Brocklebank's automatic railway coupling is another conspicuous exhibit, the models being the same as those shown by him, when he recently read a paper on the subject before the Society. Stewart's patent flag signal for communication in railway trains, also lately shown at one of the Society's meetings, is another exhibit. The Westinghouse Continuous Break Company only show drawings, but append a notice that the break may be seen in action on the Belgian State railways.

In Class IV., Means of assistance in time of war, Great Britain is not nearly as well represented as are some other countries. The Admiralty send examples of the cots used in the Transport Service for sick and wounded troops on board ship. There are three different sorts of these exhibited. The War-office sends a complete equipment for a hospital tent, which is shown arranged as if ready for use, also examples of stretchers, mule litters, and ambulance waggons; the whole collection being sufficient to show the ordinary practice in the Army Medical Department. All the objects shown are of the latest patterns.

The Order of St. John of Jerusalem in England are also exhibitors in this class. They show their ambulance wheeled litter for the transport of the wounded. This is used in the accident ambulance service established by the Order in mining and colliery service, and has proved its value by the test of experience. The Order itself, it may not be generally known, is a revival of one branch of the ancient Order of Knights Hospitallers, which was founded in 1092 at Jerusalem, for the protection of Christian Pilgrims to the Holy Sepulchre. The Order had its head-quarters successively at Jerusalem, Acre, Rhodes, and Cyprus, but its eight branches or "langues" were settled in the various countries in Europe; of these one branch was English, and possessed the Priory of St. John of Clerkenwell, the remains of which still exist in St. John's-gate. Driven from Cyprus in 1522 they obtained a grant of Malta from Charles V., and that island they held till its capitulation to Napoleon in 1798. From this they were generally known as Knights of St. John of Malta. Since then the Order, as a sovereign body, has not existed, but the different "langues" have—at least in some cases—survived. It is, of course, only as a graceful tradition that the forms of the old Order are still maintained, for the institutions have been placed on an entirely new footing, and have in fact become modern charitable societies. The continental branches have in several instances taken up as their special province the case of the wounded in war, but the English branch takes a wider scope, announcing as its object "the encouragement and promotion of all works of humanity and charity in the relief of sickness, distress, suffering, and danger." Up to the present their chief labours have been the establishment of the ambulance service above referred to, the distribution in an organised manner of food to the convalescents from certain hospitals, the founding of an institution for providing nurses for the sick poor, and the awarding medals for acts of bravery in saving life on land. Eventually it is hoped that these medals may become as well known as, and take rank with, those given by the Royal Humane Society for saving life from drowning. It may be added that the English branch cannot boast the continuous tradition enjoyed by the foreign branches. At the dissolution of the monasteries, the Order of St. John of Jerusalem in England shared the common lot, and was dispossessed of its property. After a brief resuscitation under Philip and Mary, it was again deprived of its possessions by Elizabeth, and the knights retired abroad. In order to prevent the English "langue" from becoming extinct, it was usual, at all consistories of the Order, to appoint one of the knights to represent it, and it was thus kept formally alive till, in 1826, Sir Robert Peat, one of George IV.'s chaplains, with some of his friends, undertook to resuscitate it. This was done; not, it would appear, without some doubts on the part of the other "langues" as to the propriety of recognising a Protestant branch of a Catholic order, and since then the Knights of St. John of Jerusalem in England have pursued their career of usefulness with considerable success. They have recently obtained possession of St. John's-gate, Clerkenwell, the only remaining portion of their ancient priory. In the Exhibition, examples of their medals are shown, and an illustration showing both obverse and reverse is given in the catalogue of the British Section.

There are not many other exhibitors in the same class. Surgeon-Major McNalty shows a "Fracture Box" for injuries of the leg, and some galvanised iron network splints. Surgeon-Major Porter shows some extemporised splints from telegraph wire; Major Wethered has a convertible hammock which may be turned into a couch, chair, &c.; and Deputy Commissary Young contributes a report and plans of the Herbert Hospital at Woolwich.

Class V., "Public Health and Convenience," is a somewhat miscellaneous class. The School Board for London send one of the most important

exhibits, a collection of all the apparatus used for primary and infant education in Board schools, school furniture, books, maps, diagrams, pictures, black-boards, Kinder-garten apparatus, books intended for teaching blind children to read, materials for needlework used in Board schools. This collection has attracted a good deal of attention from foreigners interested in educational matters, as it compares by no means unfavourably with the similar collections in some of the foreign sections, notably Russia and Germany.

Next in order in the catalogue come Colonel Du Cane's illustrations of the sanitary arrangements of English convict prisons. These consist of plans, sections, and elevations of various portions of the prisons at Portsmouth, Pentonville, &c. Specially noticeable are the plans for the convict prison now in course of erection at Wormwood Scrubs by convict labour. The Corporation of London also appear in this class, as showing models of parts of the Holborn Viaduct. The only other official body in this class is the Corporation of Leeds, who send a specimen of the pail and iron bucket employed in their system of collecting town sewage. After this we get to the private exhibitors, and their contributions are of so varied a character that it would be no easy task to classify them. A good many are well known, both from having exhibited on former occasions, and from their manufacturing reputation Bacon's hot-water apparatus, Howorth's ventilators, Marsden's stone-breaking machines, Musgrave's stoves, Stiff and Son's sanitary stoneware, these and many other of the objects shown are already so familiar to the public as to make it unnecessary to describe them; while there do not appear to be any very striking novelties among the articles exhibited by manufacturers whose names are less familiar to the general public. Mr. Skelton shows the ingenious street lamp, with reflectors at the top, on which he read a paper a few sessions ago before the Society. Mr. De Keyser exhibits a section of the remarkable artesian well he has had constructed to supply his hotel at Blackfriars with water. The Milburn Engineering Company show one of their sludge-drying machines, which was to be put in action, but had not got to work during the first few days of the Exhibition. This, indeed, may perhaps be considered as one of the exhibits showing the greatest amount of novelty in the class, for though the machine has been before the public for two years (as stated by the makers), it must be considered as yet on its trial. It is only when some special process of precipitation or subsidence is applied to town sewage that a sludge-drying machine can be employed, and there are as yet so few places where this is done, even experimentally, that there cannot be said to be any great demand for the machines. If, in the long run, precipitation processes are found successful, some such apparatus as this will become an obvious necessity.

The sanitary portion of this class is not very well filled. There are not very many exhibitors, and those who do exhibit do not show very much. Messrs. Stiff show some of their sanitary stoneware; the Native Guano Company send specimens of their products, and of the materials used; Ledger and Co. show their disinfectants; Mr. P. Spence sends specimens of a new material for precipitating sewage, termed "Alumino-ferric cake," and there are one or two others. It ought not to be omitted that the Society of Arts appears as a contributor to this class, in virtue of some copies of the "Report on the Recent Conference on the Health and Sewage of Towns," which were presented to the library of the Exhibition.

Class VI. contains some noticeable exhibits, but it cannot be said to be a fair representation of the means in use for preventing accidents or injury in industrial operations. There are comparatively few examples of the various devices which have of late years been adopted in so many manufacturing processes, to render them less injurious to the workers. Many instances will at once occur to those familiar with industrial operations; methods of carrying dust away from grinders and others whose work necessitates the production of much fine dust; guards for machinery, especially such special arrangements as are required for thrashing machines; improvements in chemical processes, such as the use of amorphous phosphorus for lucifer matches. These are but a few illustrations of the sort of objects which might fairly be looked for in this class. It would not, indeed, have been easy to have collected them, and it would have been a somewhat expensive undertaking, since there are no makers of such objects who might be induced to take part in the Exhibition from ordinary business motives, with the hope of a legitimate return in the extension of trade. Still, if it could have been got together, such a collection would have been of real value. By showing what had been done and what attempted, by success and failure alike, it would certainly have done some service towards the removal of one of the greatest curses of modern life, the fate that makes so many workers wear out their lives in unwholesome toil for their daily bread.

About the most important objects shown are the models and drawings exhibited by Messrs. Gibbs and Co., of the arrangements adopted in their chemical works for dealing with noxious fumes and protecting the workmen from the effects of poisonous gases. Among the other objects shown are safety lamps, driving bands, wire ropes, safety lifts, a detaching hook for preventing over-winding (Walker and Son, Birmingham), steam valves and alarms for over-pressure or lowness of water, a safety indicator for collieries, to give notice of fire and gas (Bagot, Rugeley), &c.

The next Class (No. VII.) which deals with domestic and personal hygiene, is tolerably well filled. One or two exhibitors show filters, the "spongy iron" filter being one of them; several show cooking apparatus of various sorts; there are some disinfectants in this as well as in Class V. J. Parker shows his earth closet, and Messrs. Capper show Pearson's trapless closet, both of which were shown at the Exhibition of Sanitary Appliances in connection with the Society's Conference. Messrs. Bradford have a number of their household machines, and there are several exhibitors of food preparations.

Class VIII. is purely medical, and consists for the most part of mechanical appliances for the injured or disabled. The Remington type-writing machine is placed in this class, on the ground of its suitability for use by the blind. There are, too, some disinfectants, some examples

of dental surgery, and a few medicinal preparations.

Class IX. is rather small, though it takes up a good deal of room in the catalogue. Mr. E. Johnson has been at great pains to collect for the use of the Exhibition library a set of reports and other publications issued by various public institutions. The list of these occupies nearly nine pages in the catalogue, and considerable trouble has been taken to make it as complete as possible. Any charitable or other institution which has not contributed its report will doubtless be assisting the object of the collection by sending a copy of any publication issued by them to the London offices of the Exhibition.* Mr. E. A. Gruning sends plans and drawings of the German Hospital, Dalston, and the Convalescent Hospital, Seaford; Price's Candle Company and Messrs. Gibbs show their arrangements for the comfort and benefit of their workpeople; and there are three exhibitors who propose to improve the condition of the working classes by supplying them with aërated waters.

We now come to the last class of the British Section, which treats of "The Protection of Life and Health as applied to Agriculture." Messrs. Gibbs and Co. show specimens of their artificial manures, and Messrs. Packard and Co. (Ipswich), also have a handsome case showing artificial manures and the materials from which they are made. These include various waste products, which are utilised by being worked up into manures, and specimens of the raw natural phosphates which are now generally used for making superphosphate. At present artificial manures are not highly appreciated in Belgium, so perhaps these examples of what English farmers are using so largely may attract the attention of Belgian agriculturists to this subject. Musgrave's iron stable fittings and cow stalls are shown in model and by specimens of the articles themselves. One exhibitor (J. P. Fison) shows a drum guard and feeder for preventing accidents from thrashing machines.

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MUSEUM OF SCIENCE.

The following memorial has been forwarded to the Duke of Richmond and Gordon on the subject of the creation of a Museum of Pure and Applied Science. It is signed by the President of the Royal Society, the Chairmen of Sections at the recent conferences at South Kensington, the Chairman of the Society of Arts, &c.:—

"June, 1876.

"My Lord Duke,—We, the undersigned, beg to submit for your Grace's consideration the importance of establishing a Museum of Pure and Applied Science: that is to say, a museum to contain scientific apparatus, appliances, and chemical products, illustrating both the history and the latest developments of science; where the methods and results of investigations which have marked important stages in the advancement of science may be studied, and where also the most highly perfected instruments of the day may be found.

"Among the various advantages which in our opinion would accrue from the establishment of such an institution, we would mention the following. Investigators would be saved much time and labour by being enabled to see how far, and by what processes, others have advanced in the line of research which they may be pursuing: thus leading them to a knowledge of the facts and laws already established. From an educational point of view such a collection would assist teachers by enabling them to select, or by showing them how to construct, the best apparatus for illustrating the subjects of their lessons. Great benefit would also accrue to the constructors of mechanical and philosophical apparatus from being able to refer to the original apparatus which they might be required to reproduce or to improve. To every one connected with experimental science, it would be of great service to see the actual instruments, many of which could otherwise be only known to them by description, and, under proper supervision and instruction, to learn their actual manipulation and performance. We would also contemplate lending to investigators, under suitable restrictions, such instruments as might be profitably employed in the researches they were pursuing.

"In considering this subject our attention has naturally been directed to the existing Museum of Patents. While fully recognising the value of many of the objects now belonging to that collection, we are of opinion that, as standing alone and purely as subjects of a patent, their value is far less than if they formed part of a general collection, and were placed in juxtaposition with instruments of a similar nature, some of which, though not patented, are better adapted to their purpose, and of greater instructional value. The object of a Scientific Museum is the promotion of knowledge, and the establishment of the scientific principles which must underlie all invention; and it would not only prove of great advantage to both scientific investigators and the public if the two objects could be combined in one undertaking, but we believe that the objects of a Patent Museum would be better served by a museum of the character here proposed than by a special collection, such as has hitherto subsisted. We are decidedly of opinion that the state of knowledge in reference to any invention would be only very imperfectly represented by the exhibition of patented instruments and products only.

"In support of the views which we have ventured to submit, we should draw your Grace's attention to the 4th report of the Royal Commission on Scientific Instruction, §§ 80-94. In § 93 the Commission state:—'We accordingly recommend the formation of a collection of physical and mechanical instruments; and we submit for consideration whether it may not be expedient that this collection, the collection of the Patent Museum, and of the Scientific and Educational Department of the South Kensington Museum, should be united and placed under the authority of a Minister of State.'

"We understand that the Royal Commission for the Exhibition of 1851 has offered to erect a building for the purpose contemplated in this memorial, and we would desire to point out that the purchase of objects need not entail any large outlay of public money. We contemplate the gradual formation of a collection of such objects as might be voluntarily left at the close of the existing Loan Collection, and others which might be contributed from the existing Patent Museum and other public departments, from the Parliamentary grants administered at the request of Government by the Royal Society, and from such private societies and individuals as might be disposed to avail themselves of the museum as a depository of scientific apparatus, appliances, and chemical products."

Twelve lines of tramways are now working in Paris, viz., from the Louvre to Versailles, to Sèvres, to St. Cloud, and to Vincennes; from the Place de l'Etoile to La Villette, to Courbevoie, to Suresnes, and to the Montparnasse station; from La Villette to the Place du Trone; from the Place Saint Augustin to Neuilly and to Levallois-Perret; from the Place Saint Germain-des-Prés to Montrouge; and from the Place Moncey to Clichy and Asnières.

IMPROVED MODELS AND APPARATUS FOR TEACHING PRACTICAL DRAWING.

The Society, at the Conference on Adult Education held on Friday, the 23rd June, devoted the large room on the ground floor to an exhibition of modern educational appliances, and amongst these four sets of models, all designed by Mr. Ellis A. Davidson, formed important features. The first set, called Davidson's apparatus for teaching practical geometry, comprises, in the first place, a set of geometrical planes, of polygons, and other figures; these are about 18 inches in diameter, with label giving name and special quality; adapted for hanging round the walls of a school. Next we have models by which a triangle is practically converted into a rectangle, another by which the squares constructed on the two sides of a right-angled triangle are converted into one, the side of which is equal to the hypothenuse. (Euclid, b. 1, prop. 47).

Another important feature in this series is the set of models for illustrating the construction of the cycloid, the epicycloid, and hypocycloid, which curves are, by means of the apparatus, drawn on a very large scale on the blackboard, realising the description of them hitherto only learnt by heart or by a blackboard drawing. In this way, also, a model is prepared for the construction of the involute. The series also contains a large divided cone showing the different sections.

The next set are called Davidson's advanced drawing models, and are, perhaps, the largest set hitherto introduced. These comprise an obelisk composed of three octagonal slabs as a base, the monolith standing on a cube, and capped by a pyramid, the whole group being five feet high; next is a market cross, an upright on steps, with arms at right angles to each other, the height being about three feet. A step ladder, a tube, a divided cylinder, a divided hollow sphere, and a strong trestle next carry on the series, and these are followed by a strong kitchen table, a chair, and a stool. All of these models are made separablo into their component parts. This not only contributes to their portability, by which one set may be used by a group of neighbouring schools, but the joints, &c., being all correct, the pupil may draw the separate parts, and learn the method of construction and the system of making working drawings. These two sets, which are published by Messrs. Chapman and Hall, are placed by the Government Department of Science and Art on their list of approved apparatus, towards the purchase of which a grant of 75 per cent. is made.

Another set, exhibited by Messrs. Cassell, Petter, and Galpin, called Davidson's technical drawing models, is smaller than the last, but still is of a size adapted for large classes in schools. The set comprises numerous objects and geometrical solids, so arranged that other forms may be developed from them. Thus there is a set of nine rectangular prisms which when placed together form one solid block, three of these being removed a flight of three steps remains, two of those withdrawn being placed as uprights on the upper step and the third as a lintel, and the general form of a doorway with steps is formed. A solid six-armed cross is also one of the models to be built up, by which method the pupil is guided as to the order in which the different parts of a model should be drawn. Stools, tables, and numerous groups may thus be built up. This set is also approved by the Science and Art Department, and grants made towards their purchase.

The fourth set of models, called Davidson's landscape models, exhibited by Messrs A. N. Myers and Co., comprise models of which a church is formed, a step ladder, a simple ladder, a bridge, a field gate, a cottage, a garden roller, a doorway, &c. These are adapted for advanced study in applying the principles of model drawing. They are specially designed to remedy the evil of learning to draw merely from copies, and to give sound elementary notions of drawing from nature. Several of these models are coloured, in order to be useful as water-colour studies, and all are made portable for the use of visiting teachers.

NATIONAL TRAINING SCHOOL FOR COOKERY.

The third annual general meeting of this school was held on Tuesday, 27th June, 1876, in the "Demonstration" kitchen of the school in Exhibition-road, South Kensington. H.R.H. the Princess Louise, as one of the lady patronesses, was present, and a numerous company, including the following:—The Duke of Westminster (president), the Duke of Beaufort, Earl Sydney, Earl and Countess Cowper, Lord and Lady Alwyn Compton, Lady Marian Alford, Hon. E. F. Leveson-Gower, Lady Rayleigh, Lady Knightley, Louisa Lady Ashburton, Lady O'Hagan, Sir Henry and Lady Cole, Mr. Lyon Playfair, M.P., Viscount Barrington, Hon. Mrs. Percy Wyndham, Mr. Mundella, M.P., Col. Du Cane, Mrs. Henry Reeve, Mr. C. J. Freake, Miss Shaw Lefevre, Mrs. Le Neve Foster, &c.

The Duke of Westminster having taken the chair, the following report of the Executive Committee for the past year was read:—

Report for the Year ending 31*st March*, 1876.

1. The Executive Committee lay before the donors and subscribers to the school the annual statement of accounts, together with the report of the lady superintendent on the working of the school for the year ending 31st March, 1876.

2. These documents show that the school has already justified its name as the National Training School for Cookery and is doing public service effectively. The working of the school, as shown by the attendance of students, by the increasing payment of fees, and by the establishment of local schools, has been thoroughly satisfactory. But the falling off in donations and no increase in subscriptions have rendered the financial position a matter of some anxiety. However, since the account was made up, the finances have improved, and the committee hope to have such public support as will extend the national influence of the school.

3. The Executive Committee have waited upon the Lord President of tho Council and the Vice-President of the Committee of Council on Education to point out that the school is the only institution for supplying competent teachers of cookery to give effect to the wise introduction of cookery into the Code, as a branch of domestic economy in elementary public schools. The Executive Committee have asked her Majesty's Government to send annually suitable students from each of the female training colleges to bo trained as teachers of cookery. This principle of action has been successfully pursued for years in the Science and Art Department with teachers of science and art, and the co-operation on the part of Government would give vitality to the grants offered by the State to elementary schools; would place the school on a firm basis, and justify the Executive Committee in obtaining better premises than the present, which are unsuitable and have become much too small. But whilst hoping for the assistance of the Government, the committee desiro to press upon their subscribers, school boards, corporations, and the public, the great importance of sending competent persons to be trained as teachers.

4. It should be remarked that her Majesty's Commissioners for the Exhibition of 1851 originated the first lectures on food in this building, and afterwards granted the use of theso premises rent free; without their aid the school would never have come into existence. The Executive Committee feel bound to express their gratitude to the Commissioners for having helped to create this School of Cookery, and thus giving practical effect to the observations of Count Rumford who says "The

number of inhabitants who may be supported in any country, upon its internal produce, depends about as much upon the state of the art of cookery, as upon that of agriculture, but if cookery be of so much importance, it certainly deserves the greatest care. Cookery and Agriculture are arts of civilised nations; savages understand neither of them."

5. The committee recommend that his Grace the Duke of Westminster, K.G., be requested to continue his services as President, and that the officers named be elected for the ensuing year:—

Executive Committee.—The Hon. E. F. Leveson-Gower (Chairman); the Duke of Beaufort, K.G., the Earl Sydney, G.C.B., the Viscount Barrington, M.P., Sir Daniel Cooper, Bart., Sir Henry Cole, K.C.B., Colonel Baring, James Bateman, Esq., F.R.S., Lieut.-Colonel Ducane, C.B., R.E., C. J. Freake, Esq., J. MacGregor, Esq., M.A.

Lady Visitors.—The Countess of Derby, the Countess Brownlow, Lady Marian Alford, Lady Arthur Russell, Louisa Lady Ashburton, Lady Cole, the Hon. Mrs. Sartoris, Mrs. Freake, Mrs. Millais, Mrs. Frank Morrison, Mrs. Reeve, Mrs. Holland.

The **Duke of Westminster** opened the proceedings by thanking H.R.H. the Princess Louise for her presence on that occasion. With regard to the object they had in view, he was happy to say that the Government had admitted the propriety of instruction in cookery in schools, but to make the teaching efficient they were asked to send annually suitable students from each of the female training colleges to be properly trained at South Kensington. He was glad to say that up to the present time the idea had been favourably received, and he trusted the Government would soon take the matter in hand; if carried out it would place the school on a firm basis, and justify the committee in obtaining better premises than the present, which were much too small and inconvenient. They had to thank her Majesty's Commissioners for the building now in use, otherwise the school for cookery would have never existed, but it was hoped that as the public had lately obtained a school for music, funds would be obtained to enable a school for cookery (which was certainly not less essential) to be erected.

The **Hon. E. F. Leveson-Gower** (Chairman of the Executive Committee), referring to the report, said that the school had been three years in existence; the first year as part of the International Exhibition, where lectures were delivered by Mr. Buckmaster; the second year when the instruction was principally taken advantage of by ladies; and last year, when the training of instructors in cookery had been the chief object. During the last year 23 instructors had been trained, and 23 more were in course of qualification. Branch schools had been established in Edinburgh, Glasgow, and many of the provincial towns, and the most satisfactory reports were received from all those places where schools had been established. One teacher of cookery was getting as much as £300 a-year, and another had obtained a situation of £250 a-year; by means of these teachers, he trusted, not only would the wives of men occupying the middle class station of life, and the wives of artisans, obtain a knowledge of cookery, but the instruction would be extended to children who would be the wives of the future. The value of the work initiated by the school had been admitted, as shown by the establishment by he School Board for London of four centres for cookery truction; this, he thought, proved that the idea was eciated, and not a plaything. The position of School had gradually improved, as was shown the fact that since March last they had debts to the extent of £250, but they had exer- strictest economy; but here, as in other things, ight be carried to such an extent as to diminish The public were full of praise, but not of ort. It was hoped, however, that when it was known that every subscriber and donor of £1 1s. would receive in return a vote for the nomination of a person to be trained as an instructor, free of cost, there would be an increase in the number of their subscribers. The Government had met them in a friendly but a cautious spirit, but he did not object to caution in the application of public money. That the movement was one deserving Government aid and support, the public, by their own action, could prove.

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Dr. Lyon Playfair, C.B., M.P., in moving a resolution, which affirmed the importance of Government aid to the school, said that there was an old story of the three tests of civilisation:—(1.) The quantity of soap per head of the population used; in answer to that he thought England would stand high. (2.) What was the price of rags? meaning to what extent were reading and writing carried on; in the answer to that he thought America would come to the front. (3.) Count Rumford's test of cookery; and in answer to that he thought England went down low.

Mr. Mundella, M.P., in seconding the motion, spoke as an employer of labour, affirming the necessity of placing the school upon a permanent foundation, and regretted the little profit with which the present high wages of workmen were spent. After the Lancashire famine a member of his family who visited his work-people had said to him, "I don't know which is the worse, the famine they suffered from before or the cookery they are suffering from now." His wife found the women on returning from the factory "frizzling" good meat over the fire to a substance of the consistency of shoe leather. In three years an additional £13,000,000 was paid in England for meat. The greater part of that sum must have been applied for the consumption of the working classes, and he had no doubt that a very large proportion of it might have gone in the savings banks instead, if a smaller quantity of food had been bought, and that quantity well and economically treated.

The **Duke of Beaufort** proposed the adoption of the report. He trusted that the Government would assist the work of the school by sending students from the female training colleges to go through a course of training in the manner that had been suggested.

Sir Henry Cole, in seconding the resolution, advised ladies who wanted to earn £100 a year, and to be their own mistresses, rather than governesses, to enter the school and learn cookery.

Lord Sydney moved the best thanks of the meeting to H.R.H. the Princess Louise for the interest she had throughout manifested in the work; and this was seconded by **Colonel Du Cane**.

Votes of thanks to the Duke of Westminster and Mr. Leveson-Gower were also proposed and carried, and the meeting closed.

[The report of the Lady Superintendent and the balance-sheet will be given in the next number of the *Journal*.]

The German Gasmakers' Association offer a prize of the value of £80 for an essay on methods of separating carbonic acid from ordinary illuminating gas. Essays are to be sent in before December 31st to the secretary of the Association at Munich.

In the first four months of this year, the revenue collected by the Parisian Company for Lighting and Heating by Gas amounted to £695,812, as compared with £646,095 in the corresponding period of 1875, showing an increase this year of £49,717, or 7·70 per cent.

The production of pig-iron in France last year amounted to 1,415,728 tons, as compared with 1,402,122 tons in 1874. The production of wrought iron in France last year was 775,442 tons, as compared with 768,436 tons in 1874.

THE ABOLITION OF PATENTS IN HOLLAND.

A recent article in *Engineering* discusses the state of public opinion in Holland on the subject of Patent-law, and strongly opposes the idea that Dutch manufacturers really profit from the absence of a Patent-law in their country. After a few introductory remarks, the writer of the article proceeds:—"Reference to the report of the discussion which took place in the Second Chamber of the Netherlands Legislature in the session of 21st June, 1869, would readily show that practical members were strongly opposed to the abolition of patents, and regarded the measure about to be adopted as highly dangerous. But we will not go so far back. The fact remains that by a majority the Bill was passed by which a Patent-law previously existing was abrogated. Since then a period of six or seven years has elapsed, and our friends of the Netherlands have had an opportunity of judging of the advantages derivable from the absence of protection for new inventions. Now, although Holland cannot pretend to be regarded as an important country in a manufacturing sense, yet its manufacturing interests are of sufficient extent to justify the existence of an influential manufacturers' union (Vereeniging van en voor Nederlandsche Industrieëlen). This institution is often appealed to by the Dutch Government when needing advice on industrial questions, and from its members the Government representatives and commissioners for exhibitions are generally chosen. It is essentially a representative institution. To this body a paper on the expediency of protection for inventions was submitted in the latter part of the past year by Mr. Lloyd Wise. It points very clearly to the true cause of the abolition of patents in Holland, especially when taken in connection with the resolution we shall presently refer to. In introducing the subject on the occasion of the fifty-sixth meeting of the institution, held at the Hague, the chairman, Mr. A. H. Eigeman, said the question arose whether the society did not pronounce against the law of patents of 1817, and this being the case, whether it would be becoming in its members to support the idea of Mr. Wise. Some might assert that since Dutch manufacturers could export their productions only by way of exception, they as well as their consumers ought to prefer the liberty of using foreign inventions as they thought best. Others asserted that patents had by no means been abolished in the Netherlands, for those which had been granted up to 1869 not only still existed, but might even be prolonged. Thus the law of 1817 had not been repealed; only in 1869 it had been enacted that from the day of the promulgation of the law of July 15th, no new patent for any invention or improvement or importation of artistic or industrial articles should in future be granted, excepting only those for which by that date patents should have been already solicited. Moreover, as prolongations of the patents already granted were solely limited by the maximum of fifteen years' duration, it would be readily seen that they were still to live for a rather long time under the influence of the law of 1817. The chairman proceeded to remind the society that they did not by any means wish to do away with the legal protection of inventions in the domain of art and industry by supporting the abolition of the law of 1817. For that law, said he, whilst purposing to afford that protection, did not in fact do so, and whether the law itself, or the courts of justice which ought vigilantly to have protected the enactments of the law, were to blame for the result, it was not for him to decide. But if the law did not protect the inventor against forgery or imitation, although the latter might not in every respect agree with the original, yet if the courts adopted, in the application of the law, the reverse of the maxim that '*le fond emporte la forme*,' or 'the substance ought to overrule the form,' then it would be better to abolish that law, in order that honest men might not rely on protection when nothing of the kind was afforded. The assertion of the Legislature laid down in the preamble of the law of July 15, 1869, that the granting of patents for inventions, improvements, or first importations is detrimental to the interests of industry as well as to the public weal was (proceeded the chairman) untrue, at least in its generalisation, and had, therefore, at the congress of Vienna in 1873, met with a general denial. It was a truism only as regards Holland, that is to say, so long as its manufacturers were, notwithstanding its liberal tariffs, excluded from other countries, such as Germany, France, and Belgium, not to speak of England and America. Nevertheless, he thought the meeting should manifest its sympathy with the aim Mr. Wise had in view, therefore the board of management would read his memoir with much pleasure, and make known its opinion at the next meeting of the society.

"Accordingly the communication was dealt with by the Board, who, having had it in hand several months, submitted to a subsequent meeting a lengthy report, concluding thus: The Board of Management, having maturely reconsidered this memoir, proposes to you to accept and adopt the following resolution:—'The Dutch Manufacturers' Union having taken into consideration Mr. W. Lloyd Wise's paper, and the discussion which ensued from the reading of it in committee, is of opinion that it is highly desirable, for the sake of the public in general as well as of industry in particular, that a good, liberal, and international Patent-law should be made, as an encouragement to those who wish to devote themselves to the practical production of new machines, or to the improvement of existing ones, this being the only way leading to the application of talent and knowledge to practical industry, and conducive to the increase of national prosperity.'

"Considering the source whence it emanates, it would be difficult to over-estimate the importance of this resolution in its bearing as a guide to our legislators. Let them not be led astray by any clap-trap about so-called 'free trade.' The dishonest appropriation of the fruits of a man's intellect is not 'free trade' properly so-called, and, therefore, the expression 'free trade' is entirely misapplied when used to describe what would be the state of things were protection for inventions entirely abolished. So far as we know, Holland affords the only example of a country which, having once had a Patent-law, has wholly abrogated it, and, as we have shown, the very people who were in favour of the abrogation of that particular law, are strongly in favour of the establishment of an equitable law for the protection of new inventions. Indeed, after the peculiar circumstances in which their country is placed as a small manufacturing state having low tariffs, competing with large manufacturing states with high tariffs, the strongest objection they urge as against the abrogated law is that whilst professedly giving protection to inventors it did not in reality do so. One cause of dissatisfaction with the law and the mode of executing it was the examination to which applications were subjected, as the arbitrary decision of one man, or a few men, however incapable, decided on the fate of an application for Letters Patent, and might be productive of most injurious consequences Now this is just the sort of difficulty the Lord Chancellor's Bill now before Parliament would lead us into if carried out in its integrity. Any examination whatever as to utility, by whomsoever conducted, would be a most dangerous innovation. Mr. Bramwell, in his elaborate reply to the discussion on the able paper he read to the Society of Arts in 1874, whilst deprecating examination as to utility, went so far as to say on this question, 'I have very great fear of it, even in respect of novelty.' He showed the mistaken notions formed, not by mere uneducated mechanics, but by highly scientific men, as to Watt's invention, and the inventions of Dr. Potts and others. The questions of novelty and utility are closely allied. We ourselves call to mind a comparatively recent patent case, in which a most eminent and able engineer gave evidence respecting a simple invention. The invention consisted in a combina-

tion, as most inventions do, one element in particular being most essential to the satisfactory working of the combination. Now a question was submitted to the witness with the view of eliciting whether a certain alteration dispensing with that one element would be equally satisfactory, and it was not until the following day, and after he had had an opportunity of experimenting (for which in this particular case apparatus was fortunately available) that he was prepared to say that the element it was suggested might be dispensed with was in reality essential to the efficiency of the machine. This evidence involved a contradiction of the opinion given by the same gentleman on the previous day. Now supposing that the machine did not require the element in question, in other words, assuming that element could have been dispensed with as being unnecessary, the leading feature of novelty and the essence of the principal claim would have disappeared from the patentee's specification. How readily even a most able examiner might fall into the grievous error of pronouncing such an invention 'frivolous, and not worthy of a patent.'

"As we have seen in the case of Holland, provisions for preliminary examinations of this class tend to bring a patent system into disrepute. So also do such interpretations of a law as fall short of free and open-handed justice to inventors. This much, and this much only, as against patents, is to be deduced from the abrogation of the Dutch Patent-law of 1817, coupled with the verdict that has been pronounced by the Dutch Manufacturers' Union. We are glad this most salutary expression of opinion goes forth at the present time. It is most opportune, and will go far to upset the erroneous impressions of many who may have been guided by tho one-sided statements of enthusiasts, who would wish to see protection for inventions abolished at any cost save to themselves."

CASK-MAKING MACHINERY.

The members of the Society of Engineers lately paid a visit to the Stanley Works of Messrs. A. Ransome and Company, Chelsea, the well-known makers of wood-working machinery. Here they saw a cask made out of the rough oak planks entirely by a set of machines especially designed for the purpose, all of them performing two or three functions. First, the rough boards were cut to length by a cross-cut saw and jointed; holes were drilled for the dowells, or wooden pins to hold the pieces together; the dowells were inserted, and the joints closed up. The square piece of wood was then placed in the head turning machine, which is a kind of lathe: a lever, jointed on the tappet, brings a knife to bear on the side of the square piece, and so cuts out the round head, allowing the corners to fly off. A pair of slide rests, set at the proper angle, are then brought into action by a lever for bevelling off the edges, and the head is complete. There is a very ingenious arrangement, consisting of a hollow-shaft and friction washer, for holding the head in the lathe and making it revolve with the lathe or not, although the latter is continually running. Not less ingenious is the manner in which the rough slats for the staves are brought to the required curve on the edges. The slat is sprung into a frame or cradle having the proper convexity, and held there by a lever with eccentric head. The cradle is then passed in a straight line between two cutters above and below, and at right angles to their axis. The cutters are coned to the same angle as the desired bevel of the edges of the staves, and as the ends of the stave come in contact with the larger diameter of the conical cutter, and the middle in contact with the smaller diameter in the passage of the stave, owing to its convex form, it follows that more is taken off the ends then the middle, and the desired shape is thus given to the stave. The staves are collected into the form of a barrel in a gathering machine, drawn tight by a rope being twisted round them, and temporarily secured by hoops. The cask is then put in another machine of the lathe type to have the ends of the staves turned off, and the "croze" or groove made for the head. The heads are inserted, and the cask is complete. It should be mentioned, however, that for large casks a few more operations are necessary, such as planing the heads, and rounding and steaming the staves; but all can be done by machinery, five sets of ten or eleven machines each having lately been sent out by Messrs. Ransome to a cooperage at Oporto. The firm calculate a saving of 2s. 10½d. on each hogshead cask made by machinery instead of by hand labour.

LIGHTNING CONDUCTORS.

M. R. F. Michel has lately made two interesting communications on the subject of lightning conductors to the Académie des Sciences; the first points out the objections to making conductors of iron or copper wire rope, while the second relates to the numerous opportunities for fraud to which the use of platinum for the points of the rods gives rise.

For some years the use of copper wire ropes has been recommended for this purpose, this metal being a much better conductor of electricity than iron, and the ropes formed from it lending themselves readily to the architectural contours to which they might be attached. But, besides the fact that the high value of the metal affords too great a temptation to the cupidity of the workman, the ropes themselves frequently undergo considerable deterioration under the action of the electrical currents passing along them, of the atmosphere, and of the vibrations to which they are exposed; the copper becomes crystallised and brittle, the wires snap one after the other, and the consequence is that in a short time the available sectional area of the rope is considerably reduced.

The author also calls attention to the very defective method of manufacturing these cables, whether of copper or of iron. When it is desired to join a wire accidentally broken, or of insufficient length, the two ends are merely twisted together, without any precaution being taken to secure the proper contact at the joint. Oxidation ensues, and it may happen that the conductive power of the rope is materially lessened, and even completely destroyed. The conductor should, therefore, be formed of iron rods welded together, or of a rope consisting of large wires with no joints; plates of copper, however, seem to possess considerable advantages for this purpose, without any of the drawbacks mentioned. The Paris Bourse has a ridge cover of copper connected with the lightning conductors, which was put up a long time ago, but is still in a perfect state of preservation and electrical conductibility, as proved by some recent delicate tests.

In the second communication, the author states that for the last year he has undertaken a microscopical examination of the points of lightning conductors, and has also subjected them to chemical analysis. The result has been that about 40 per cent. of the points examined were found to contain from 6 to 17 per cent. of lead. Some points, even of small dimensions, had been hollowed out inside, so as to leave a shell of only 0·75 of a millimetre thick, and into the cavity thus made a composition of equal parts of lead and tin had been run. After cutting one of these points, and placing it in a crucible raised to a dark red heat, the fusion of the composition left an empty space, and in some of the platinum points the composition adhered so slightly as to be easily removed by the aid of a punch.

At the time of the enquiry into the state of the lightning conductors surmounting the municipal buildings, M. Michel found that the proportion of platinum points bent, burnt, or fallen off, amounted to 80 per

cent., and he has come to the conclusion that it is quite impossible to verify the state of the platinum points of lightning conductors.

SIMPLIFICATION IN GALVANIC BATTERIES.

The following account of some improvements in galvanic batteries, intended to render them easier and therefore cheaper of construction, and more portable in a variety of cases in which an ordinary battery would be inadmissible, is taken from the *comptes rendus* of the *Académie* :—

The improvements consist in the substitution of artificial parchment for the diaphragm or porous jar, and in the simple arrangement of the different portions of the battery. The paper parchment, on account of its suppleness, readily lends itself to any form; it has only a small volume, and acts as a dialyser as efficiently as porous earthenware. The sulphate of copper battery, for instance, thus becomes one of great simplicity, and may be first in action at any time. All that is necessary is to wrap a sheet of paper parchment round a zinc cylinder and to roll a copper wire spirally round the parchment, thus forming a diaphragm. The whole is plunged into a solution of sulphate of copper, and the battery immediately works with regularity, all the parts thus constituting a small cylinder hardly longer than the zinc rod employed.

In the case of some carbon batteries a similar arrangement may be adopted: the carbon may be enveloped in the paper parchment, and on the outside may be placed a cylinder of zinc, or a thick zinc wire, which serves at the same time to keep the paper in its place. When the battery thus constructed is wetted, it is capable of continuing in action for some hours after being taken out of the exciting liquid; and it may be rendered more portable, and be endowed with all the advantages of a dry battery, by folding the paper double and placing the exciting salt between the folds. This modification has also the advantage of giving with a single liquid the effect of a two-liquid battery. In fact, on immersing this battery in an exciting liquid, a difference is immediately set up between the latter and the liquid which has penetrated into the interior and occupied a place between the paper and the metal covering.

ILLUMINATION OF LIGHTHOUSES.

M. E. Allard, engineer-in-chief of the administration of lighthouses, has lately brought before the *Académie des Sciences* some papers on the illuminating power of the flames employed for illumination, their transparency, and the translucency of the atmosphere.

The first paper treated of the transparency of flames. The burners used in lighthouses have diameters of 3 to 13 centimetres (1 to 5 inches), and carry from 1 to 6 concentric wicks. In measuring the luminous intensity of the flames which they produce, it is found that these intensities increase a little less rapidly than the consumption of oil, and also that the intensity per square centimetre of apparent surface increases, while on the contrary the intensity per cubic centimetre of volume diminishes, in direct proportion to the diameter. These results can only be explained by admitting that the transparency of the flame is not absolute.

This is the subject of the first investigation made by M. Allard; he has determined the co-efficient of this transparency by three series of experiments: by measuring the intensity of different flames with a flat wick looked at side or edge wise; by means of a curved mirror, which reflects towards the focus the rays which it receives, and thus causes them to pass through the flame; and by measuring the intensity of an electric light across a flame of large diameter. These investigations have led to the adoption of the number 0·8, as a mean value of this coefficient reduced to a thickness of one centimetre in the flame passed through. One important conclusion is arrived at, viz., that the total quantity of light produced, or the absolute intensity, increases much more rapidly than the weight of oil consumed; but, as the quantity of light absorbed by the passage of the rays across the flame itself increases in a still greater proportion, the difference between these two quantities, or the effective intensity, follows a law of augmentation a little less rapid than the consumption of oil.

M. Allard was next engaged on the translucency of the atmosphere. The observations made by lighthouse keepers on the visibleness of neighbouring lights consisted in noticing, three times each night, whether each of the lights could or could not be perceived, so that it might be ascertained at the end of a certain number of years, how many times out of a hundred each of these lights was visible. A diagram showed, for each of the lights noticed, what is the limit of translucency in which it ceases to be perceived from the place of observation.

In another paper M. Allard has studied the impressions produced on the organ of sight by flashing lights. It appears that, by causing a series of flashes to be succeeded by equal intervals of darkness, each flash at moderate speed produces the same effect as if in an isolated state; in proportion as the speed increases, the impression on the retina is prolonged, and after a certain speed the effect is that of a constant light.

THE EXPORT TRADE OF HOLLAND.

The great resources of Holland in the yield of food products, such as live cattle, meat, fish, fruits, vegetables, butter, cheese, &c., is exemplified in the increased and increasing exportation from that country of all these articles to England, Belgium, France, and Germany. The British representative in the Netherlands reports that this state of things, though no doubt satisfactory to the particular class of persons by whom the articles in question are produced, or who profit directly by the export trade in them, is by no means so satisfactory to the population at large of that country, for the natural result of this wholesale exportation is that the markets of Holland are almost cleared in order to feed those of other parts of Europe, and the retail prices of such commodities are consequently driven up to very nearly the level of those current in the largest and most expensive capitals of Europe; and not only are the retail prices very high, but as the best of everything in the shape of provisions is taken by the contractors for the export trade, that portion which remains for home consumption is, as a rule, of but second-rate quality. It is especially in the article of butchers' meat that the effects of this organised system of wholesale exportation is injuriously felt by the population generally; for although Holland is probably as rich in cattle, if not richer than any other country in Europe, and in a normal state of things, meat should be plentiful there, and cheap in proportion, this commodity is, on the contrary, so extremely dear not only in the large cities, but also in the provincial towns and throughout the kingdom generally, as to be quite beyond the reach of the labouring classes, of whose regular daily food it consequently forms no part, whilst even among the less well-to-do of the middle class it is considered rather as a luxury. In addition to the cause in question, there is one other which acts directly in the sense of increasing still further the price of butchers' meat in Holland, viz., the excise tax of 15 per cent., which is levied on the assessed value of every head of cattle of every description slaughtered in Holland, and this tax, as it is not charged on cattle sent alive out of the country, acts indirectly as a premium on exportation. In the same manner as meat, sea fish is only to be purchased retail at extremely high prices; for, though the quantity of fish

caught by the great fleet of Dutch fishing boats, and landed in Holland, is enormous, it is no sooner brought on shore than the greater portion falls into the hands of the contractors, and is packed and sent off to foreign countries. Salmon, too, which the great Dutch rivers—the Meuse, the Waal, the Lek, the Yssel, &c.—produce in such abundance, is exported on so large a scale as to be almost a rarity in the retail markets, and it is stated as a positive fact that Dutch salmon may frequently be bought in the London fishmongers' shops at little more than half the price that it usually fetches in the markets of the Hague, Amsterdam, &c., where from 3s. to 3s. 6d. the pound may be considered as the minimum price, and 5s. to 8s. the pound by no means an unusual one. The prices of poultry, fruit, vegetables, in fact, of all provisions of all kinds which will bear a journey of a couple of days, are equally high in proportion, and seem to be constantly on the increase.

PORTUGUESE POSSESSIONS, EAST COAST OF AFRICA.

The Portuguese possessions on the East Coast of Africa extend over more than 1,200 miles of coast line, from Cape Delgado to the Bay of Lorenço Marques, comprising the southern shores of Delagoa Bay as far south as 26° 30′ south latitude. The further points in the interior occupied by the Portuguese are on the Zambezi River, where a few men were recently stationed as high as Zumbo, but are now withdrawn to Tate. There are no posts held in the interior by the Portuguese on the East Coast elsewhere than in their district of Zambezia. Here with assistance from the Portuguese Government, the colonists maintain their best footing, and it is possible they may subsequently succeed in creating a profitable and creditable settlement, although local energy is on the ebb. Consul Elton states that the domestic trade is principally in the hands of Banyans and Hindis, who with coasting craft and by means of native traders barter goods for produce with the tribes upon the coast. Most of these merchants are supplied with goods by the French and Dutch houses, payments being made partly in cash and partly in produce, such as ivory, wax, oil seeds, cowries, orchil, indiarubber, copra (the dried kernel of the cocoa-nut), matting, bags, &c. The ivory is principally with the Indian market, where tusks of the convenient size to cut into the armlets worn by women, always command a higher price than in Europe. Ibo exports sesame, calumba-root, oil seeds, copra, ivory, wax, and cowries. The exports of Mozambique are similar, and in both districts the india-rubber Lliana abounds in the forests, as well as the gum copal tree, but owing to local disturbances and slave trade distractions, but little of the produce of either tree reaches the settlements. Quilimana and Zambezia generally, are capable of great development, but are now only beginning to recover from a recent war. At Bazarnto pearl oysters are plentiful, and a properly worked system of fishing would prove remunerative. Mhambane and Lorenço Marques furnish hides and ivory, and the former wax, oil seeds, and india-rubber.

The mineral resources of the East Coast are sufficiently important to demand a separate notice hereafter. Coal measures are widely scattered throughout the province, notably in the Zambezi and near Delagoa Bay. The mines near Tate have been recently purchased by a company, which asks for a monopoly of the steam navigation of Zambezi to carry out its projected workings in combination with a carrying trade. A trial was made of this coal by H.M.S. *Thetis*. The existence of coal in this district is, however, of greater importance to general trade, for, with a short line of rail projected, run to the foot of the range, it might be delivered to steamers in the bay itself at such a price as to transform Delagoa Bay, with its undoubted facilities for trade, into the coaling station for the eastern seas. Malachite and copper are reported in the interior west of Mozambique, and iron and coal, but this has been hitherto a sealed country, and no Portuguese can venture beyond the coast settlements near the capital, owing to the bitter memories preserved by the unfortunate natives of the slave trade, of which they have been the ill-used victims. The gold mines of the interior have completely passed away from the Portuguese, together with all hold upon the ancient kingdom of Monomotapa, which is now divided between Umscila and Lobengule, chiefs of tribes of Zulu extraction, the former the son of Manicusse, the latter the son of Umsiligazi, otherwise known as Mosilikatze, both energetic Zulu adventurers, who conquered the districts now held by their sons. Lobengule permits access to the gold fields in the Matabêle country, and granted his southern mines on the Tate settlement to a company in 1871, and also a concession of part of his northern fields, still very imperfectly explored, to the late Mr. Baines, F.R.G.S.; but the richest mines are undoubtedly known to exist within 120 miles of the coast, and in Umseila's country, who is not inclined at present to let any white man travel to within 30 miles of their exact whereabouts. But recent gold discoveries in the Transvaal, commencing with Marabastadt, have led to active prospecting, and alluvial diggings being found south of Umseila's country, at Pilgrim's rest, and on the Blyde river, near Leydenburg, in the Transvaal Republic. From 800 to 1,000 Europeans are at work here, exclusive of their families and natives employed, and from five of the best claims, situated near each other, gold to the value of £26,000 is reported to have been extracted. Want of water is a drawback, and the work is very heavy, owing to the best nuggets being covered over by a stratum composed of heavy, water-worn, boulder drift. The climate is healthy, and a prosperous settlement is springing up, to which Delagoa Bay is the natural port.

THE KAURI PINE-TREES OF NEW ZEALAND.

Chief among the timber trees of New Zealand is the Kauri pine. These trees in some instances have been found 15 feet in diameter and 150 feet in height. On an average they may be estimated as yielding, when sawn into conveniently sized boards, between 6,000 feet and 7,000 feet of timber, the market price of which at the mills is from 9s. 6d. to 11s. 6d. per 100 feet. The wood in some Kauri trees is prettily marked or mottled, and is in great demand for cabinet making, which gives it a special value. An illustration of this occurred some time ago when a tree was cut by a settler residing about eighteen miles north of Auckland. The trunk of this tree was 40 feet high and 37 feet in circumference, and it yielded, when sawn, 22,000 feet of rich mottled Kauri, which was sold for £500, leaving, after deducting £200 for expenses connected with the cutting of the tree and getting it to market, a clear profit of £300. The Kauri is valuable for shipbuilding as well as for all general purposes, and has been classed as the Germanic Lloyd. It furnishes excellent spars for vessels, and it is with this timber that nearly all wooden buildings in Auckland are erected. Strange to say, the tree does not grow further south than 37° 30′ latitude. It is accordingly unknown in the forests of the southern part of Auckland province, and in all other parts of New Zealand. It is, however, very plentiful north of Auckland, and for about thirty miles south of that city.

The gum which exudes from the tree is especially an Auckland product, being found in no other part of the world. Over a large area of land which has been exhausted by Kauri forests in past ages, and is now barren and almost unfit for cultivation, the gum that has exuded from the dead trees is found at a depth of 2ft. to 3ft. This gum is an important article of commerce, being found valuable for the manufacture of varnish; and it is calculated that two thousand men have at times been employed in various parts of the province digging it,

there being no restriction placed upon the right to dig on Government waste lands. The great demand for labour in other directions has reduced the number of gum-diggers, but the trade still gives employment to a section of the population. Its importance may be estimated from the fact that in the last three years for which the statistics are complete—namely, 1870, 1871, and 1872—no less than 14,276 tons of the gum were exported, the value of which amounted to £497,179. The production of this article is entirely due to the aboriginal natives, and to this they are stimulated by the presence of European purchasers. The Maoris bring a considerable quantity to market, and the proceeds thus obtained enable them to procure the comforts of dress and living to which they have now become accustomed. In travelling through the country districts, it is not uncommon to see comfortable board houses adopted by the natives instead of their huts, and European dress is found to have, to a great extent, supplanted the primitive attire of olden days. The buying price of first-class Kauri gum at Auckland, in March, 1874, was £30 to £33 per ton. At that price the gum-diggers would earn from 30s. to £4 a week, according to the nature of the field they were working on. The average earnings would, however, be about £2 a week. The work possesses attractions for many on account of its freedom, the labourer working and resting when he pleases.

MATÉ, OR PARAGUAYAN TEA.

Some interesting paragraphs respecting this substance are quoted in the *Revista Farmacéutica*, the organ of the Argentine Pharmaceutical Society, from an unpublished work by Dr. Bialet, entitled "Compendio de Anatomia, Fiscologia é Higiene humana." Of these the following is an abstract:—

The Maté or Paraguay Tea tree (*Ilex mate paraguayensis*), is a small tree belonging to the family of the Celastrineæ, which reaches at the most a height of seven metres; ordinarily it does not exceed four or five. Its trunk is about twenty centimetres in circumference, and is covered by a whitish bark. The leaves are oblong, cuneiform, obtuse and finely dentate. It has axillary multipartite peduncles; calyx tetrasepalous; the corolla with four petals in the form of a crown; stile none; stigma 4-fid; fruit a 4-seeded berry. The plant grows very abundantly in Paraguay, North Corrientes, Chaco, and South Brazil, where it forms woods called "*yerbales*."

According to Dr. Mantegazza, maté is prepared in Paraguay in the following way:—The entire trees are cut down, and the small branches and shoots are taken with the leaves and placed in the tatacúa, a plot of earth about six foot square surrounded by a fire, where the plant undergoes its first roasting. From thence it is taken to the *barbacúa*, which is a grating supported by a strong arch, underneath which burns a large fire; here it is submitted to a particular torrefaction, determined by experience, which develops the aromatic principle. Then it is reduced to a coarse powder in mortars formed of pits dug in the earth and well rammed. It is next put into fresh bullock skins, well pressed and placed in the sun to dry. The packages (*tercois*) thus obtained, which weigh 90 to 100 kilograms, are very compact; and have an average value in commerce of one to two dollars the kilo, according to quality, those of Paraguay and Missiones being the better, or least hurtful, those of Oran and Paranaguá being much more prejudicial to health.

Of all the analyses of maté that have appeared in books, Dr. Bialet considers not one, up to the present time, deserves much credit. Senor Arata, however, who has devoted much time and skill to the subject has placed the following data at his service:—

Maté contains in 100 parts:

Organic combustible substances ..	91·685
Ash	8·315

The ash contains—

Calcium oxide	12·344
Magnesium oxide	11·395
Sodium oxide	7·281
Potassium oxide	2·983
Manganese oxide................	2·500
Ferric oxide....................	3·410
Sulphuric acid..................	0·926
Hydrochloric acid	0·716
Phosphoric acid	5·540
Carbonic acid	8·150
Sand, silica, carbon, and loss......	44·754

It will be understood that the enormous relative quantities of sand found in the analysis is a result of the mode of preparation, in excavations made in the soil.

The plant contains—

Principles soluble in ether........	9·820
" " alcohol	8·432
" " water	26·208
" " water acidulated with hydrochloric acid	7·260
" " solution of caustic soda	16·880
Cellulose	13·280
Water	9·000
Sand	9·120
	100·000

Among the soluble principles is an average of 1·300 of caffeine. The quantity, however, was found to be very variable in different plants analysed; the Paraguay and Missiones plants contained the most, and the Paranaguá and Argentine the least. Senor Arata has made a careful search for caffeic acid and the caffeates that some say they have found in maté, but hitherto always with negative results; the same remark applies to the examination for a volatile acid.

The tannin of maté is peculiar; it does not tan hides, and requires a special method for its estimation; the average amount obtained by the ordinary method is not more than 12 per cent.; but the whole quantity present amounts to about 16 per cent.

Maté contains also a large quantity of a peculiar fatty matter, not entirely saponifiable by potash, besides pectic matters.

Comparing maté with the other caffeic substances it ranks between coffee and tea for the proportion of caffeine it contains, and has the largest proportion of mineral salts.

The action of maté, like that of all other caffeic substances, is upon the nervous system; but though it contains a large quantity of caffeine it does not exalt the peripheric nerves like tea, nor the cerebric like coffee; but rather contributes in a high degree to the indolence and drowsiness of the ordinary drinkers of maté, whose mental faculties become at length disarranged and impoverished to a lamentable degree. It accelerates the cardiac contractions, producing many more affections of the heart than tea or coffee. Upon the digestive organs it act variously; no other beverage disturbs them so much, though there are persons who can olerate its use. It accelerates the peristaltic movements and produces an irritation of the organs generally. The effects are produced in whatever way the maté may be taken, but the most injurious effects are produced upon the mucous membrane when the maté is taken hot and is sucked through a "bombilla," as it then passes into the stomach uncooled by previous contact with the mouth.

When the use of maté is prolonged it becomes an imperious necessity, such a gloominess following abstention from it, that habitual drinkers would rather go without food than without mate. The moderate use of two or three doses a day during the summer heats or

great fatigue is convenient, but it should be taken from a cup. It adds to the disadvantage of the "bombilla" that by indiscriminate use of the same bombilla by different persons it may become the vehicle of contagion for the most repulsive complaints.—*Pharmaceutical Journal.*

CORRESPONDENCE.

HEALTH AND SEWAGE OF TOWNS.

Sir,—In your issue of June 2nd you were good enough to insert a letter of mine on the operations of the "Town Manure Company."

Mislead by an expression used by Mr. Fereday, C.E., in his paper at the recent Sanitary Conference, I referred to him as the engineer of that company, and treated his remarks as a description of what is being done by them.

In this I have most unwittingly done him an injustice. He informs me, and asks me to state through your *Journal*, that he has no connection whatever with them; that they do not use his new patent at all; and, in fact, that he (Mr. Fereday) has not yet, either in England or abroad, exhibited his new patent process.

I beg, therefore, to withdraw Mr. Fereday's name entirely from all connection with the subject of my letter; and am truly sorry that (suffering as I and my neighbours are from the operations of that company) I have been led into an error displeasing to another person.—I am, &c., Alfred Payne.

Etlingshall, Wolverhampton,
June 29, 1876.

OBITUARY.

Robert Napier.—Mr. Robert Napier died on the 23rd June, at the age of 85. When a young man he worked in Dumbarton, Edinburgh, and Glasgow, as an engineer, till in 1815 he set up for himself in a small business in Glasgow. In 1823 Mr. Napier made his first marine engine, which was worked for many years in a vessel on the Clyde, and was then put into a new vessel, and is believed to be still at work on one of the Mersey ferries. In 1827, in a steamboat race on the Clyde, the fastest boats were two which had been provided for a Glasgow company by Mr. Napier. In 1840 the Hon. Samuel Cunard and his partners were supplied by Mr. Napier with their first four steamers. Since that time he had constructed the machinery for many other Atlantic steamers. He built and supplied with machinery, for the same company, the *Persia*, of 3,000 tons and 900 horses' power, the first iron vessel belonging to the Cunard Company. In 1853 Messrs. Robert Napier and Sons fitted up the machinery on board the *Duke of Wellington*, at that time the largest ship of war. Since that time the firm have constructed for the Admiralty the *Black Prince*, 6,100 tons, and the *Hector*, in addition to many steam rams and other iron clads for foreign governments. Mr. Napier has been President of the Institution of Mechanical Engineers; he was also a member of the Institution of Civil Engineers. At the Paris Exposition of 1855 the International Jury awarded him the great gold medal of honour, and the Emperor Napoleon III. conferred on him the decoration of the Legion of Honour, in testimony to the success which had attended the vessels fitted out by him for the Atlantic navigation. Mr. Napier joined the Society as a member in 1861.

GENERAL NOTES.

Antidote for Lead and Mercurial Poisoning.—M. Melsens has addressed a note to the Académie des Sciences with reference to the excellent effect produced by iodide of potassium in cases of lead or mercurial poisoning. He states that this substance, by rendering soluble the metal accumulated in the system, causes all the symptoms of the malady to disappear. More than that, employed as a preventative, this salt exercises a beneficial action. A small daily dose of iodide of potassium is sufficient to preserve from the effects of poisoning workmen engaged in deleterious processes with lead and mercury.

Constant Service Mains in London.—The number of miles of streets which contain mains constantly charged, and upon which hydrants for fire purposes could at once be fixed, in each district of the metropolis, is now as follows:—Kent, 80 miles; New River, 170; East London, 85; Southwark and Vauxhall, 100; West Middlesex, 70; Grand Junction, 41½; Lambeth, 90; Chelsea, 60—making a total length of 686½ miles. The water companies are ready to affix hydrants on these mains when required by the authorities. The total number of hydrants erected is at present 4,196, of which 2,686 are for private purposes, 535 for street watering, 500 for public use, and 475 in Government establishments.

Writing on Glass with Common or Indian Ink.—A mode has been described to the Industrial Society of the north of France, by M. Terquem, of writing on glass with common or Indian ink. The glass is heated over a spirit lamp, or gas, until steam ceases to be deposited in it, that is to say, 50° to 60° Centigrade; a varnish, composed of 80 grammes of alcohol at 95°, 4 grammes of mastic in drops (*larmes*) and a gramme of gum sandarac heated together in a flask, corked, and fastened with twine in a *Bain-marie*, is then applied to the glass as in photography for collodion. The varnish must, however, be filtered. This varnish is very hard, and becomes brilliant and completely transparent; but if applied cold to the surface of glass it remains opaque and absorbs ink. A sheet of glass thus prepared may be written or drawn upon with either ordinary or Indian ink, but it must afterwards be dipped in very thin gum water or other like substance not containing alcohol. No process is specially recommended for labelling bottles in laboratories, &c., but is considered applicable to the production of designs in slides for the magic lantern, or for transferring photographic designs.

Forecasts of the Weather in France.—M. Leverrier, the Director of the Paris Observatory, lately offered to warn mining engineers and colliery managers, twenty-four hours in advance, of any variations of the barometer with a view to prevent explosions of fire-damp, which had been noticed to take place after sudden and considerable diminutions of atmospheric pressure. He now proposes to convey to agriculturists a general account of the state of the atmosphere, which will serve them as a guide, in many farming operations; but, as there are many purely local conditions to be taken into consideration in foretelling rain, hail, and tempest, it is proposed that a local committee be formed in each department, consisting of men who have devoted themselves to the study of meteorology in that department, for the translation, so to speak, of the general indications telegraphed from the Observatory into more precise and special information adapted to their own region. These committees will receive each day, from Paris, a summary of the general weather observations, and will, while availing themselves of the previous investigations of their *confrères*, deduce the phenomena which may be expected in their own district. The departments of Vienne and Haute-Vienne have already organised their meteorological service, under the direction of MM. Touchimbert and Hébert, and they will shortly be followed by that of the Puy-de-Dome, under M. Alluard.

SUBSCRIPTIONS.

The Midsummer subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

The first lecture of the second course of Cantor Lectures for the past Session, on "Iron and Steel Manufacture," by Mr. W. Mattieu Williams, was delivered on Monday evening, January 17th, as follows:—

Lecture I.

I am tempted to follow the usual custom of commencing my subject with a historical introduction, not merely in obedience to custom, but because the history of this subject is especially instructive and throws much light on many questions of present-day practical importance; but as our time will not permit such preliminary excursion, I must only touch on the historical matters when they are absolutely needed in elucidation of present practice.

I also must assume that the general properties of metals are sufficiently understood by my audience, their lustre, opacity, colour, occasional odour, their varying density from 22·4 times that of water in the case of iridium to little more than half the specific gravity of water in the case of lithium, to say nothing of the hypothetical metal hydrogenium; their tenacity varying from that of lead to iron, the second 50 times stronger than the first, their equally variable hardness and brittleness; the wonderful malleability of some of them, such as gold, which is capable of being beaten into leaves of 1-200,000 of an inch in thickness; their ductility, of which the climax was displayed in Wollaston's metallic substitute for a telescope cobweb 1-30,000 of an inch in diameter, a wire so thin that 7 ounces would reach from London to New York, though made of platinum, the heaviest but one of all known substances. The fusibility and volatility of the metals, and their special, though varying aptitude for conducting heat and electricity, may also be assumed as understood.

The sources of the metals are very variable. A few are found native or reguline. This is usually the case with the "noble" metals, *i.e.*, those which may be melted without loss of lustre or other metallic qualities. The connection between their nobility and this mode of crude existence is obvious enough. Metals that may be fused without oxidation are likely to remain metallic in the earth, while those with more active affinities naturally combine with neighbouring substances, especially if lying in those parts of the earth that at any time have been heated. Silver, though one of the noble metals, readily combines with sulphur, and accordingly is found in the condition of a sulphuret as well as in the noble or reguline condition. Mercury, copper, and a few other metals not quite so aristocratic as gold and silver, are occasionally found in the reguline condition, but as we come down among the plebeian metals we find them variously associated with their vulgar neighbours. Some are simply oxidized, many exist as sulphurets and carbonates, others are irregularly combined or mixed with a variety of earthy matters, such as alumina compounds, silica, &c.

These are variously distributed in veins, in nodules, or as strata forming massive rocks of varying thickness. The heavier of the common metals are most commonly found in veins, or fissures of massive rocks, where they have been deposited either by eruption from below, or other obscure debateable actions that I cannot here discuss. This being the especial condition of the sulphurets opens up a very tempting field for speculation concerning the connection of metallic sulphurets with volcanoes and their other sulphurous accompaniments.

The lighter of the common metals that greedily hunger for oxygen, and whose oxides are earthy and strongly basic or alkaline, are usually found combined with carbonic or silicic acid, and forming massive rocks such as our common limestones, slates, clays, &c.

Finally, those metals that form soluble alkaline compounds with oxygen are found most abundantly in saline combination, and dissolved in sea water or mineral springs. Such are sodium, potassium, lithium, magnesium, &c.

Iron is remarkable as existing in all these conditions, and being found everywhere. There is no geological formation on the earth that is free from it, and in most of them it is abundant. It is in the primary plutonic rocks, in their metamorphic neighbours, and in the sedimentary rocks of all ages. It is found in the metallic state, as oxide, as carbonate, as sulphuret; in combination and in admixture, with alumina, silica, and all the chief materials of the earth. It is in the waters of the ocean, in mineral springs, in the blood of the higher animals, in the atmosphere around us, and in the heavens beyond. So rarely is it absent from any part of the earth that a bed of sand free from iron is more valuable than a gold mine. The glass maker has great difficulty in obtaining supplies of such material.

As the practical manufacture of iron is materially modified by the original constitution of the ore, it is necessary to go a little further into particulars on this part of the subject.

First, as regards native iron, or iron found in the metallic condition. Knowing, as we all do, how liable this metal is to oxidation, whether hot or cold, we must naturally anticipate that it is found but rarely in the reguline condition. This is the case. The most notable specimens of native iron are of celestial origin; they are meteoric masses that have fallen upon earth at various times, and found resting where they fell. They are not of pure iron, although metallic. These metallic meteorites usually contain from 80 to 90 per cent. of iron, 5 to 10 per cent. of nickel, and smaller proportions of cobalt, besides still smaller

and more variable admixtures of manganese, copper, tin, and earthy matter. The iron, nickel, and cobalt, the most characteristic constituents of these meteorites, are remarkable as constituting what has been called "the magnetic triad," or the three metals having sufficient magnetic energy to overpower their gravitation. Masses of either of these may be lifted by an ordinary magnet.

A fine collection of these mysterious visitors to our planet may be seen at one end of the mineral room of the British Museum. They fall occasionally on all parts of the earth, and vary in size from mere dust grains to masses of many tons in weight. The celebrated aerolite seen by Pallas in Siberia, which was worshipped by the Tartars as a stone that had fallen from heaven, weighed about 14,000 lbs. Another in South America, at Chaco Gualambra, is computed to weigh above 32,000 lbs.

Besides the meteorites, or aerolites, or siderites, as they are also called, which are mainly composed of metallic iron, there are others of earthy composition which contain a considerable, though smaller, proportion of iron, both in the metallic state, and combined with other matter.

Small grains of metallic iron are found in basaltic rocks, imbedded there apparently when the rock was in a state of fusion, and protected from subsequent oxidation by this hermetrical sealing. Such are found in the basalt of the Giants' Causeway, in Auvergne, &c. How they came there is a question upon which much speculation may be be based. It is possible that these may be of meteoric origin, and have become entangled in the rock when it was in a state of fusion or semifusion. This hypothesis, however, demands further investigation. Its probability would be grently heightened if these grains are found to contain nickel and cobalt in the proportions common to meteoric iron.

Buttons of iron combined with carbon, and described as "native steel" have been found in seams of coal that have burned. These are evidently due to the reduction of oxide of iron by the heated coal. Messier describes a mass weighing 16 lbs. found in such a coal seam at Laborche in the Department of Allier.

These are mineralogical curiosities, but we now come to the practical ores of iron. The richest is magnetic oxide, composed of Fe_3O_4 or Fe_2O_3. FeO_1, and containing when pure above 72 per cent. of iron. It is found in more or less perfect crystals, or in granular masses. This oxide is attracted by the magnet, and its crystals are sometimes polarised or actively magnetic, and hence have been called loadstones or leadstones. Magnetic oxide occurs in the older rocks, the primary and metamorphic, such as granite, gneiss, mica schist, &c., which contain no organic remains. When crystalline and unmixed it is the richest, the purest, and in all respects the best of the iron ores, was used by the most ancient iron makers, and is still used by their primitive successors who work the same material, and in a similar manner.

It occurs but rarely in this pure condition, its most abundant deposits being admixed with impurities which greatly diminish its value. Very little is found in this country, but it is especially abundant in Sweden, Norway, and Lapland; also in the Ural mountains, in Piedmont, in Saxony, and other mountainous regions where the older rocks prevail.

Next in richness is the red ore, or hæmatite, anhydrous sesquioxide of iron, Fe_2O_3, which when pure contains about 70 per cent. of iron. This is found in various forms, crystalline, massive, earthy, and reniform, or kidney shaped, as in the "kidney ore." In some deposits, or portions of a deposit, it is so soft that it rubs off and stains the fingers with an unctuous smear like plumbago, but of red colour.

It is usually associated with more or less of siliceous impurities, or with alumina, lime, magnesia, &c., 60 to 65 per cent. of iron being a fair quantity in commercial samples. When it occurs interstratified with a limestone rock, it is sometimes very deceptive. As an instructive example, I mention a case that came under my own notice. A friend had purchased the working lease of what appeared a splendid deposit of hæmatite in the Vale of Clwyd. He sent out samples for analysis, and the results were highly satisfactory. Upon these samples he obtained orders from an ironmaster in Denbighshire, and the ore was charged into the furnace mixed with commoner ores. The yield of the furnace immediately declined, and further supplies were refused.

Shortly after this I visited the deposit, and upon careful examination found a thick face of bright red rock fully exposed, which was said to be the face of a solid deposit of hæmatite. It appeared to be such at first sight. On careful examination I found that the bulk of the deposit was merely a porous limestone, deeply stained throughout by red oxide of iron, which had apparently been deposited simultaneously with the carbonate of lime, and that here and there were strata of true hæmatite, varying from mere laminæ to layers of a few inches thick. In these place the hæmatite was soft, nearly pure, and easily removable. It was evident that the samples had been taken from these strata, while the bulk delivered to the ironmaster was an average of the whole deposit, and therefore chiefly composed of merely a stained limestone.

Hæmatites are more abundant than the magnetic oxide. The most important British deposit of this ore is in the neighbourhood of Ulverstone, in Lancashire. Near Cleator Moor it varies from 15 to 60 feet in thickness, and is of very fine quality, being especially free from phosphates, and therefore in present great demand for the manufacture of Bessemer pigs, of which hereafter. It is found near the opposite coast of Ireland, and has been supposed to extend under the sea lying between.

Vast deposits exist in the neighbourhood of Bilbao, in Spain, and some English companies have lately been formed for working it there. They propose to make their own railways from the mines, or rather quarries, of the ore, to the coast, and to build or charter suitable steam vessels for bringing it across.

From the accounts I have heard of the magnitude of these "mountains of iron ore," we may look forward to this locality for great supplies of this now specially demanded ore, unless the delusion of the Vale of Clwyd has been there repeated. At the present moment* the wretched Civil War with the Carlists keeps this enterprise in abeyance.

* January, 1876.

There are great quantities of this ore in America. The deposits on the shores of Lake Superior and those of the Iron Mountain and Pilot Knob near St. Louis in Missouri, are the most famous.

It occurs most abundantly in the Cambrian, Silurian, and Devonian rocks, those in which the beginning of animal life appear. There are also important deposits in the carboniferous limestone.

There is another modification of anhydrous sesquioxide of iron, differing very much in physical properties and appearance from the red hæmatite—the specular iron ore. It forms hard brilliant crystalline plates, and is found in volcanic districts. It is probably formed by the volcanic fusion of hæmatite.

Brown hæmatite, brown iron ore or limonite, differs from red hæmatite in containing water. It is a hydrated sesquioxide of iron. It is sometimes found very nearly pure, but is commonly mixed with siliceous, calcareous, and earthy impurities, and contains from 30 to above 60 per cent. of iron. The common ores are ochreous, brown, or yellow brown, and earthy in appearance; but the brown hæmatite of the mineralogical cabinet has quite a different appearance, being compact, fibrous, hard, and of a rich brown colour. They are all distinguishable from the red hæmatites by the colour of their streak, *i.e.*, if a specimen of each be scratched with a hard substance the mark upon the red hæmatite will be red, that upon the brown hæmatite, brown, although the surfaces of both masses may be very similar in colour, as sometimes is the case.

The most important British deposits of this ore are those of the Forest of Dean and Northamptonshire; the first was worked by the Romans and is still used. This ore is used largely in France and Belgium.

Bog iron ore is a remarkable modification of hydrated peroxide. It is formed on the bottom of lakes and in bogs, and appears to have been deposited as a constituent of the hard cuticle or case of microscopic creatures, formerly regarded as animals, but now classed as locomotive vegetables living in water. The iron must have been derived from the water, and assimilated by these creatures, fresh supplies of water holding small quantities of iron in solution continually flowing into the lakes or pools in which they lived. Countless millions of these minute creatures appear to be still engaged in this productive industry. The ore is found in Sweden, Norway, Finland, Holland, and North Germany, especially in the great lake dotted plain and slopes surrounding the Baltic, the Gulf of Finland, and the Gulf of Bothnia. It reaches as much as 30 inches in thickness in some of these places. It is widely diffused in other similar districts, especially in Lower Canada. It contains from 40 to 55 per cent. of iron.

Franklinite is a curious ore, a mixture of oxides of iron with oxides of zinc and manganese. As it contains as much as 20 per cent. of zinc, it is worked (in New Jersey, where it is found), primarily for its zinc, the residue being smelted for the production of spiegeleisen, which will be presently described.

Ilmenite is a dark-grey dense rock, of granular and somewhat micaceous structure, composed of sesquioxide of iron, with varying proportions of titanic acid. It is specially abundant in Norway.

The black sand, found on the north-east shores of Canada, and in especial abundance at the Bay of Naples, Taranaki, New Zealand, also contains titanic acid in varying proportions, but the oxide of iron is for the most part magnetic; the particles of this are easily separable from the siliceous particles by means of an ordinary magnet.

We now come to the ores in which the iron exists as carbonate. These are poorer than the preceding, but are, nevertheless, very important, as we shall presently see.

The richest of these ores is the crystallised or spathic carbonate of iron, or sparry iron ore, containing from 35 to 48 per cent. of iron, and commonly associated with protoxide of manganese in varying quantities, from mere traces up to 25 per cent., and also with magnesia and a little lime. The Erzberg, near Eisenerz, in Styria, is the most famous locality for this ore, where it has been worked for ages. It is also found in many parts of Central Europe and in Sweden, and in some parts of England, as in the Brendon Hills and Exmoor, at Weardale in Durham, &c. The spathic carbonates, which are richest in manganese, are used for the manufacture of spiegeleisen.

The clay ironstones are very impure ores, containing carbonate of iron mixed with silica, alumina, lime, magnesia, phosphates, sulphates, water, organic matter, &c., in short, with a muddle of dirt. They are the poorest and worst of all the iron ores, yielding from 20 to a maximum 40 per cent. of iron, and yet from these more iron has been produced in modern times than from any other class of iron ores, I might perhaps say, than from all the other ores together. This arises from the fact they occur abundantly in the British coal measures, and are the main sources of our native supply. These clay ironstones exist in many forms. They usually have a compact earthy structure, and vary in colour from grey and yellowish, to light brown and black, with intermediate shades. The grey varieties commonly change to brown on exposure to the air, owing to superficial peroxidation. They occur in strata or beds, and in nodules of various forms and sizes. All have been obviously deposited from water, and this accounts for their varying heterogeneous composition, as whatever turbidity the water contained has more or less settled down with the carbonate of iron. The nodules commonly enclose some kind of nucleus, sometimes a fish or fragment of fish, or other organic matter.

This organic matter is the main source of the worst impurity of these ores, the phosphoric acid. The iron ores found in the most ancient rocks, in which are no organic remains, are free from this source of impurity, and this is also the case, to a great extent, with those ores that occur in the next series of rocks, viz., those containing only the remains of the lower forms of animal life, the solid framework of these creatures being formed of carbonate of lime, the phosphate making its appearance only with the advance of animal organisation, and reaching its maximum proportion in the higher vertebrate animals.

The great coalfields of North and South Staffordshire, Yorkshire, Derbyshire, Warwickshire, Worcestershire, North and South Wales, and Scotland, contain workable deposits of these ores.

The black-band ironstone, the composition and value of which was discovered by Mushet in 1810,

but which was not fully used until 1830, is an important modification of this. It contains 20 to 25 per cent. of bituminous or coaly matter, and 30 to 40 per cent. of iron. There we have the most complete and intimate association of coal and iron, the ore itself containing an important contribution to the material required for its own smelting. The Airdrie black-band extends in workable quantities over an area of about ten square miles, and in thinner seams over five times that extent. It is also found in thick seams in North Staffordshire. Thin strata exist irregularly in nearly all our coalfields. It has evidently been formed by deposition of the carbonate of iron from water simultaneously depositing vegetable matter.

I need only mention the compounds of iron and sulphur, such as iron pyrites, which are very abundant, and are worked for the sulphur they contain rather than for their iron.

Before describing any of the details of the methods by which metallic iron is extracted from these ores, I must briefly explain the principles upon which such extraction is based.

It will be seen at once that, in all cases except the sulphurets, we have primarily to deal with oxides of iron, or such oxygen compounds as the carbonates. The separation of oxygen may be described as a primary metallurgical operation. It is called "reduction," and I shall use this term accordingly.

The reduction of the noble metals is a very simple operation. It may be easily effected by availing ourselves of the simple repulsive agency of heat. Thus, if oxides of gold, silver, or platinum are simply heated, the oxygen flies off as a gas, and leaves the bright, pure metal behind. This is the case with mercury, which, on this account, is sometimes classed with the noble metals.

When a compound is thus separated into its elements by the simple application of heat, the process is termed "dissociation." When other chemical affinities are used to aid in effecting the separation, the term "decomposition" is properly used.

In reducing such metals as tin, copper, lead, &c., we use some agent that will co-operate with the repulsive agency of heat, something which at high temperatures has a strong affinity for oxygen. Hydrogen gas is very effective for this purpose, so also is carbonic oxide, the gaseous product of the first stage of oxidation of carbon, containing but one equivalent of oxygen, and thirsting for another when heated. If either of these gases are passed over red hot oxides of tin, copper, lead, &c., the oxygen, which otherwise remains attached at that temperature, leaves the metal and combines with the hydrogen or carbonic oxide, forming water or carbonic acid. We obtain a similar reduction by heating these oxides in close contact with readily combustible forms of carbon, such as charcoal or lamp black, or with compounds of carbon and hydrogen, such as starch, sugar, woody fibre, coal, resins, oils, &c.

Metals like tin, copper, lead, &c., which are fusible at or about the temperature at which their reduction is effected, are easily separated from their oxides as well as from earthy infusible impurities, as the pure metal runs down as a liquid and thus can be collected without further difficulty.

Oxides of iron are not so manageable, as the metal is practically infusible when pure, and thus when we heat a simple oxide of iron with carbonic oxide, or hydrogen, or solid carbon, we obtain an infusible spongy mass exposing a greatly extended surface, which rapidly recombines with oxygen, when exposed to the air in a state of purity, or approximate purity.

Iron, however, has a property which helps us over this difficulty to a certain extent. It is weldable, it becomes soft and pasty, at a temperature considerably below its melting point, and thus the particles of the spongy mass may be beaten together into a compact solid.

It was thus that the ancient iron makers worked. They used nearly pure oxides such as the magnetic oxides or the hæmatites, and charcoal or nearly pure carbon. They heated these together in furnaces of simple construction—some of which I shall describe as we proceed; they thus produced a spongy mass or "bloom," and hammered this together immediately upon drawing it from the furnace, proceeding afterwards to forge it to the forms they required.

I have said that iron when pure is practically infusible. This, however, is not the case with many of its compounds. Carbon is one of the many elementary substances which by uniting with iron increase its fusibility. Now, it happens that in any primitive arrangement for the reduction of an oxide of iron by means of carbon, the action is likely to go a little further than mere reduction, and a compound of iron and carbon will be formed, and if a tolerably strong blast is used this may be fused.

Such a compound would be steel of high quality, if only pure oxide and charcoal were used. Thus it will be seen that the primitive iron makers were likely to produce steel accidentally. Even when they failed to obtain an iron sufficiently carburetted to fuse, they were likely to produce lower compounds of iron and carbon, mild steels, or a compound intermediate between iron and hard steel.

Our forefathers worked thus upon the purest of our native ores, and with the charcoal obtained by cutting down our then abundant forest trees; but at last the supply of charcoal fell short, "the disforesting" of the kingdom became a matter of national alarm, and the iron trade declined for lack of carbon.

At this time a very remarkable man came to the rescue. In 1624, Dud Dudley made good iron from "pit coal," and sold it at £12 per ton. The other iron masters, instead of hailing this invention as a means of saving their declining trade from the ruin with which it was threatened, adopted the barbarous stupidity of "rattening" their supposed rival; they combined to oppose him by the most disgraceful means, by cutting his bellows, by petitioning to the King and Parliament to forcibly suppress his innovation, and they finally succeeded in effecting his ruin, and hastening his death. His invention died with him, and remained buried for upwards of a century—until 1740.

In these 124 years the iron trade of Great Britain declined to but three-fourths of its former magnitude, only 17,350 tons being produced in 1740.

The following figures show the effect of the revival of Dudley's invention:—

In 1740 we produced	17,350	tons of crude iron.	
1788	61,300	„	„
1806	250,000	„	„
1820	380,000	„	„
1827	654,000	„	„
1845	1,250,000	„	„
1851	2,500,000	„	„
1865	4,819,000	„	„
1871	6,627,178	„	„
1872	6,741,929	„	„
1873	6,566,451	„	„
1874	5,991,408	„	„

Thus in 126 years, between 1624 and 1740, the produce of iron declined to three-fourths, while in the following 126 years, it has increased nearly 500 times; the difference being directly and mainly due to the use of Dudley's invention. More than a century of most important progress was lost to the nation and the world, for every department of industry is influenced by the abundance of iron. Such was the cost of blind industrial conservatism, of restrictive trades unionism among capitalists. All the nation, all the world, suffered from this stupidity, but most of all the infatuated obstructionists themselves. These consequences afford an instructive lesson to artisans and all others who imagine they can benefit their own trade and themselves by restricting the energy or industry of their fellow workers, by attempting to limit the quantity or efficiency of any man's industry, especially of those in their own trade.

MISCELLANEOUS.

THE EXHIBITION OF SCIENTIFIC IMPLEMENTS.

The present Loan Exhibition at South Kensington differs very considerably from all that have preceded it in the same buildings. Instead of being devoted to Art and Industry, it is given up entirely to Science, its chief object being to illustrate the history of Science, by bringing together the existing examples of the apparatus of the earliest investigators, and the instruments used in the most advanced researches of modern science. Former exhibitions dealt at most with the practical applications of Science. That under notice treats of Pure Science while not excluding its practical applications. It is true the term has been used in its widest sense, and the exhibition includes not only apparatus for research, but educational appliances and examples of engineering construction, but all the exhibits bear in one way or another on the history and progress of science. Following the precedent of the former International Exhibitions, it is intended to give in the pages of the *Journal* a brief account of the more noteworthy objects shown in each class. It may, however, be well to preface these reports by a short summary of the history of the exhibition, and a general view of its contents and their arrangement.

By a minute dated January, 1875, the Lords of the Committee of Council on Education approved of the proposal to form the collection, and in accordance therewith a large general committee was formed, to carry out the necessary arrangements. By this committee a scheme of classification was prepared, according to which the objects were to be divided into five sections.—1, Mechanics; 2, Physics; 3, Chemistry; 4, Geology, Mineralogy, and Geography; 5, Biology. For each of these a sub-committee was appointed. Communications were sent to the principal foreign Governments, inviting co-operation, an invitation which was in most cases cordially accepted. It was decided that the exhibition should be international in character, though its arrangement was to follow subjects, not localities. It was at first intended to exhibit the collection in the South Kensington Museum, and to open it in June, 1875. Afterwards the place was changed to the Exhibition Buildings, and the time of opening was postponed to March, 1876, and then again to May. The actual opening took place on the 15th May, after a visit of inspection by the Queen on the 13th.

The exhibition is arranged in the south and west galleries of the building, the east gallery being now occupied by the India Museum. The south gallery is devoted to the educational collections belonging to the South Kensington Museum, and the objects illustrating applied mechanics, naval architecture, and marine engineering. In the west gallery, the first part of the collection reached in passing on from the south contains the lighthouse apparatus. Then, after passing Mr. Buckland's fish museum, come, in the order named, magnetism and electricity, arithmetic and geometry, measurement, astronomy and meteorology. This brings the visitor to the northern end of the west gallery, where the machinery in motion used to be placed during the International Exhibitions. The rest of the collection is arranged in the gallery above, which was formerly devoted to pictures. Here, proceeding back from north to south, we find in order geography, geology and mining, biology, chemistry, and light, heat, sound, and molecular physics.

As regards the countries contributing, Germany almost rivals Great Britain in the amount of objects sent. France is next to Germany, but with a much shorter list. Austria, Italy, and Russia have about the same number of contributors, and they come next in order. Holland has not quite so many, Belgium and Switzerland have still fewer, Norway has only two contributors, and Spain's list had not arrived in time for the first edition of the catalogue.

The clasification adopted in the catalogue differs somewhat from that employed in arranging the collection. In it the following arrangement is used:—The first class is devoted to arithmetic, and includes apparatus for teaching arithmetic, calculating machines, &c. Class II., Geometry, comprises instruments, models, machines for describing curves, models to illustrate crystallography, &c. In Class III. we have instruments for measuring length, area, volume, angles, mass, density, time, velocity, momentum, force and work. Kinematics, statics, and dynamics occupy Class IV. Class V. is allotted to Molecular Physics, classified under the sub-heads:—Pressure on matter, communication of pressure through fluids, density, adhesion and cohesion. Sound has Class VI. to itself, the divisions being:—Methods of illustrating the laws of wave motion, generation of sound, conduction, velocity, detection, reflexion and refraction, dispersion and absorption, musical sounds, musical quality, musical instruments illustrating any of the above points. Following Sound comes Light, in Class VII., the divisions being:—Production, measurement, action of matter on light, action of light on light, action of light on matter, technical applications of optical principles. Next is Heat, in Class VIII., the instruments being classified as dealing with:—Sources of heat, effects of heat on matter, measurement, propagation, effect of change of molecular state on temperature, effect of change of pressure and volume, heat quantity, mechanical equivalent of heat, electrical equivalent of heat, analysis of solar radiation. Class IX., Magnetism, includes:—Natural magnets, permanent artificial magnets, electro-magnets, methods of magnetisation, magnetic induction, measurement, terrestrial magnetism. Class X., Electricity, is rather a large one; it is divided as follows:—Production and maintenance of difference of potential, direction and measurement of difference of potential, accumulation of electricity,

measurement of electric quantity, detection and measurement of electric currents, resistance, effects of electric currents, technical applications of electricity. Astronomy occupies the next place, in Class XI., the arrangement of which class needs no explanation. As regards Class XII., Applied Mechanics, there is a special remark, that as the exhibition is to be regarded as referring chiefly to education, research, and other scientific purposes, it must in this division consist principally of models, diagrams, mechanical drawings, and small machines, illustrative of the principles and progress of mechanical science, and of the application of mechanics to the arts. The description of instruments included in the next class (No. XIII.) Chemistry, will be obvious enough, and the same remark applies to Class XIV., Meteorology. In Geography (Class XV.), we get besides maps, &c., surveying instruments, instruments used in geodesy, hydrography, and seismography, and deep-sea sounding apparatus. In Class XVI., Geology and Mining, are instruments for field and underground surveying, typical collections, maps, models, diagrams, microscopic sections, and apparatus for cutting them, also anemometers, water-gauges, mining barometers and thermometers. Mineralogy, Crystallography, &c., are placed in Class XVII., and Biology has the last class, XVIII. Here are found miscroscopes, apparatus for investigating the various conditions of living organisms, for anatomical research, and for collecting and preserving objects of natural history.

Before attempting any account of the different departments of the exhibition, it may perhaps be worth while to mention some of the most noteworthy of the objects collected. This has indeed already been done in many of the daily and weekly papers, but it must be remembered that it is only after the conclusion of the Session that space can be spared in this *Journal* for other purposes that the record of the Society's proceedings. But for this a notice of the loan collection would have appeared before now.

As mentioned above, the first part of the loan collection proper, that is reached after passing through the South Kensington Educational collection, is the part devoted to applied mechanics. Here are placed several of the most important objects from the Patent-office Museum, and the fact that they can now be properly examined for the first time has attracted to them an amount of attention that may appear strange when it is remembered that they have for years been exhibited close to the spot they now occupy. Among these are Stephenson's "Rocket;" "Puffing Billy," the first passenger locomotive, with smooth wheels; Bramah's original hydraulic press; the steam-engine made for Miller, of Dalswinton, by Symington, in 1788, the parent engine of steam navigation; the engine of the *Comet*, the first steamboat in Europe advertised for the conveyance of passengers and goods. Besides these are Sir Isambard Brunel's models of block-making machinery, set up in Portsmouth Dockyard in 1804, and in use up to the present time. Papin's celebrated cylinder, said by some authorities to have been cast for the cylinder of a steam-engine, is lent by the Royal Museum of Cassel.

In the part devoted to arithmetic, measurement, &c., are Babbage's calculating machine; Sir Joseph Whitworth's gauges, by one of which a difference of one-millionth of an inch can be discovered; and Sir W. Thomson's tide calculating machine. Among the historical objects in this section should also be mentioned the apparatus used by Joule in determining the mechanical equivalent of heat.

Magnetism and electricity, as might be expected, occupy a large space. The Post-office send a collection of instruments, illustrating the progress of telegraphic science. Gramme's electro-magnetic machine is naturally a conspicuous object from the intense light it produces when set in action. Faraday's apparatus is shown as a contrast to some of the most recent appliances. The largest natural magnet known has been sent over from Haarlem, and there is besides an immense variety of the different descriptions of electrical apparatus.

In the section devoted to kinematics, statics, and dynamics the most important exhibit will probably be considered to be the collection of kinematic models, lent by Professor Reuleaux, of Berlin. These models are nearly 300 in number, and are intended to illustrate Prof. Reuleaux's theory of machines. They are specially treated of in the Professor's work on "Mechanics," of which an English translation, by Prof. Kennedy, has just appeared. It is intended to make this series of models the subject of a special article in the *Journal* at an early date.

Astronomy and meteorology form a large class, rich both in historical relics and in examples of the latest instruments constructed. Some of Galileo's instruments, lent by the Royal Institute of Florence, have naturally attracted much popular attention. They include two telescopes made by himself, a thermometer, a microscope, &c. Huyghens, too, has some memorials in the exhibition, and there are two large telescopes made by Sir W. Herschel. A quadrant belonging to Tycho Brahé may be said to complete the list of the principal historical objects in this portion of the exhibition. The modern instruments will be treated of hereafter.

The geographical part of the exhibition contains a large number of maps and charts. Besides these, it includes surveying instruments, a collection of which is lent by the Ordnance Survey, and apparatus used in deep sea exploration. The Royal Geographical Society send some instruments used by Livingstone in his last journey, and there are also notebooks and logs of several early travellers and seamen.

In biology there is a great variety of microscopes, both old and new, from 1590 (Jansen's) down to the present day. There are also examples of the delicate apparatus employed in researches and experiments upon the living body.

Chemistry is naturally less capable of being illustrated by apparatus than are some of the other sciences, but still there is a large and varied collection of chemical apparatus. Among the historical part is found some apparatus constructed and used by Dalton. This is lent by the Literary and Philosophical Society of Manchester, which has in its possession a large quantity of apparatus belonging to Dalton. The articles shown at South Kensington were selected as having been made by Dalton, as well as used by him, and are considered to show very well the rude and simple character of the appliances with which so much valuable work was effected. Some tubes containing gases liquified by Faraday form another interesting exhibit. There are also some balances used by Cavendish and Humphrey Davy.

The last section in order is that devoted to light, heat, sound, and molecular physics. The original tion. There are of course specimens of all the varieties Magdeburg hemispheres of Otto von Guericke, and his air-pump, have attracted a great deal of attenof air-pumps, from the one just mentioned to the latest modifications of Sprengel's mercurial pump. The enharmonic organ is perhaps the most conspicuous object in the acoustical department. Light has in its department a variety of apparatus, from the early camera obscura down to the radiometer. Heat contains a large collection of thermometers, though some are also shown among the meteorological instruments, notably a unique sensitive thermometer with a gridiron bulb.

By a return just issued it is shown that the cost of public elementary education in the year 1874-5 amounted to £5,289,036. The Imperial grant in the United Kingdom was £2,228,470, expended in the year ended the 31st March, 1875, and the amount locally raised £3,060,566. The per centage of total expenditure locally raised was in the United Kingdom 57·87.

PARIS EXHIBITION IN 1878.

Rumours have gone abroad of the proposed exhibition being deferred until the year 1879, but such statements gain no credit in Paris where the idea of the exhibition was received with enthusiasm, and no well informed person doubts it being carried out at the appointed time.

The Minister of Agriculture and Commerce, and the Minister of Finance have just laid the Bill relative to the exhibition before the Assembly, so that we have now for the first time before us the views of the Government upon the subject. The document is a long one, but the following are the main points in it:—

The proposal that the exhibition should be held in the Champ de Mars was adopted unanimously by the Superior Commission appointed to consider the subject, and draw up the Bill; and, after having considered the dimensions of the late Vienna and present Philadelphia Exhibitions, and taking into account the constant growth of production, the Commission arrived at the conclusion that the covered building should be not less than 240,000 square metres in area. Further it was decided that the arrangement adopted in 1867, namely, that of placing the various countries in successive order in one direction and the classes in the other, was more likely than any other to give the exhibition a serious and really useful character.*

The size of the proposed building will reduce that of the park around it to about two-thirds of what it was in 1867, and therefore in order to obtain sufficient space for what is called "living art"—musical societies and like associations, which are in high favour—the Commission recommend the adoption ot the proposed annexation of the Trocadéro, "the rapid slopes of which," the Commission consider, "will lend themselves marvellously to decorative designs."

The mode of connecting the Champ de Mars and the Trocadéro, finally arrived at by the Commission, with the full assent of the Prefecture of the Seine and the Prefect of Police, was to give up the Pont de Jena and the quays entirely to the exhibition, and to carry on the ordinary traffic by means of two curved and sunken ways, passing through the Champ de Mars and the Trocadéro, and to employ a small steamer to ferry general pedestrians over the river.

The principal building proposed to be erected on the summit of the Trocadéro is a grand hall, capable of holding six to eight thousand persons, for the purposes of concerts, musical competitions, experiments with large instruments, and assemblages connected with the exhibition. This building is proposed to be retained as a permanent establishment; a large vestibule attached to it is to be connected at the sides by two peristyles, one leading to the gardens of the Trocadéro, and the other to two semi-circular galleries facing the Seine, to be devoted to retrospective and archæological exhibitions, illustrations of the history of labour, and the geographical sciences.

Basing their calculations on the results of the former exhibition, the Commission estimate the total cost of the buildings, park, and gardens at 26,493,000 francs, and with subsidiary items, such as a special exhibition of live animals, steam, water, gas, &c., 32,313,000 francs. In addition to which they set down 3,000,000 francs for medals, *fêtes*, and sundry unforeseen expenses.

In 1867 the cost amounted to 23,000,000 frs.

In that year the income from visitors reached 10,765,000 frs. The Commission estimate that in 1878 it will amount to 14,000,000 frs., and setting down the profit from catalogues and other sources at the same sum as was received in 1867, they arrive at the conclusion that the deficit to be provided for will be about 16,000,000 frs., or 4,000,000 frs. more than in 1867. This sum would be divided between the State and the municipality of Paris, the latter to contribute 6,000,000 frs. of the total.

* It is not so stated, but it is perfectly understood that the building will be a parallelogram and not circular or oval as in 1867.

CONGRESS OF BELGIAN SCIENTIFIC BODIES.

The Scientific Societies of Belgium, who last year formed themselves into a confederation on the initiative of the Malacological Society, will hold their first Congress at Brussels next week. The following is the programme:—

July 16, noon.—Opening of the Congress by the President in the academical hall of the University of Brussels; reception of the reports of the preliminary session of 1875, and of the federated societies on their labours, &c., since their foundation; formation of sections; discussion of general questions, viz.:—(1) Greater facilities for the transmission of scientific objects; (2) as to the opening of public scientific institutions at convenient hours, and especially in the evening; (3) as to interchange of reports of the proceedings of the federated societies; (4) the organisation of libraries and scientific collections in the towns and communes; (5) the publication of elementary treatises on various branches of science.

Afternoon.—(1) Establishment at one of the littoral towns of a collection of works concerning the coast; (2) a study of the geological formation of the district round Brussels; (3) the part played by molluscs in nature; (4) the malacological zones of Belgium; (5) the transmission of tubercles from animals to man by means of milk and meat; (6) analytical investigation into food substances; (7) sanitary supervision of butchers' meat; (8) as to the awarding of the publications of the scientific societies as prizes.

On the 17th, the discussion will be continued, communications will be received, the subjects for next year will be fixed upon, aud the time and place for the Congress of 1878 will be determined.

On the 18th, there is to be a scientific excursion into the environs of Brussels; and the Congress will be closed by an address from the President.

SÈVRES.

The old museum of the Sèvres porcelain works has just been transferred to the new building, and the *Débats* newspaper has given tho following account of the establishment which will interest those who may visit Paris, and doubtless many other persons.

It was only in 1756 that the royal manufacture of porcelain of France was established at Sèvres; it was created at Vincennes in 1740 as a private venture of the superintendent of finances to Louis XV., who, after a few years, sold the privilege he had obtained to a company with a capital in shares of 240,000 francs. In 1755 Louis XV. became a shareholder of the company, and gave the manufactory the title of royal, and in 1759 his Majesty bought out his co-shareholders, and annexed the manufactory to the royal palaces. It remained in the domain of the crown ever afterwards till the republic, when it became national, as it is now, and at present it is under the Director of Beaux-Arts.

The new building is in sight of the old one, but nearer to the bridge; it was finished in 1870. After the Commune it was used for the meetings of a Council of War. After a time the works of completion was re-commenced, and it is now sufficiently advanced to allow of the installation of the museum, which is a most interesting collection. The plan of the new establishment is unlike that of its predecessor; it consists of several separate buildings connected together by glazed galleries. The principal pavilion, which faces the Seine, contains the ceramic museum and the exhibition of new productions;

behind this are the pottery works, and further in the rear still the engine-house and mills, which are completely isolated from the rest of the establishment.

THE POLLUTION OF RIVERS BILL.

The Bill introduced by Mr. Sclater-Booth "for making further provision for the prevention of the pollution of rivers" contains prohibitions against putting solid matters into streams, and against the drainage into them of sewers and of poisonous and polluting liquids from manufactories or from mines. Persons are not, however, to be deemed to have committed an offence against the Act if they can show, to the satisfaction of the court having cognisance of the case, that they are using the best practicable and available means to render harmless the polluting matter. It is also provided that no proceedings are to be taken against owners of factories or mines under the Act, save by a sanitary authority, nor without the consent of the Local Government Board, "which Board, in giving or withholding their consent, shall have regard to the industrial interests involved in the case, and to the circumstances and requirements of the locality." Other provisions are that the sanitary authority is to afford facilities for factories draining into sewers, and that the Local Government Board may authorise sanitary authorities to make bye-laws for the protection of streams.

The following is the full text of the clauses relating to sewage pollutions and to manufacturing and mining pollutions:—

Every person who causes to fall or flow, or knowingly permits to fall or flow, or to be carried into any stream, any solid or liquid sewage matter, shall (subject as in this Act mentioned) be deemed to have committed an offence against this Act. Where any sewage matter falls or flows, or is carried into any stream, along a channel used, or in process of construction at the date of the passing of this Act, for the purpose of conveying such sewage matter, the person causing or knowingly permitting the sewage matter so to fall or flow, or to be carried, shall not be deemed to have committed an offence against this Act if he shows to the satisfaction of the court having cognisance of the case he is using the best practicable and available means to render harmless the sewage matter so falling or flowing or carried into the stream. Where the Local Government Board are satisfied that further time ought to be granted to any sanitary authority which at the date of the passing of this Act is discharging sewage matter into any stream by any such channel as aforesaid, for the purpose of enabling such authority to adopt the best practicable and available means for rendering harmless such sewage matter, the Local Government Board may by order declare that this section shall not, as far as regards the discharge of sewage matter by such channel, be in operation within the district of such authority until the expiration of a period to be limited in the order. Any order made under this section may be from time to time renewed by the Local Government Board, subject to such conditions, if any, as they may deem fit. A person shall not be guilty of an offence under this section in respect of the passing of sewage into a stream along a channel over which he has no control.

Every person who causes to fall or flow or knowingly permits to fall or flow or to be carried into any stream any poisonous, noxious, or polluting liquid proceeding from any factory or manufacturing process shall (subject as in this Act mentioned) be deemed to have committed an offence against this Act. Where any such poisonous, noxious, or polluting liquid as aforesaid falls or flows or is carried into any stream along a channel used or in process of construction at the date of the passing of this Act for the purpose of conveying such liquid, the person causing or knowingly permitting the poisonous, noxious, or polluting liquid so to fall or flow or to be carried shall not be deemed to have committed an offence against this Act if he shows, to the satisfaction of the court having cognisance of the case, that he is using the best practicable and available means to render harmless the poisonous, noxious, or polluting liquid so falling or flowing or carried into the stream.

Every person who causes to fall or flow or knowingly permits to fall or flow, or to be carried into any stream any poisonous, noxious, or polluting liquid proceeding from any mine, other than water which has been drained or raised from such mine, and has not been subsequently used for washing or cleansing ore, shall be deemed to have committed an offence against this Act, unless he shows, to the satisfaction of the court having cognisance of the case, that he is using the best practicable and available means to render harmless the poisonous, noxious, or polluting liquid so falling or flowing or carried into the stream. Unless and until Parliament otherwise provides, proceedings shall not be taken against any person under this part of this Act, save by a sanitary authority; nor shall any proceedings be taken without the consent of the Local Government Board, which Board, in giving or withholding their consent, shall have regard to the industrial interests involved in the case, and to the circumstances and requirements of the locality.

ROTARY SEWAGE SCREEN.

Among the sanitary appliances at the Exhibition in connection with the Social Science Congress at Brighton last autumn, was a model of Messrs. Odams and Blackburn's rotary self-cleansing screen for separating the solid matters of sewage from the effiuent, so as to leave the latter sufficiently pure to be allowed to run into any stream not used for drinking purposes. Two of these screens, made by Messrs. Rotheroe and Co., King William-street, E.C., have lately been erected at the Canning-town pumping station of the West Ham Local Board, by way of trial, and have been in practical operation for the last few months, though the experience of their working was not sufficiently long to admit of their being brought before the notice of the late Sewage Conference.

This apparatus consists of two cylindrical frames one within the other, in the present instance 15 feet long, and of the diameters of 4 feet 6 inches, and 5 feet 3 inches respectively, thus leaving an annular space of 9 inches between the two. The cylinders are inclined at an angle of 1 in 10, are mounted on a strong cast-iron frame, and driven at the rate of from 10 to 15 revolutions a minute; or they may be so arranged as to be worked by the sewage itself by means of a turbine. The cylinders are covered with perforated zinc, having 100 holes to the inch in the case of the inner, and about 200 in the case of the outer, though still finer wire gauze may be substituted for the latter. On the sewage pumped up from the town level being allowed to flow in at the upper end of the screen, the larger particles of solid matter are arrested by the coarser perforated zinc, and a considerable proportion of the remainder by the finer; so that altogether 25 cwt. of solid matter are abstracted every 24 hours from the 3,000 gallons a minute which at this station alone are discharged into the Thames. It is believed that a still larger proportion would be eliminated, but for the fact that the sewage is very much macerated by the action of the pumps, and the latter are in such close proximity to the screens as to force a considerable proportion of the solid matter through the perforations at each stroke. The solid matter is raised by an endless band elevator in front of each screen and delivered, if necessary, in carts or trucks, by which it may be immediately removed. In this state it is stated to be equal in value to ordinary farm manure, that is about 5s. a ton.

It will readily be imagined that the liquid is thus in a far more fit state to be dealt with by any of the systems of precipitation, and its manurial value is not diminished by the process, as all the salts, the most valuable fertilisers, are still held in solution, while a very small proportion only of the organic matter is retained in suspension. More is, of course, arrested by the screens, owing to a much finer mesh employed on account of the centrifugal action of the liquid, than would be possible in the case of a mere stationary filter.

The great difficulty that has until now been experienced with sewage filters, viz., their choking, has been overcome, partly, perhaps, by their centrifugal action, partly by the successive filtration by media of different degrees of fineness, but more especially by the fact that the filtered liquid is raised by longitudinal floats, like those of a paddle-wheel, fixed to the outside of the screen, and falls by gravity through the meshes from the outside, thus keeping them constantly clean. This action has also the effect of minutely subdividing the liquid and exposing each particle to the action of the atmosphere, whereby, it is said, it becomes oxygenated, to a certain extent deodorised, and, at any rate, more capable of being acted upon by any chemical precipitant.

The great objection urged against sewage irrigation

farms, viz., that the solid portion of the sewage forms a compact mass on the surface of the ground, which decomposes or prevents the permeation of rain and a future flow of sewage, is thus practically combatted, as the effluent, after passing through the screens, is deprived of all but the most infinitesimally small solid particles; decomposition is thus arrested as soon as possible at the outfall.

FILTERS AND TYPHOID GERMS.

A discussion has arisen between Dr. Tripe and Mr. Wanklyn, originated by the statements made by the latter gentleman at the recent Sewage Conference, to the effect that typhoid germs could with certainty be removed from dangerous water by efficient filtration. Dr. Tripe thinks that Mr. Wanklyn's process may not be sufficiently delicate to detect every one of the minute organisms, or even spores of these organisms, which exist in water, and which are called typhoid germs, and, further, that it is not yet beyond the possibility of doubt that these so-called typhoid germs are really the occasion of typhoid fever. In the last issue of the *Sanitary Record* Mr. Wanklyn answers this attack vigorously. He maintains that his process is capable of converting any kind of albuminoid matter into ammonia, and proceeds to give a record of the effect of some filtrations on which he has himself experimented. He claims that all chemists acknowledge the high organic purity of deep spring water.

"And why," he asks, "is deep spring water so pure? Because it has undergone thorough filtration; because it has passed through hundreds of feet of porous material, and in some instances taken many years in traversing this porous material.

"The artificial purification of water was investigated by me (he continues) in the year 1872, when I showed that a thickness of about six inches of the admirable filtering material with which the Silicated Carbon Filter Company furnishes its filters avails to do the work which in nature is done by the hundreds of feet of porous strata traversed by the water of deep springs. My experiments are published in the *British Medical Journal* for the year 1872. I showed that when a dirty river water is passed through some six inches of the filter it becomes as pure as 'West Middlesex' water, and that by repeated passage through the filter it becomes as pure as a deep spring water. More than that, I established the nature of the process of filtration which goes on in porous filters of this description. It is an energetic oxidising process, very like the action of the strongly alkaline solution of permanganate with which we are in the habit of boiling the nitrogenous organic matters in drinking waters. Just as by working the ammonia-process we make the nitrogenous organic matters contained in drinking water yield ammomia, so the silicated carbon filter breaks up nitrogenous matters, and makes them yield ammonia. In fact (though the modification is not practically to be recommended for general adoption by chemists), it is possible to work the ammonia-process of water-analysis by means of a silicated carbon filter, instead of the boiling alkaline solution of permanganate of potash.

"I have, at this moment, open before me my note-book, wherein are recorded experiments on the oxidation, not only of drinking-water, but of urine and of milk by the silicated carbon filter, and I can assure Dr. Tripe that just as no germ is capable of surviving passage through a furnace at a white or red heat, so in like manner, no germ will survive passage through any considerable stratum of good porous filtering medium."

According to the last published report on public petitions, only one petition has been presented in favour of the Patent Bill, 33 praying for various alterations (in some cases so extensive as to strike at the root of every principle of of the Bill), one asking that the Bill do not pass, and one for referring it to a Select Committee. In the House of Commons on Monday, the Attorney-General stated, in answer to Mr. Dillwyn, that though the Session was getting late, the Government hoped to be able to go on with the Bill at a reasonable period.

In answer to several inquiries, it may be stated that the Pilchards in oil, and Cornish Sardines, to which the Society's medal has been awarded, are prepared by the "Cornish Sardine Company," Falmouth, and can be obtained from the principal dealers in such matters.

NATIONAL TRAINING SCHOOL FOR COOKERY.

The following is the annual report of the lady superintendent, referred to in last week's *Journal*:—

1. I beg leave to lay the following facts, together with the financial statement prepared by the accountant, before the Committee of Management as respects the last year's working of the school, over which I was appointed superintendent on the retirement of Lady Barker, in June, 1875.

2. The classes which were opened last year are still in operation, only upon a larger and more fully developed principle of action, and the system of training teachers of cookery is now thoroughly organised, but this has been successfully working only for the last 11 months. During this period we have trained and granted diplomas to twelve teachers in cookery, and there are now nineteen more students in training as teachers. The number of pupils who have passed through the school since the 1st of April, 1875, to the 31st of March, 1876, is 1,503, as compared with 766 pupils of last year. This large number is made up of pupils from schools who have been admitted to demonstrations at the rate of twelve persons for 10s. Numerous individuals have paid only one shilling each. The pupils who have attended the different divisions of the school—the scullery, the lectures, the middle class, and the artisan kitchens—have been counted as students for each division. The total receipt of fees for this year from all sources is £1,634 16s. 4d., as compared with £1,603 for the previous year. The increase in the fees, for the reasons given, is not proportionate to the increased number of pupils. It should also be noticed that persons desirous of training for teachers have been admitted to the three months' course upon the votes of subscribers and no credit for their fees is taken in the above total, or they would amount to £1,739. The returns of payment for fees have consequently not increased in proportion to the amount of knowledge and interest which has been lately so widely spread through the kingdom.

3. It was essential for the ultimate success of the school to create a wide-spread interest through the country in the improvement of cookery among the middle and working classes. This has been happily effected, as the following facts will show. There have been schools opened for instruction in cookery, taught by teachers trained at South Kensington, in Liverpool, Leeds, Oxford, Leamington, Shrewsbury, Birmingham, Edinburgh, and Glasgow, and from all these satisfactory reports have been recived; whilst other towns, such as Hereford, Bristol, Sheffield, Rugby, Dundee, and Wickham, will shortly have teachers sent to them to open schools in those towns also.

4. A class of practical cookery has lately been started at Whiteland's Training College, Chelsea, the lessons being given by one of our staff of teachers. This is a beginning of a connection of the school with the Female Training Colleges, which it is hoped will largely extend itself.

5. The School Board for London has, for some time past, been actively aware of the need for instruction in cookery among the working classes from which their pupils are taken, and there are now established four cookery centres, at work in London with great success and giving satisfaction, both to the pupils and the Board.

6. The cookery class held last year at St. Mary's Vicarage, Soho, has been successfully carried on up to the present time.

7. The Society of Arts has lately given five free scholarships of £10 10s. each, which were competed for at the School of Cookery, at South Kensington, and it is hoped that this proceeding will be imitated by other corporations.

NATIONAL TRAINING SCHOOL FOR COOKERY.

RECEIPTS, PAYMENTS, ASSETS, AND LIABILITIES, FOR THE TWO YEARS ENDING 31st MARCH, 1876.

Receipts.	1875. £ s. d.	1876. £ s. d.	Increase. £ s. d.	Decrease. £ s. d.
Students' Fees	1,603 5 0	1,634 16 4	31 11 4	
Fees for Local Teaching		373 19 0	373 19 0	
Examination Fees		3 12 6	3 12 6	
Sale of Food	110 15 6	566 5 6	455 10 0	
Sale of Recipes and Publications	13 11 0	86 1 1	72 10 1	
Donations	687 18 0	201 5 0		486 13 0
Annual Subscriptions	152 2 0	151 2 0		1 0 0
Seats at Lectures during the Exhibition of 1874	103 13 6			103 13 6
Miscellaneous		1 8 0	1 8 0	
	2,671 5 0	3,018 9 5	938 10 11	591 6 6

Payments.	1875. £ s. d.	1876. £ s. d.	Increase. £ s. d.	Decrease. £ s. d.
Salaries and Lecturer's Fees	920 1 0	521 14 0		398 7 0
Examiner's Fees	11 15 0	24 0 0	12 5 0	
Payments for Local Teaching		127 10 4	127 10 4	
Commission to Collector	29 15 3	nil.		29 15 3
Clerical Assistance, Miscellaneous, &c.	9 0 8	32 17 3	23 16 7	
Wages of Cooks and Assistants	466 6 3	616 4 11	149 18 8	
Food	466 2 0	1,276 12 3	810 10 3	
Utensils	76 8 11	in liabilities.		
Gatekeeper and Messenger	17 13 0	92 6 6	74 13 6	
Postage and Telegrams	10 19 9	36 6 2	25 6 5	
Printing and Stationery (Recipes)	105 17 10	141 2 0	35 4 2	
Advertising	23 15 9	178 9 6	154 13 9	
Rates	10 7 5	10 19 1	0 11 8	
Gas, Coal, Water, &c.	26 3 10	92 11 3	66 7 5	
Alterations in structure	257 8 3	43 8 9		213 19 6
Fittings	48 3 6	57 7 2	9 3 8	
Travelling and Miscellaneous		40 10 4	40 10 4	
	2,479 18 5	3,291 19 6	1,530 11 9	642 1 9

Assets—

	£ s. d.	£ s. d.
Balance at Bankers		133 18 9
Fees Due and Outstanding Subscriptions	61 18 0	
Stock of Recipes	129 16 0	
Utensils, Stoves, Ovens, &c.	167 0 0	
		358 14 0
To Deficit		219 16 9
Total		£712 9 6

Liabilities—

	£ s. d.	£ s. d.
Buildings	293 9 11	
Printing for Recipes	123 0 0	
Stationery and Printing	58 5 4	
Utensils	49 7 6	
Sundry Tradesmen	38 6 9	
Banker's Advance	150 0 0	
		712 9 6

JAMES RICHARDS,

1st May, 1876.

8. Five of the teachers trained in the school have been employed in various parts of the country, and the school has received for their services £373 19s. which sum, added to the pupils' fees, amounts in all to £2,008 15s. 4d.

9. The cost of advertising for the past year has been £178 9s. 6d., made necessary by the closing of the exhibition; the public believing that the School of Cookery was part of the exhibition and would consequently close with it. The school being now firmly established on its basis, this item of advertising will, it is hoped, for the future be much reduced.

10. The privileges of the subscribers have this year been increased; they are now at liberty to purchase, at a moderate charge, dishes cooked at the school, as well as to nominate students to be trained for teachers in proportion to the amount of their subscriptions.

11. For the period ending 31st March, 1875, the cost of food bought amounted to £466 2s., and the food sold realised £110 15s. 6d., or about 24 per cent.; whereas for the period ending 31st March, 1876, the cost of the food was £1,276 12s. 3d., and the food sold realised £566 5s 6d., or about 44 per cent., which may be said to represent a saving of £260 in the last year.

12. Recipes of the dishes taught in the school have been lately increased largely, and now comprehend all the artisan and middle class cookery contained in the various courses at work in the school. Each recipe is sold for one penny a sheet, and is a source of income to the school.

13. For the full development and practical training of teachers in the economical principles taught by the training school for cookery, and for the turning out of good domestic cooks, it is absolutely necessary that suitable premises be provided. In the building at present used, the accommodation is small, and from the nature of the structure there is continual outlay entailed by almost every change of weather. There is also no possibility of boarding pupils from the country while undergoing the needful course of instruction. The outlay for repairs this year will be found to be considerable, and bearing heavily on an educational institution still in its infancy.

(Signed) Edith Nicolls.

VILLAGE COOKERY.

The *Saturday Review* gives the following account of a lesson given in a little village school of cookery near Watford:—"In a pleasant, well lighted room, built for the purpose by a generous friend, stood four neat little girls with bared arms and tidy aprons. A pupil teacher, who had passed at South Kensington, directed operations. At one end of the room was a bright fire burning in an ordinary cottage range. Under the window was the sink; at one side plenty of cupboard room. Everything was scrupulously clean and tidy. There was no fuss or confusion. To each little girl were given the materials for a certain dish, and she was directed how to make it, or, if she had done it before, allowed to manage for herself, and perhaps cook some vegetables besides. When everything was on the fire or in the oven, the table was laid and the chairs set. The clergyman came to claim his beef-tea for a sick parishioner, and a couple of visitors joined the party and asked to be allowed to stay for dinner. Then, with much pride, each little cook produced her dish for approbation, and cooks, teachers, visitors, and one or two children besides, sat down to a perfectly served, simple, wholesome meal. This routine is gone through two days each week, much to the disgust of the School Inspector, who denounces such innovations. The whole current expenses of the year do not amount to more than £15, which includes a subscription to South Kensington, by which a pupil teacher can be sent up each year. Although the dinners cost on an average 3d. per head, there is not much loss, as the children pay 2d. each. Mr. Newton Price, to whose energy and judgment the school owes its success, says that the lessons in cookery, far from interfering with the regular school teaching, so develop the intelligence of the school children that they more than make up for lost time. He has been able through his little pupils to cultivate a taste for haricot beans, macaroni, dried peas, and many other nourishing foods not in general use among the working classes. Any one who has seen the little cooks at Watford will wish to see established in every village such a useful, well-managed school, and will feel that we might then hope to have better servants, better working men's wives, and in time a new generation who would neither waste nor want." Such a proceeding in every village school in the kingdom is what the National Training School for Cookery aims to establish; but it will be years before it comes about, unless measures are taken by the Goverment to assist in the supply of teachers.

THE STRUCTURE OF STEEL.

Remarks on the Manufacture of Steel, and the Mode of Working it.*

By D. Chernoff,

Assistant Manager of the Abouchoff Cast Steel Works, near St. Petersburgh.

Steel, as generally used in the arts, is a combination of iron and carbon. The purer these elements in steel the higher are its qualities. The best steel that has ever been made in any age or country is, without question, "boulat" (the sabre steel of the Tartars). The special qualities of "boulat," and especially the markings appearing on its surface, have sent many investigators on a wrong scent; all thought to find the extraordinary qualities of this steel in some special mixtures. Careful analyses have been made, but, to the surprise of all, nothing has been found competent to explain the presense of the characteristic veining. Inasmuch as the veining of "boulat" is closely connected with its quality, it was attempted to find substances which, being melted with the steel, would produce the markings required. Steel was melted with various metals—with platinum, silver, and so on—and veinings were, no doubt, produced; but in the first place, they were far from having the same regularity and beauty, and secondly, as well as chiefly, the steel produced was always inferior to "boulat." The peculiarity of the veining of "boulat" lies also in this, that if you heat a good specimen of the steel with clearly marked veining to a bright red heat, and then allow it to cool, it will be impossible to restore the markings, no matter how long you treat the surfaces with acid. The veining, on the other hand, produced by the mixture of metals never disappears, however much the steel may be heated. But if the piece of "boulat" in which the veining has disappeared be melted again, then, if certain conditions in the cooling of the ingot are observed, the veining appears again, though of a somewhat different design; and in this manner it is possible to produce or annihilate the pattern several times. The investigations of Anosoff have clearly shown that the problem is solved in the purity of the steel, and he has succeeded, as is well known, in producing the very highest qualities of Eastern "boulat."

On a former occasion I spoke of the observations I had made on the ribbons of dead tint observable on the surfaces of steel guns in the lathe. By means of careful daily records of the forging of the gun ignots, I found that these tints appeared in the boundaries between the hot and the cold portions of the ingot being forged;

* Communicated to the Russian Technical Society in April and May, 1868, and translated by W. Anderson. It appeared in *Engineering* last week, and is republished here as bearing on one subject of the Technological Examinations.

that is to say, always at those points up to which the ingot was pushed into the furnace. The position and appearance of the strips of dead tint always coincided with the position and form of the limit of heating. If a spot so noted by me was afterwards re-heated, then the ribbon of dead tint no longer appeared after turning in the lathe. Besides this, some of these ribbons would disappear as a greater or less thickness of metal was turned off; others penetrated right through the mass of the gun, and never disappeared.

It is further remarkable that although, at times, the transition from the heated to the cold portion of the ingot was so gradual that it was impossible to assign any limit, yet the ribbon of dead tint developed by the turning of the surface of gun, and corresponding to the above ill-defined limit of heating, was so clearly marked, that it was easy to trace its boundaries with a pencil on the surface of the gun. It must be remarked also that the ribbon has only one well-defined margin, that which was turned towards the cold end of the ingot; the other margin is shaded off imperceptibly into the normal tint of the steel.

Fig 1.

Wishing to investigate the effects of steam hammer on the structure of steel, I heated a $4\frac{1}{2}$-in. ingot to a bright red colour, and subjected it to two heavy blows of a 5-ton hammer, so that one-third the length was not touched at all, the second third was flattened to 3 in., and the last received two cross blows, under each of which there was a compression of at least $1\frac{1}{2}$-in. The ingot was then left to cool in the open air, and on being broken it was found that the appearance of the structure of each of the three sections remained identical, not only to the naked eye, but to the most careful miscroscopical examination.

I have also drawn attention to the circumstances that on one occasion, when experimenting on the influence of the temperature to which steel was heated on its hardness in tempering, I ordered a smith to heat a piece of steel to dull red, but he by mistake heated it bright red. Wishing to rectify the error, I did not at once plunge the steel into water, but let it first cool down into dull red, and then immersed it. Although the steel was of a quality capable of extreme hardness in tempering, the immersion not only did not make it hard, but actually made it sensibly softer. I have recalled the above circumstances because, in connection with many others, they induced me to investigate the effects of temperature on steel, and formed points of departure for my researches. Space will not allow of my describing my experiments in detail. I must content myself with stating the conclusions to which I have arrived.

If steel melted in a crucible is constantly kept in violent agitation while cooling, agitation violent enough to keep all its particles in motion, then the cold ingot produced will have a very finely crystallised structure; if, on the other hand, the melted steel is allowed to cool in perfect quiet, then the resulting casting will consist of large well developed crystals. The appearance of these crystals, and generally the tendency to crystallise under these circumstances, will depend on the purity of the steel. As I have already stated, the ultimate purity of the steel consists in that of its two component elements, iron and carbon, and the best steel is composed of only these two elements.

With reference to other elements, the presence of which is supposed to influence the quality of steel, it is impossible to avoid mentioning the opinion of Fremy, who considers nitrogen so essential, not only to the formation, but to the very existence of steel, that he has laid down the proposition that "if the nitrogen is taken away from steel it will cease to be steel" ("Comptes rendus," vol. lii., April, 1861); and the supporters of this theory, who go further, and affirm that a steel is a union or iron with cyanogen which can even be seen burning with a violet flame during the process of casting steel! However, up to the present time (1868) the most careful researches of Caron, Marchand, Biot, Bousingault, Rammelsberg, and others, have not confirmed the assertions of Fremy; for on the one hand, nitrogen is found also in soft wrought iron and in cast iron, and on the other, the quantity of nitrogen found in steel is very variable, and bears no fixed relation to the quantity of carbon; and furthermore, it exists in such small quantities as to be less than a tenth part of the carbon. For instance, Bousingault found 0·00057 part of nitrogen in cast steel, and 0·00124 part in soft wrought iron ("Comptes rendus," vol. lii., p. 1251). On another occasion he found in Krupp steel 0·00022 part of nitrogen and in soft wrought iron and in cast steel 0·00007 each ("Comptes rendus," vol. liii., p. 9).

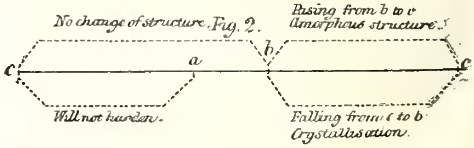
With reference to the influence of different metals on the quality of steel, it is necessary to state that some of them communicate a particular colour, some diminish the tendency to rust, and others, displacing the carbon, enable the steel to acquire very great hardness in tempering, and so on; but the greater number of substances combined with steel, even in the most insignificant proportions, very considerably lower its quality.

For example, the malleability of steel, being in direct relation to the quantity of carbon contained in it, is materially lowered by the presence of foreign substances. Bessemer steel No. 1, containing 2 per cent. of carbon, is hardly malleable (Boman, "Das Bessemern in Schweden," 1864); whereas, according to Anosoff, pure steel retains its malleability with 3 per cent. of carbon, forming the hardest "boulat." Speaking generally, all the efforts of metallurgists to obtain the highest qualities of steel should be directed to separating impurities from the raw materials, so that the produce of their operations should be a combination of iron and carbon; and all the specifics and nostrums forming the subjects of so-called secrets will be found to consist, in effect, not in the introduction of new materials, but in purifying the raw, and only, as a last expedient, driving out pernicious impurities by means of substances less harmful.

It may as well be said that tungsten steel has not proved a dangerous rival to carbon steel. The fact is that tungsten, when steel containing it is heated, gradually oxidises, at first on the surface of the ingots, and then by degrees to the very centre, so that after a few heats the steel loses its peculiar qualities. This oxidation takes place even at ordinary temperatures.

As I have already stated, steel, cast and allowed to cool quietly, assumes a crystalline structure. If you heat such an ingot to a bright red heat, and allow it to cool without working it in any way, then on breaking the mass you will find that its structure has been altered. In order to explain the law regulating the change of structure produced by heating, I draw a line, on which, as on the scale of a thermometer, I shall mark certain points corresponding to several determined temperatures.

Let the point *o* be the zero of thermometrical scale; *a* marks the temperature of dark cherry red; *b* red, but not sparkling; and *c* the melting point of a given sample



of steel. The points *a*, *b*, and *c* have no permanent place on the scale, but vary with the quality of the steel (in pure steel this variation depends directly on the

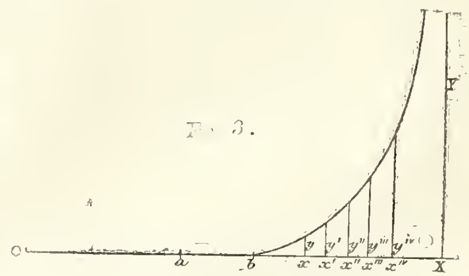
quantity of carbon contained); the harder the steel the nearer the points move to o, and the softer the steel the farther off, and, speaking generally, with varying rates. The limits of these movements are sufficiently narrow, so that an inexperienced eye would hardly discern them. Not having suitable apparatus for measuring the temperatures, I have been compelled to denote them by the colours exhibited in heating, the various shades of which only an experienced eye can appreciate; and it must be added that the colours named have references only to hard and medium qualities of steel; for in the very soft kinds, nearly approaching to wrought iron, the points a and b recede very far, so that, for example, in wrought iron the point b corresponds to white heat.

The definition of the point a is as follows:—Steel, however hard it may be, will not harden if heated to a temperature lower than a, however quickly it is cooled; on the contrary, it will get sensibly softer and more easily worked with the file. Not having time to enter into the explanation of this phenomenon, I will refer to the investigation of Jullien ("Les affinités capillaires et les phénomène de la trempe mis en presence," Paris, 1866) on tempering in general, from which he deduces the very probable conclusion that steel, in cooling from a red heat, appropriates a certain amount of latent heat, the quantity of which is directly dependent on the rate of cooling; so that the quicker the steel is cooled the greater quantity of latent heat it will contain; but if the rate of cooling diminishes below a certain limit, then the latent heat all escapes, and no hardening can take place. The actual hardening Jullien explains by the supposition that the carbon assumes an abnormal crystalline condition. I will add myself that all this takes place only when steel is heated above the point marked a on our scale. The definition on the point b is that steel heated to a lower temperature than b does not change its structure, whether cooled quickly or slowly. This expression, however, must be taken conditionally, because steel, during long periods of time, and especially under the influence of shocks and vibrations, and at ordinary temperatures, but to a less extent than wrought iron, changes from the finely granular to the coarse crystalline structure; and as regards the heated, and therefore softened, condition, and especially at temperatures approximating to that indicated by the point b, it it is probable that, with the great facility of motion, the change of structure will take place more rapidly. In my own experiments I have kept pieces of steel at temperatures near to b for about eight hours, but after cooling slowly in hot sand I have been unable to detect any change of structure.

As soon as the temperature had reached the point b the substance of steel quickly passes from the granular (or, speaking generally, crystalline) condition to the amorphous (wax-like structure), which it retains up to its melting point, that is, to the point c. In this condition steel possesses the property of incompressibility, and at the same time (with respect to the permanence of the amorphism), has an analogy to an exceedingly concentrated solution of a strongly crystalline salt. To make my meaning clearer, imagine a piece of crystallised alum put in a beaker and carefully heated. On attaining a certain determined temperature, the piece of alum will appear as if damp, the separate crystals forming the mass will seem, as it were, to be sticking or clinging to each other, forming a mass on the point of melting and which actually gradually becomes fluid, and forms a solution of the crystals of alum in their own water of crystallisation. Now if this fluid mass is allowed to cool it will again crystallise, and according to the conditions under which this cooling takes place we can obtain any quality of crystals, from the coarsest to grains so fine as to be scarcely perceptible to the naked eye.

If the fluid is allowed to cool very slowly, and in perfect quiet, then large regular-shaped, well-developed crystals will be formed; but if, with the same gradual cooling, the liquid is kept in constant agitation (shaken up), the crystals will come out very small. Allowed to cool quietly but rapidly, the crystals will also be small; and, finally, the least favourable condition for crystallisation is when the liquid cools rapidly, and is at the same time violently agitated. In a word, all depends upon the greater or less time and the greater or less freedom of motion the particles possess among themselves for collection into crystals; and first condition depends upon the rate of cooling, the second, upon quiet and the greater or less density (thickness) of the mass undergoing crystallisation.

The same changes take place in the structure of steel heated above the point b. The higher steel is heated the softer it becomes; the greater, therefore, is the liberty its particles possess to group themselves into crystals (if the quiet of the mass is not disturbed by extraneous forces); and the slower the temperature is suffered to fall to the point b, the more time they have for the purpose. At temperatures lower than b, as already stated, the structure of the mass does not alter. In this case the action of carbon on iron may be likened to that of water of crystallisation on its salt; that is, it may be supposed that carbon at the temperature b begins to dissolve iron, just as the water of crystallisation at certain temperatures commences to dissolve the solid substance of the salt. This hypothesis receives confirmation in the process of cementation, in which the iron must be heated to above a certain temperature or no effect will be produced, no matter how long the bars remain in contact with the carbon; it is very probable that the temperature at which carbon begins to be absorbed in cementation is very near to the point b.



The power of steel to become granular may be graphically illustrated thus:—On our scale of temperatures o, a, b, c, a curved line rises to the point b, and the ordinates y y, &c., of this curve represent the degree of development of the grains for the corresponding temperatures x x x, which become the abscissæ, but necessarily under similar conditions of cooling from the several temperatures x x to the temperature b. At some temperature X lower than the melting point C, the ordinate Y becomes infinite, and an asymptote to the curve, the practical significance of which is apparent in the well-known fact that steel will not endure a high welding heat, but falls to pieces in the fire; and the harder the steel the lower is the temperature at which this takes place, and therefore the nearer is the temperature X to o, and the further from C.

In manufacturing articles of steel, we try to get them as much as possible of a fine-grained structure, especially if strength or toughness be the first object sought. I say that it is better to obtain steel of a finely crystalline structure, because numerous experiments have demonstrated that the greater the preponderance of the crystalline formation, the larger and more regular the crystals are in a given piece of steel, the less resistance does it offer to fracture, the less tenacity does it possess, and therefore men connected practically with the working of steel recognise its qualities by the appearance of its fracture. If the fracture is fine-grained, they say the

steel is well forged and consolidated; if it is coarse-grained, it is badly forged and of an open character.

Although we are in the habit of associating with the forging of steel an idea of increased density, yet in reality it appears that, in most cases, forging only changes the form of the steel, and according to the relations between the force of the blows and the thickness of the piece of steel being worked, hinders crystallisation of the mass to a greater or less degree, but does not increase its density (I am speaking only of forging above the temperature *b*, such as is general in working large ingots). The force of the blows is too small to vanquish that gigantic molecular force of heat that keeps the particles of steel at a definite distance one from the other. The problem of forging (at temperatures higher than *b*) consists in this, that while changing the form of the mass of steel, it should have no time to cool and crystallise quietly, but should be kept in the amorphous condition till such time as the temperature sinks below the point *b*, after which, if left to cool in quiet, the mass will no longer crystallise, but will possess great tenacity and homogeneity of structure, so that it will oppose in all its parts a uniform resistance to external forces, of course supposing the chemical composition of the mass throughout to be the same.

But if the problem of forging was limited to the above conditions, it is easily seen that working steel under the hammer might be dispensed with, and the required form given at once by casting in suitable moulds, and preventing crystallisation by rapid cooling. In reality, however, things are very different. The difficulty of forging is aggravated by the circumstance that the cast ingots out of which guns, for example, have to be made are full of pores filled with gas, bubbles penetrating the interior as well as the surface of the mass, and also with scales and cracks due to contraction, so that as the castings are delivered from the foundry, it would be impossible to make use of them. These bubbles and cracks must be squeezed or pressed together, and this can only be done by powerful mechanical means —by heavy forging. Simply unforged cast steel is neither less dense nor less strong than steel of the same molecular structure, and forged at temperatures higher than *b*. To convince myself of this I made a number of experiments, first on the density of the two kinds of steel, and found that in most cases forging had diminished the specific gravity; and secondly, I found that the tenacity of the cast steel was in nowise less than that of the forged, provided, as I said before, both have the same structure. To prove this, I took a cast ingot of coarse crystalline structure; I had it cut longitudinally into four parts. One of these parts was turned down in the lathe, and tested in the proving machine. The second piece was heated to bright red, and vigorously forged under a 3-ton hammer; the forging being stopped when the temperature fell to very nearly the point *b*; the specimen was then turned down, and also tested in the proving machine. The third piece was made red-hot, very nearly the same temperature at which the forging of the second piece terminated, and was allowed to cool in the open air without being forged. Having broken a small piece off this last specimen, I found that it had assumed a finely granular structure, very similar to that of the second forged specimen. The third sample was also turned down in the lathe, and tested. The three specimens are now before you, and you may judge for yourselves what varieties of structure the self-same piece of steel may be made to assume. The result of the experiments are given in the table below.

I must also remark, that on the fractured surface of the third sample, as you may observe for yourselves, there is a spot of iron occupying about one-sixth of the area, and this was undoubtedly the cause of premature fracture, for the appearance of the surface clearly shows that it began at that spot.

In order to establish the propositions I have advanced, it will of course be necessary to institute a complete series of experiments.* As regards trials by bending and breaking under the hammer, an immense number of experiments have convinced me of the correctness of my views.

	Ultimate Strength in tons per square inch.	Ultimate Extension.	Diameter of Specimen.	Dynamic Resistance per cubic inch in inch tons. Ultimate strength × $\frac{1}{2}$ elongation.
			Inch.	
1st. Unforged specimen..	34·8	0·023	0·885	0·8
2nd. Vigorously forged specimen..	41·5	0·053	0·85	1·1
3rd. Not forged, but made finely granular by heating	38·7	0·166	0·63	3·21

THE SULPHUR MINES OF FORLI.

The sulphur deposits of the Romagna, of miocene lacustrian formation, are situated amid the sub-Apennine hills. The mines now under work in the province of Forli, described by Consul Colnaghi, are spread over a superficial area of 260 square kilos. From a document existing in the archives of Ravenna, in which the parish of San Pietro, in Sulferina, in the district of Cesena, is mentioned, the existence of this mineral would appear to have been known in the eleventh century. In 1344, Ostasio da Polenta bought certain estates in the neighbourhood of Polenta, his right to dig for sulphur being expressly mentioned. The mineral is noticed in the poems of Dario Tiburto in the fifteenth, and of Folengo in the sixteenth, centuries; and George Baner or Agricola, in his work on mineralogy, published in 1546, speaks twice of the sulphur of Cesena, and praises its quality. More recently, in 1872, the principal mines belonging to the Società delle Miniere Zolfuree Cesenati, were purchased by an English company, the Cesena Sulphur Company Limited, and a new era of activity commenced for the sulphur region of this district.

The chain of the Apennines of the provinces of Forli, and Pesaro, and Urbino, offers a large field for the growth of this industry. The total amount of refined sulphur produced in 1874 amounted to about 24,700 tons. The cost of extraction, refining, &c., may be calculated, on an average, at from 100 to 120 Italian lire per ton, including royalties. The price of refined sulphur is from 160 to 170 lire per ton, leaving a profit of from 50 to 60 lire. The sulphur of Romagna is worth from 15 to 20 per cent. more than that of Sicily on account of its intrinsic good quality and the degree of purity to which the refineries have brought it. In 1874, about 2,134 tons of Romagna sulphur were exported from the district of Ancona to France, Turkey, and Austria. A certain quantity appears also to be sent overland to the ports of Genoa and Leghorn for shipment. Foreign trade is, as yet, but little acquainted with the value of Romagna sulphur, the production of which has not long been brought to its present development, the facility of shipment of the Sicilian sulphur naturally attracting trade to the south. At the mines of the district of Cesena, including Marazzana, and Perticara, upwards of 3,000 workmen are constantly employed as miners, firemen, carters, &c.

* 1875. Since the above was written, numerous experiments at the Abouchoff works have fully demonstrated the truth of my views.

The Cesena Sulphur Company, after undergoing the vicissitudes which seem inherent to the establishment of similar undertakings, especially in foreign countries, appears to be steadily advancing on the path of prosperity. The only foreigners employed at the mines are the managing director and one English mining engineer. All the miners are Italian, and nearly all natives of the district. The men work in gangs, three in twenty-four hours. Each miner is required to bore three holes in six hours, which being done, the whole gang fire their mines together, an operation attended with great difficulty from the dense sulphur smoke, which renders respiration barely possible. The mineral is cleared away by the gangs of carriers and wheelers, and carried over tramways which extend to the headings. The men live chiefly on bread, cheese, and vegetables, eating meat on Sundays. They spend much in dress, and on holidays look like well-to-do people; they drink wine freely, but no spirits. Very keen and sharp as to their own interest, they are open to persuasion when treated with kindness. They are more persevering at work than English workmen in cases of urgency, and many of them have remained underground for twenty-four consecutive hours when required. As a general rule, the Italians have less muscular power than English miners, and less courage when not under excitement.

FIREPROOF TOWNS.

A correspondent of the *Builder*, signing himself "Alma," writes:—It is curious that, while we have such disastrous and numerous fires in this and neighbouring countries and in North America, there are cities and towns not far off absolutely fireproof—as Buenos Ayres and Monte Video. In Buenos Ayres, a city of 250,000 inhabitants, a poor charwoman sleeps with her children with more safety from fire than the Princess of Wales and the Royal children. Yet it is so easy to make houses fireproof, using wood, not to speak of iron, that the older architects and builders of Buenos Ayres and other towns there probably never knew they were building fireproof! They neither use iron nor the arch, but simply, that province being without trees, they have to use the hard woods from far up the river, which are, therefore, dear, and so they use little, this being the whole secret. A hundred walking-sticks may be placed 2 in. from each other, and yet a fire cannot be made of them if they are placed gridiron fashion, say, across two little walls of brick and a fire kindled below; it will burn through, say four of the sticks which are in the flames, but there it ends. In the same way, if a cart-load of shavings and pieces of pine were provided, and half be packed under the best bed in a Buenos Ayres house, and the other piled over it and set on fire, the bonfire would eventually burn through four or five of the joists above, and the bricks and tiles of the floor would fall through, but there it would end; the house could not be set on fire. The houses are built as follows, the material being brick:—Alike each floor and the roof (which is flat) are supported by joists of hard wood about the same distance apart as in this country; across these are laid rails of the same ($3\frac{1}{2}$ in. by $1\frac{1}{2}$ in), and the space between these is bridged over by thin bricks $13\frac{1}{2}$in. long; another layer of bricks is then laid, and generally on this a layer of tiles. The roof is exactly the same, but has a slope of 1 in 30 or 35. Then the doors and windows have no boxes, but simple frames, which are set up on building the wall and built in; and there is no lathing, nor wainscot, nor skirting of the bottom of the walls. And all the wood is of the hard and hardish kinds, the doors and windows and shutters of cedar, slow to ignite. The modern houses of Buenos Ayres are pretty much like those of London, Bath, or Edinburgh, nor would any one see any difference. It would be easy, therefore, to adopt the same way of building here with the necessary slight modifications. The ends of the joists in the walls would probably rot in course of time, from external damp penetrating if they were not of wood indestructible by damp, as in the River Plate towns, where, in the experience of the Spaniards, which extends to nearly two centuries, it does not rot in the damp in that time. Hence, if they were only of oak in this country, a *battre*, like a cornice, should be built at the top of the walls of each story on which the ends of the joists are to rest, so as to sustain them if their ends, built into the wall, ever rotted. The projection, stuccoed over, would form a cornice; but the joists could easily be of iron instead, this being the cheapest country for iron in the world. The lathing of the ceilings and walls should be done with iron ribbons, and the slates be supported by sheet iron, to which they could be fixed by small screws and nuts. Then the coldness of the floors should be obviated by a lining of black poplar, $\frac{1}{2}$in. or $\frac{3}{4}$in. thick, and carpets above; but all the rest to be of oak or teak, or other hard wood, both hard and wanting in that resin which makes pine so combustible. Instead of filling our houses with combustible pine it would surely be better thus to copy the Spaniards in their fireproof towns—Buenos Ayres, Monte Video, Rosario, Parana, &c.

SILK PRODUCTION OF THE LEBANON.

The cultivation of the mulberry tree succeeds admirably at the base and thoroughout the fertile parts of the Lebanon range, and the rearing of the silkworm and the production of silk have acquired, of late years, a remarkable extension, and form at the present time the chief source of the support of the people. Vice-Consul Jago states that, prior to 1836, the silk of the country was reeled by native machinery. In that year, however, the system of reeling by European machinery was introduced into the mountain by French merchants, and has now become almost universal. European-reeled silk sells at double the price of that reeled by native means. The improvements consist in stifling the cocoon instead of hurriedly reeling it when fresh, in diminishing the diameter, in creating and regulating the speed of the reels, and in the employment of steam for heating the basins into which the cocoons are plunged, whereby uniformity of the thread is attained. The native way of reeling produces a thick coarse thread of varying size, and therefore unadapted to European looms.

The new system has obtained to such a degree that there are now fifty-six spinning factories in the mountain, of the aggregate value of about £25,000, containing 2,662 basins, and employing upwards of 3,500 persons. Of these, eight are owned and worked by Frenchmen, and the remainder by natives, who have thus shown themselves apt to learn, and ready to profit by the instruction conveyed into the country by European enterprise. About three-fourths of the cocoons produced are spun in the above factories, and the raw silk sent almost exclusively to France for the use of the Lyonnaise looms, while the remainder is retained for home consumption, and spun in the coarse native way suitable for the manufactures of the country. While great changes have taken place since 1840, when the cocoons could be purchased at 11 and 12 pias, the oke, the size of the cocoon, and the quality of the silk, have greatly deteriorated. In 1851, the disease first showed itself in Syria, and has since caused the almost total destruction of tho native cocoon. Importations of Egyptian seed succeeded fairly for a time, but in 1866 the production began to fall off, and recourse was had to Japanese seed. The silk season lasts ten months, from June to the end of April. Its success depends, however, upon two things, viz., the good prices in France and an abundant crop in Syria, permitting purchases to be made at advantageous rates. The duration of the spinning averages from eight and a half to nine months; the wages paid in the

factories are from 6d. to 1s. per diem. In a few of these girls form the majority of the hands, in others the proportion is insignificant, and women are employed only at harvest time in assorting the cocoons. The girls are from ten to eighteen years old, after which they cease to hire themselves out and remain at home. Boys and men are employed from ten to thirty years of age. The native workman is found to be generally very intelligent and to take readily to spinning. The girls show more patience and application, and evince greater skill than the boys; the character of both is very docile. They are almost exclusively members of the various Christian communities of the Lebanon. Few or no Moslems are employed. The Druzes are found useful as labourers, messengers, and for out-door work generally, the characteristic of the race not fitting them for sedentary occupations. The hours of labour are from sunrise to sunset, with three stoppages for food and repose. Presents of money and dress are made to the deserving. With shorter days a corresponding diminution of wages takes place.

The original Japanese seed when first introduced into the Lebanon about ten years ago, produced a cocoon about half of an inch long, of a green colour. Reproduction, however, has since resulted in obtaining a cocoon of colour and form almost similar to the golden yellow of the indigenous cocoon and more voluminous in size. The old native seed, now seldom produced, and that only in the higher ranges, yielded for every dram from 3 to 4 okes of cocoons; the original Japanese, from 1 to $1\frac{1}{2}$ okes; and reproduced Japanese 2 okes per dram. With the native seed, 1 oke of silk was obtained from 9 to 11 okes of cocoons; with the original Japanese, 17 to 18 okes; while with reproduced Japanese, from $13\frac{1}{2}$ to 15 okes. This crcumstance, coupled with the price of reproduced seed being five times less than the original seed, has given the preference to the former throughout the whole of Syria, besides causing it to become an article of considerable importance for export to France, Egypt, Cyprus, and Candia. Disease, however, occasionally shows itself in the reproduced seed as well as in the original, producing black spots on the head and feet of the worm, followed by refusal of food, and ultimately death. The moth which produces the seed required for export and reproduction is laid upon a stretched cloth, which is afterward rolled up and placed in a perforated box; the box is then hung up in a spot accessible to the air. Seed for local purposes is kept in convents and churches and other dry places, free from smoke, and airy, until the middle of March. The production of seed in 1874 was 2,400,000 drams (or 2,400,000 papers) of which 300,000 were sent to France; the same quantity to Cyprus, Egypt, and Crete, and the remainder consumed in the country. The importation of original Japanese seed is now only 1,000 papers per annum, of which a fourth contains unfruitful eggs, owing to fraud in Japan. The thread produced by the original Japanese seed is weak, that of the reproduced seed becomes yearly stronger and more elastic. The principal export of silk is to France, and a very small quantity to Italy.

It is reported that the unfavourable meteorological conditions experienced at the critical time of the formation of the cocoons by the worms have renewed the fears of the Italian silk cultivators with respect to this year's crop. In any case it seems improbable that the French yield will be more than half, or the Italian yield more than two-thirds of an ordinary crop; while only in the East may a full average supply be expected.

A series of experiments with life-saving appliances will take place on Thursday next at Dover, from the *Castalia*, which has been engaged for the purpose. The principal apparatus to be tested is Parratt's Deck Seat Life Raft.

The value of the fleet of the Messageries Maritimes was officially estimated at the close of 1875 at £4,342,653, or £10,242 less than the corresponding value at the close of 1874.

GENERAL NOTES.

Depreciation of Silver.—The report of the select committee on the depreciation of silver has been laid before Parliament. It is a very voluminous document, prepared by Mr. Goschen. As the committee were simply appointed to report on the causes which have led to the recent depreciation they have not made any recommendations. They report that the cause of depreciation is threefold—(1) The fluctuations of Indian trade; (2) the change of the standard of currency in Germany; (3) the enormous increase in production of silver mines in America. In respect to the last point the committee declare that the production is more likely to increase than diminish.

Trade Marks in America.—In the United States a bill has recently been introduced into Congress by Senator Conkling to supply deficiencies in the present law regulating trade marks. The counterfeiting and false use of trade marks are now regarded only as an invasion of the property rights of their owners, an injunction and suit for damages being the only remedy. The piracy of trade maks has, therefore, flourished because only the actual owner could interfere with the pirate. The consumer, who is in many cases as great a sufferer, can rarely detect the imposture; and if he does he has no redress. Mr. Conkling's bill is directed at providing an adequate punishment for the wrong by making the counterfeiting the trade marks a penal offence. An imprisonment not exceeding two years is imposed upon any person who engraves, or knowingly has in his possession, or sells, or offers for sale, or uses counterfeit trade marks; and also, upon any person making dishonest use of empty packages with genuine trade marks thereon. All such imitation goods are, furthermore, to be forfeited.

Preservation of Food.—The *Chemist* gives the following abstract of a paper by Mr. Massié in the *Repertoire de Pharmacie*:—For three years the author has made use of bars of forged iron weighing about $1\frac{1}{2}$ kilogramme for the preservation of barley, rice, bran, wheat, &c., in white wood boxes holding 150 litres. Though it is difficult to explain the action of the metal, it is none the less an excellent preservative. Metallic mercury produces similar results, and in certain cases is more efficacious than iron. That he might be in possession of certain data on the efficacy of two metals, the author experimented by placing in glass vessels, holding one litre, the following substances, viz., barley, rice, bran, meal, ergot of rye, cantharides and white biscuit. Three flasks were filled with each: in one a piece of iron (80 grammes) was placed; in the second, mercury (5 grammes); to the third no addition was made. With one exception the vessels were not closed, and were allowed to stand in an ordinary well lighted room from May 7, 1875, till December 2 in the same year. On the latter date they were examined, when it was found that the sound specimens without addition had in almost every instance suffered deterioration to a greater or less extent, and in two or three weevils had made their appearance; the same specimens with iron or mercury were unaltered, save the biscuit with iron, in which a few holes could be counted. The specimens containing weevils originally did not seem to be affected by iron, but mercury seems to have had a decided effect in checking the multiplication of the insects, if it did not destroy them altogether. The experiments having most interest for pharmacists are those on ergot and cantharides, both of which were decidedly benefited by the presence of either of the metals, particularly, as with the former, when kept in a closed vessel.

NOTICES.

SUBSCRIPTIONS.

The Midsummer subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

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FRIDAY, JULY 21, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PRIZE IN INDUSTRIAL HYGIENE.

An offer of a medal in connection with this subject has been made by Mr. Benjamin Shaw, and has been gratefully accepted by the Council.

The medal will be of the value of £20, and will be awarded every fifth year. Mr. Shaw has directed a sufficient amount of Consols for the purpose to be transferred into the name of the Society.

The terms of the offer are as follows:—"For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

The first award will be made in May, 1877.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The Scholarship founded by Mr. H. A. Brassey, M.P. for the port of Sandwich, was competed for on the 29th ult., and has been awarded to Miss Florence Nightingale Norris.

The School will close for the Midsummer Vacation on Wednesday, the 26th inst. The Michaelmas Term will begin on Thursday, the 28th September, 1876.

CANTOR LECTURES.

The second lecture of the second course of Cantor Lectures for the past Session, on "Iron and Steel Manufacture," by Mr. W. MATTIEU WILLIAMS, was delivered on Monday evening, January 24th, as follows:—

LECTURE II.

As I have already stated, the primitive ironmakers used the richest and purest of ores, and nearly pure carbon for their reduction. With such material, the manufacture of iron, although more difficult than that of the more fusible and reducible metals, was far easier than it has subsequently become, now that the increasing demand has gradually brought poorer and poorer, and more and more impure, ores into use. It is in our own country, and recently, that the worst ores and the most impure heating and reducing agent have been used, and it is here, consequently, that the greatest difficulties have been overcome, and the more complex means of working have been used.

Dudley succeeded in obtaining merchantable iron, by using coal for the reduction of the ores found in the Staffordshire coal measures, but his immediate successors failed, and, as I have already stated, 126 years elapsed before his invention was re-invented and practically worked by Darby, of Coalbrookdale.

The modern English ironmaster has not merely to reduce an oxide of iron by means of carbon, and then to forge the spongy iron thus produced, but he has, in addition to this, to remove the silicates and other impurities associated with the clay ironstones described in the last lecture. Besides this, he has to battle with the impurities of his fuel, some of which are especially mischievous, by uniting with the iron while he is removing the impurities of the ores. Thus, he is driven to the inconsistency of adding one set of impurities while he is taking another set away, and so forcing upon himself the necessity of a second process of purification, to take out what he has himself put in. This will be better nnderstood as we proceed.

Having, in the first lecture, sketched in outline the general principles and processes by which the simplest ores are reduced by the purest obtainable carbon, I will now describe—as far as time permits—the processes by which the worst but most abundant and conveniently situated ores are reduced by the most impure and abundant form of carbon.

These ores may be put into the reducing furnace in their raw state, or they may be previously calcined.

This calcination is a very simple process, and the simplest mode of conducting it is to build up heaps consisting of alternate layers of ironstone and coal or slack, thin layers of coal to thick layers of ironstone, in the proportion of $2\frac{1}{2}$ to 3 cwt. of coal or slack to each ton of iron. The coal is fired, and burns slowly, driving off or "roasting" away more or less of the water, the carbonic acid, and other volatile matter contained in the ore. It renders the ore more porous and lighter, without altering its bulk. Kilns or ovens are used for the same purpose, and consume less coal. The waste gases of the blast furnace have also been used for roasting ores. The black-band ironstone usually supplies its own fuel for roasting, when started by means of a bottom layer of coal.

The modern blast furnace, in which the reduction of the common iron ores and the removal of the bulk of their earthy impurities is effected, is a hollow fire tower, varying from 30 to 100 feet in height. It has various forms, that shown in the woodcuts (Figs. 1 and 2) being a fair typical example. They represent one of the furnaces erected by the Lilleshall Company, in the neighbourhood of Oaken-gates, Shropshire, and are copied from drawings accurately made to scale, and kindly supplied to me by the company.

As the internal form of construction is the most important, I will describe that first. It is shown in section by Fig. 2, where it will be seen that the upper part, down to about the level of the floor of the surrounding gallery, is cylindrical. From this part it gradually widens downwards, till we reach about two-thirds of its depth, and it then commences a rapid contraction or narrowing, which continues to the base. In some furnaces this narrowing ceases at *h*, and the part below is cylindrical. Another common and, I think, desirable modification of the form shown in the diagram is to connect the widening and narrowing portions at *f* by a gradual swelling curve, rather than a sudden angle, as there shown. If we could examine this particular furnace now, after it has been working for some years, I have no doubt we should find the "belly" thus curved by the wearing action of the descending charge.

The cylindrical portion, *a e*, at the top, which

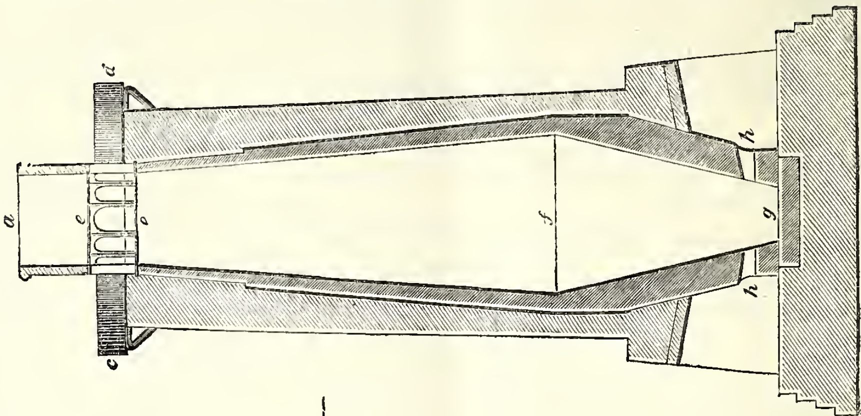


Fig. 2.

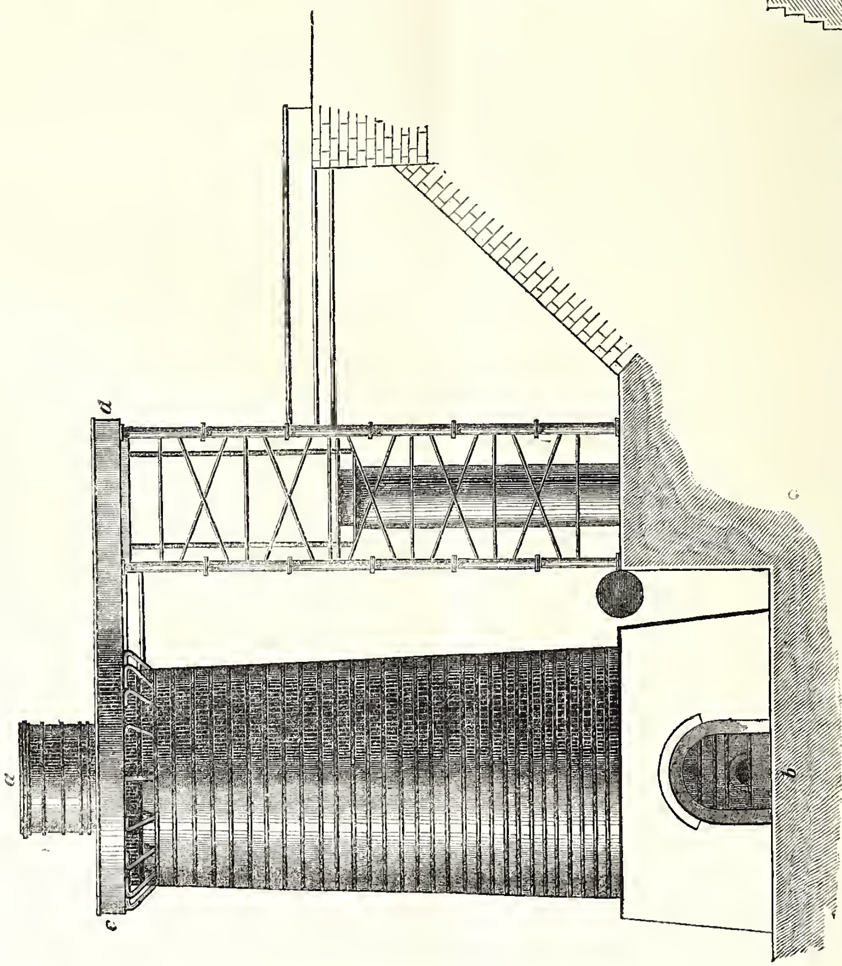


Fig. 1.

acts merely as a chimney, and is not added to all furnaces, is called the "tunnel head;" *e e* is the "throat." The upper truncated cone, *e f*, extending from the bottom of the throat to the widest part of the interior, is the "stack." The widest portion itself is called the "belly," and the lower cone, down to *h h* forms the "boshes." The openings at *h h* are the "tuyere holes," and below them are the "hearth" and "crucible." The term "bosh" or "boshes" appear to be a corruption of the German *bauch*, or belly, and is sometimes applied only to the swell or curve of the widest portion, but more commonly to the whole of the lower cone.

The downward widening of the stack serves to facilitate the descent of the charge, which retains its original bulk so far. The narrowing of the walls below this is adapted to the contraction of bulk produced by combustion and fusion, and assists in supporting the weight of the charge. The tuyere holes, varying from two to six in number, are for the introduction of the blast, and the hearth and the crucible below for the melted cinder and metal.

The whole of the interior is lined with fire brick, which, in the figurative language of the Black Country, is called the "shirt" of the furnace. It is thickened downwards, as shown in the section, in order to resist the increasing heat. The inner portion of this lining is made of the best fire bricks, the outer sometimes of inferior quality. Between the lining and shell is a layer of loose sand or cinder.

The size and proportions of blast furnaces vary very considerably, some might suppose capriciously, but this is not commonly the case. There are good reasons for many, perhaps I may say for most, of these differences. Thus, the tallest furnaces are in the Cleveland district, where the poorest and most impure ores are used, and the smallest and shortest of modern furnaces are those used for making charcoal iron from rich oxides. The reasons for this extreme difference, and for some of the intermediate modifications, will appear as we proceed with the actions occurring in different parts of the blast furnace.

There are also considerable differences in external form and structure. The old blast furnaces, many of which still remain, were built very massively of stone and brick, the outside form being conical, with a square base. The lower walls were very thick, in order to enable them to resist the out-thrust of the charge. The modern furnace is usually of tower shape, and nearly cylindrical, like Fig. 1, with a much thinner casing, which is jacketed and bound together by wrought-iron rivetted plates, and these again are bound with strong iron bands. The old forms may still be seen in Scotland and South Staffordshire. In Lancashire, Yorkshire, Shropshire, &c., the towers or "cupolas" decidedly prevail. In recently opened iron districts, the new form is alone visible.

The gallery surrounding the upper part of the furnace, and in the diagram, extending from *c* to *d*, is called the charging plate. The charge is raised to this, wheeled in barrows to the throat, down which it is tipped. Various devices are adopted for raising the charge to this level. Remembering that some of our modern furnaces reach a height of 80 to 100 feet, and have so voracious an appetite that from 200 to 500 tons of raw material have to be daily poured into their fiery throats, we see that there is no small amount of work to be done in merely lifting this to the charging plate.

Wherever it is practicable, the furnace is built by a hill side, and starting from a lower level than that from whence the materials are derived. In some cases this can be so effectively done that a mere level gallery and road-way connects the furnace throat with the highway by which the materials are brought. Where this cannot be so completely done, inclined planes are sometimes used, and the materials are wheeled up these, either by hand or steam power. I need scarcely add that hand-wheeling of charges up considerable slopes belongs to the past history of iron-making. In other cases, especially where the height is great, ordinary steam lifts are used, or, better still, hydraulic lifts, such as shown in the diagram (Fig. 1). This is an elegant and effective contrivance, in which friction is reduced to its minimum. An inner tube, made air-tight, and filled with air, slides telescope fashion, but loosely, within an outer tube. Its capacity must be such that it shall have sufficient floating power to raise itself and the burden to be placed upon it. A cock is turned and water from a raised tank or other suitable receptacle flows into the outer tube, taking the place of the lower portion of the under tube and raising it thereby. The rising tube and stage are of course steadied by suitable guides. On stopping the supply of water the rising ceases, and when the stage is required to descend, this is effected by simply opening another cock and allowing the water to flow from the outer tube. This is especially convenient where a high level natural water supply is available. No other power is then required. As many tons of water must fall down a depth equal to the working height of the lift as will equal the whole weight of material and machinery that is raised, plus the friction and the force required to set it all in motion.

The lower part of the furnace and its appliances demand a little further explanation. It is shown on the diagram Fig. 3, which is a section through

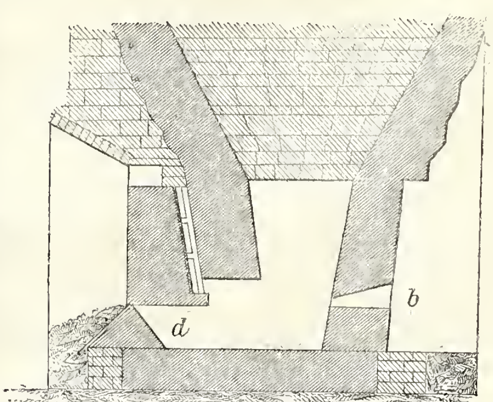


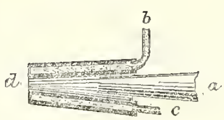
Fig. 3.

that part of the hearth crucible where *d*, the dam-stone, is shown. It is not easy to represent this intelligibly on paper. It is the barrier that blocks

up the tapping face of the furnace under the tymp or tymp arch shown in the section above it. A semicircular furrow on the top edge of this damstone serves as the outlet for the overflow of the fusible silicates forming the cinder, which float on the top of the melted metal. Besides this, a vertical slit is pierced through the lower part of the dam. This is the "tap hole," which is rammed with sand, to be knocked out or perforated by means of an iron bar when the metal is cast. This dam is formed of firebrick or refractory sandstone, and is protected on the outside by a cast-iron plate—the "dam-plate."

The opening, b, for the admission of the tuyeres, or twyers, from the French *tuyau* or *tuyere*, which in the Black Country is freely translated "two irons," being made of two pieces, as shown in Figs. 4 and 5, Fig. 4 being a section. The tube or nozzle, a, communicates with the blast engine, and delivers the blast into the outer tube or casing, d. This is surrounded by a water-jacket, supplied with a continuous flow of water, which enters by the pipe b, and after circulating passes out at c. The object of this arrangement is to prevent the fusion of the nozzle of the blast pipe which must otherwise occur, as it penetrates the hottest part of the furnace.

FIG. 4.



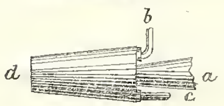


FIG. 5.

Furnaces were blown by the simple injection of air at its ordinary temperature until 1828, when Neilson, of Glasgow, invented and patented the hot-blast, whereby a most important economy was effected. At the Clyde Iron Works, where the hot-blast was introduced in 1829, during the first half of the year with a cold blast, 8 tons $1\frac{1}{4}$ cwt. of coal was used for each ton of iron produced. During the second half of the year, when the hot-blast was used, and worked at a temperature of 300° Fah., this quantity was reduced to 5 tons $3\frac{1}{2}$ cwt. Higher temperatures and greater economy are now obtained.

The blast is heated by various devices of convoluted pipes or chambers of iron or fire-clay, which are heated externally while the air is passing through them. By this means it is heated to a temperature varying from 300° to 700° or 800° Fahrenheit.

The cold-blast is not entirely superseded. It is still used for the manufacture of certain qualities of iron, specially branded as "cold-blast."

At first the furnaces of the hot-blast ovens or stoves were heated by coal consumed directly for this purpose, and such is still the case in some places, but recently an important economy has been effected by using for this purpose the waste gases that were formerly allowed to blaze away from the open top of the blast furnace.

Various methods have been adopted for conducting these gases down to the ovens, and to the boilers of the engines, which they also supply with fuel when fairly economised. The "cup and cone" shown on the diagram (Fig. 6) is one of the most

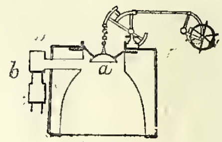


FIG. 6.

common contrivances for this purpose, where the cup, a, may be raised or lowered. When raised, it presses against the truncated cone, and thus closes the furnace top. This being done, the gases pass down the large pipe, $a\ b$, and are conveyed to their destination. The charge for the furnace is tipped into the cone, and rests upon the cup while it remains in this position, but immediately the cup is lowered the charge falls over its edge into the throat of the furnace. A still simpler device is shown in Fig. 7.

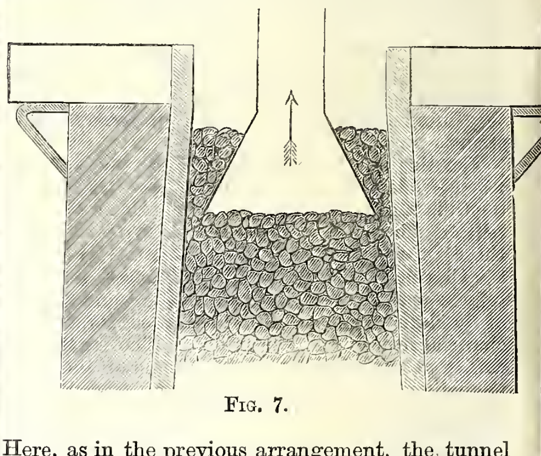


FIG. 7.

Here, as in the previous arrangement, the tunnel head is absent, and a simple inverted funnel, the mouth of which is of rather smaller diameter than the throat of the furnace, forms the termination of the large tube which conducts away the gases. The charge is heaped above the mouth of the funnel, and offers sufficient resistance to prevent any more than a small escape of the unburnt gases; the bulk of them, following the path of least resistance, pass through the tube, which of course leads downwards. I have seen this simple arrangement successfully working at the Frood Iron Works, near Wrexham. Other and more complex devices are used—aspirators, fans, &c.; but here, as in most cases, complexity, however ingenious, is excelled by simplicity.

The composition of these gases is as follows, stated in percentage by volume:—

Nitrogen	55	to	58
Carbonic acid	8	„	13
Carbonic oxide	24	„	29
Hydrogen	2	„	7
Various hydrocarbons	$2\frac{3}{4}$	„	$6\frac{3}{4}$

Of these, the carbonic oxide, hydrogen, and hydrocarbons only are combustible.

A newly-erected blast furnace requires careful drying before its working may be commenced, and even then the first charging and heating, or "blowing in" as it is called, must be slowly and gradually done, especially in large furnaces. About 10 to 20 cwt. of firewood, in large pieces, are laid at the bottom, and five or six tons of coke upon this. Then regular charges of coal, or of coal and coke ore and flux are laid upon these; but the "burden," or proportion of ore, is made very light at first. The furnace is thus filled to about one-third of its height. The wood below is then fired, and, when the burning reaches the upper part of this preliminary charge, more fuel, flux, and ore are added, with gradually-increasing burden. Then a light blast is turned in, and the charging is continued, with increasing burden and increasing pressure of blast, until the furnace is filled, and full charges and full pressure are safely attainable. Careful watching of results, and considerable skill and experience are necessary to regulate this blowing in, in such a manner that good, full, and proper working may be started, with the smallest possible waste of material and loss of time. A few days are sufficient for the blowing in of small furnaces, but large furnaces demand a much longer time.

The regular working charge of a blast furnace varies of course with the material used. In ordinary English working, the poor ores are commonly mixed with richer, so as to yield an average of about 50 per cent. of iron. When this is done, one part limestone, two parts of coal or coke, or mixture of these, and three parts of ore may be stated as an approximate round number average of the proportions of a charge. These are added alternately. The following examples are selected from three important English districts:—The first (South Staffordshire) gives the working charge of Russel's-hall furnace, Dudley, with mixed ores; the second (Cleveland district) that of the Clarence Iron Works, where very poor ore is used without admixture; the third (Ulverstone hæmatite district) is the charge of the Barrow furnace, where exceptionally rich ores are used:—

1.

Mixed ores	28 cwt.
Cinder (tap and flue)	2 "
Dudley limestone	9 "
Coke	16 "
Coal	$2\frac{1}{4}$ "

2.

Cleveland ore, 30 per cent. iron	8 cwt.
Limestone	2·2 "
Coke	6 "

3.

Red hæmatite (raw)	34 to $34\frac{1}{2}$ cwt.
Durham coke	18 to $18\frac{1}{2}$ "
Limestone	$5\frac{3}{4}$ "

Examination of these figures shows that in No. 1 the proportions of 1, 2, 3, flux, fuel, and ore are closely approximated, the ores being mixed to contain the 50 per cent. of iron. In the second and third these proportions are not maintained, as the following analysis (stated in round numbers) shows:—

In No. 1 the proportion of lime to ore is about $\frac{1}{3}$
" 2 " " between $\frac{1}{3}$ and $\frac{1}{4}$
" 3 " " about $\frac{1}{6}$

In No. 1 the proportion of fuel to ore is about $\frac{2}{3}$
" 2 " " " $\frac{3}{4}$
" 3 " " little more than $\frac{1}{2}$

The difference between No. 1 and 2 limestone is trivial, and probably due in some degree to quality; but the difference between these and No. 3 is very great, on account of the small quantity of silica requiring to be removed from the hæmatite.

The proportion of carbon varies inversely with the richness of the ore, least for the rich hæmatite, No. 3; most for the poor Cleveland, No. 2; and intermediate for the intermediate richness of the mixed ores, No. 1.

These proportions have been regulated by practical experience on "the rule-of-thumb," a rule which ignorant pedants too commonly condemn; for the only sound method of scientific investigation, the inductive method taught by Bacon, and by means of which all the mighty triumphs of modern science have been achieved, is nothing more nor less than this rule-of-thumb systematically and accurately carried out, with the aid of universal co-operation among the world's investigators.

The largest blast furnaces are those of the Cleveland district. In 1860 they varied in height from 40 to 60 feet, with a width at the boshes from 14 to 18 feet, and a capacity of 4,000 to 8,000 cubic feet. They have gradually advanced from these dimensions to nearly 100 feet in height, 30 feet in extreme internal width, and a capacity which has reached upwards of 40,000 cubic feet. 400 to 450 tons of pig iron per week may be stated as the maximum production of these furnaces, or 200 to 250 as an average. In some exceptional cases 550 tons is stated to have been reached. The furnaces of the Ulverstone hæmatite district are large, but not so large as those of the Cleveland district; their yield of iron, however, is greater than these. This, of course, is a natural result of using a much richer ore. 90 tons per day is recorded as having been obtained at Barrow-in-Furness. This, of course, is an extreme instance.

I will now, so far as time permits, describe the actions which occur within the blast furnace, premising, however, that in spite of the admirable researches of Playfair, Bunsen, Ebelmen, Lowthian Bell, and others, a great deal yet remains to be learned. Laboratory re-actions are well understood, but materials in the midst of the fiery mass of the interior of a blast furnace are not easily handled, and the changes taking place among them are proportionally difficult to apprehend. When I commenced the study of chemistry, the good old-fashioned text-books told us that certain elements and compounds had certain affinities, and stated these so definitely that tables of affinities were made; the chemical student of those times supposed that he knew the relative attractive forces of specified elements and compounds for most other substances. This charming simplicity is now sadly disturbed. We find that, as we alter the physical condition of any substance by heating or cooling it, or changing its solid, liquid, or gaseous form, we upset all these tabular chemical relations, and in many cases even reverse them.

Thus, in a table of affinities for oxygen, iron would stand a long way before carbon, for, as we all know, iron will rust by ordinary exposure to the air, while a piece of charcoal remains unaltered.

When, however, both are raised to a red heat, their relations to oxygen are reversed, and so completely, that the carbon appropriates that which was attached to the iron. Again, several of the lighter metals have sufficient affinity for oxygen, when cold, to decompose water when they are immersed in it, taking the oxygen to themselves and setting the hydrogen free. If this same hydrogen is passed over oxides thus formed when both are highly heated, the oxygen leaves the metal and returns to the hydrogen, forming water again; but if the water thus formed is heated still higher, the affinity between the oxygen and hydrogen is entirely overcome, and they remain side by side as separated gases so long as this temperature is maintained, but unite again with explosive violence if cooled a little below it. Thus, any of the chemical relations with which we are familiar under ordinary circumstances in the laboratory may be modified to any degree up to complete reversal, in the midst of a blast furnace; and not only this, but these modifications may vary through a very wide range in different parts of the same furnace, according to its variations of temperature. Therefore to understand the philosophy of the blast furnace, we require to study a special chemistry, over and above that which is presented to us under ordinary atmospheric conditions.

Following the charge as it proceeds downwards, it is easy to understand that at first it is simply heated to a comparatively moderate extent, and subjected to the action of the gases already named as issuing from the top of the furnace. If raw ores and raw limestone are used, the upper part of the blast furnace must obviously act as a calcining oven and limekiln. A good deal of discussion has been devoted to the question whether it is more economical to work with raw or roasted ores, limestone or lime, and decided opinions on both sides have been expressed by men of great practical experience. I suspect that where the differences of opinion have been logically based upon practical experiences, they have depended upon the heights of the furnaces with which the opposing authorities have worked. In the tall furnaces the ore and limestone have time to become fully roasted before they reach that region where their carbonic acid, &c., would be a hindrance or do mischief; or, otherwise expressed, the difference between the owner of the tall furnace and the owner of the shorter one is, that the latter has his limekilns and roasting ovens on the ground by the side of his furnace, while the first builds his limekiln and oven on the top of his furnace. If the tall furnace owner were to roast and calcine outside, he would waste fuel and labour; if the short furnace master were to use raw ore and flux, he would be forcing his furnace to do calcining and limeburning in that region where it should be engaged in a more advanced stage of the process.

Reasoning simply upon what is now before us, we should naturally decide in favour of the simple device of the tall furnaces and a single operation, but I ought to add that there are other considerations involved in the problem. The higher the furnace the greater the resistance to the passage of the issuing gases, and the greater consequent pressure on the gaseous matter below. This pressure affects the quality of the iron, as we shall presently see. Another result of calcining the raw material at the upper part of the furnace is that the gases issuing from it are much poorer in combustible constituents. They contain more carbonic acid. Thus, the economy of fuel is very trivial as compared with the outside calcination, where the waste gases are used for this purpose.

The ore is not merely roasted by the heat of the ascending gases, but it is subjected to their chemical action. We have already seen what these are when they issue from the stack of the furnace. They have been carefully collected at different depths, and examined analytically. I wish the time permitted me to tell you some of the details of these interesting researches, but I must be content with general results. Referring, then, to the previously stated composition of the issuing gases, I may state generally that, in descending, the carbonic acid diminishes in relative quantity, and the combustible or reducing agents are more abundant.

The presence of these reducing gases is easily explained. Coal or coke and water are intensely heated lower down, with a limited supply of air, or with air that has already been deprived of its oxygen by the violent combustion occurring about the still lower region where it was admitted as the blast.

What, then, are the gaseous results? Carbon thus heated with a limited supply of oxygen is converted into carbonic oxide, and water is decomposed at the lower or hottest part of the furnace, giving up its oxygen to convert some of the carbon into carbonic oxide, and its hydrogen is set free. But you will probably ask where does this water come from?

The air around us contains more or less aqueous vapour diffused through it, and this water of course enters the furnace with the air of the blast. About 5 tons of air are blown into a Cleveland furnace for every ton of pig iron produced, and these 5 tons of air contain an average of about 60 lbs. of water. Thus, with a make of 50 tons, 250 tons of air, containing 3,000 lbs. of water in a state of invisible vapour, are blown daily into such a furnace.

Another gaseous reducing agent, viz., cyanogen, is formed by the carbon of the lower fuel combining with some of the nitrogen of the blast.

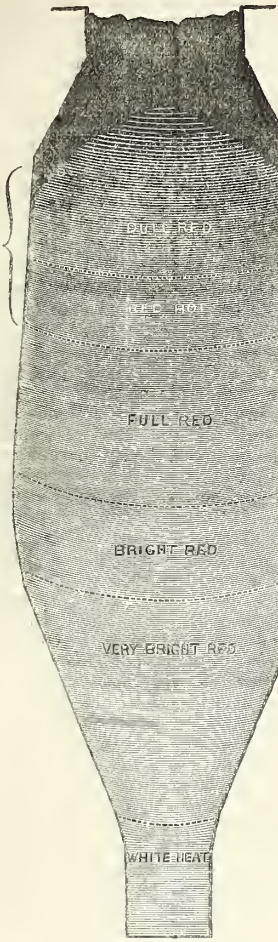
All these heated gases, carbonic oxide, hydrogen, cyanogen, and some hydrocarbons distilled from the coal, are thirsting for oxygen, the ore is enveloped by them, and its porosity produced by the roasting increases the surface exposed to their action.

Under these circumstances, the reduction of the oxide of iron commences as soon as it reaches a dull red heat. Mr. Lowthian Bell says that it is completed at this temperature, but I doubt this. It may be the case with small fragments of ore, but not with large lumps. I have, therefore, taken a small liberty, in my copy of Mr. Lowthian Bell's interesting diagram of the zones of the blast furnace (Fig. 8), and have bracketed together the second and third zones, carrying the "reduction" through both, but leaving Mr. Bell's own designations undisturbed on the right hand side.

Next below the reduction and limekiln zone, is the zone of "absorption," at full red heat. I have already stated that when iron ores are simply reduced, the iron is in what is called the "spongy" state. This iron sponge, as you will see by the specimens on the table, is composed of small

particles of iron, &c., loosely cohering, with pores between, giving it a spongy structure. If the ore had been pure oxide, this sponge would be nearly

Fig. 8.



pure iron, and it might now, with certain precautions be withdrawn and forged at once; but such is far from the case with the ores that are sufficiently abundant to supply the practical demand of the British ironmaster. There are the earthy impurities, mostly silicates, involved with the iron, and these must be removed as well as the oxygen. This is effected mainly by the agency of the lime or "flux," which combines with the silica, and forms a fusible lime-glass, that carries with it in a state of mechanical entanglement or actual solution or co-fusion a considerable quantity of clay, and the other earthy impurities. But in the diagram the zone of fusion is much lower down, a considerable intermediate space being assigned to that of absorption.

This demands further explanation, the reaction occurring hereabouts being somewhat complex. A whole lecture would be necessary to do justice to this particular region of the furnace. The chief substances absorbed are carbon, silicon, sulphur, and phosphorus; iron in the spongy state being specially vigorous in its chemical relations. If exposed heated to the air it oxidises with great rapidity, but lacking oxygen in the interior of the furnace, it seizes almost any other non-metallic element that comes within reach.

But how does it get its carbon? Is it from the solid coke around it? This does not appear possible, seeing that only the bare surfaces of the spongy masses are in loose contact with the pieces of glowing coke. The researches of M. Deville on the dissociation of chemical compounds by the simple repulsive agency of heat, and those of Mr. Lowthian Bell, have enabled as to approximately solve this riddle.

When carbonic oxide is simply heated to about 1,200° Cent. = 2,190° Fah., it is converted into carbon and carbonic acid. Thus taking two equivalents of carbonic oxide, C O, we have—

$$\left.\begin{array}{l} \text{O} \ldots\ldots\ldots\ldots\ldots\ldots \\ \text{O} \ldots\ldots\ldots\ldots\ldots\ldots \\ \text{C} \ldots\ldots\ldots\ldots\ldots\ldots \end{array}\right\} \text{C O}^2$$
$$\text{C} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{C}$$

According to Mr. Bell, this dissociation takes place in the blast furnace at a much lower temperature, viz., 572° C = 1,062° Fah. It is possible that the difference may be duc to the predisposing affinity of the iron, or there may be some error in determining the temperature, a rather difficult practical problem. At any rate, I may safely state that this dissociation does take place, and that the carbon is thus separated in the condition most favourable for combination and deposited on all parts of the spongy iron exposed to the gas. Some of this delicate deposit actually combines or is absorbed by the iron and increases its fusibility.

The silicic acid of the fusible glassy silicates with which the granules of spongy iron are more or less coated or varnished, is more or less reduced or dissociated, and some of the silicon, which has so many curious resemblances to carbon, combines with, or is absorbed by the iron, and acts like the carbon in still further lowering its melting-point.

The sulphur is accounted for by the reduction or dissociation of the sulphurous acid which is produced by the previous dissociation and combustion of the sulphur from the iron pyrites in the coal. This attacks the spongy iron much in the same manner as the carbon.

The phosphorus is in like manner derived from the organic matter of the ore. The phosphoric acid of the phosphate of lime is dissociated and reduced, the lime probably combining with some of the silicic acid, and the phosphorus uniting with the iron directly. These two, like the carbon and silicon, increase the fusibility of iron, and thus we now have a compound, or mixture (which it should be called is a debatable question), of all these with iron, rendering it far more fusible than pure iron, but not so fusible as the silicates of lime, &c.

These absorptions or combinations being effected in the two zones marked "full red" and "bright red," the fusion commences, and continues down the lower cone of the furnace, which narrows to fit the decreasing bulk of its contents, and finally the melted mixtures trickle down, passing the region of fierce combustion, the white heat near the blast; there the fusion is quite completed, and the fluidity of the mixture becomes sufficient to allow the metallic mixture, which is much more

dense than the silicates, to sink to the bottom of the crucible, while the silicates float on its surface, and protect the metal from the otherwise oxidising action of the blast. As the pool rises the cinder overflows by the cinder notch, on the upper part of the dam, and when the metal becomes so deep that it threatens to overflow in like manner, or to lose the protection of the silicates, the tap hole is opened, and the fluid contents withdrawn. The silicates are called the "cinder," or sometimes, but improperly—as I shall hereafter explain—the "slag" and the impure iron is affectionately and poetically—*i.e.*, in Black Country poetry—called "sows" or "pigs" after it has solidified. The mould into which the iron is run is made by forming a long main channel in an open bed of sand; from this main channel little side channels branch out. The main or parent channel is the sow, and the side branches are the "pigs," hence pig iron, which I must describe more particularly in the next lecture.

MISCELLANEOUS.

THE LOAN COLLECTION OF SCIENTIFIC APPARATUS AT SOUTH KENSINGTON.

Astronomical Instruments.—Telescopes.

The foremost place in the Astronomical Section of this remarkable collection of the instrumental achievements of science naturally belongs to the telescope, viewed simply as a contrivance for neutralising the vast distances of space, and for enabling man to acquire some knowledge of the conditions of remote suns and worlds, that lie so enormously beyond the reach of his unassisted powers of observation. In the present notice the fine series of telescopes which have been here brought together will be contemplated from this point of view alone. Upon a subsequent occasion the telescope may perhaps be considered in its further development as a mechanical contrivance for the measurement of space, direction, and time.

The object in this exhibition which may advantageously be taken as the starting point of the review of telescopic invention and construction which it is the purpose of this article to supply—the centre of the far glancing survey which the reader is invited to enter upon —is a small oval frame (No. 1,815), which stands upright in the centre of one of the glass cases near the middle of the Astronomical Room, with fantastic carvings of ivory ornaments round, and with a circular bull's eye of crystal of about an inch and a half diameter, looking out from the space where the picture would be in an ordinary picture-frame. The central crystal has been broken across, and is somewhat splintered and chipped at one part of its margin. This fractured piece of glass is, however, a very precious relic. The record upon the frame states that it was a cherished possession of the Prince Leopoldo dei Medici, and that it was put into this ornamental frame by him. If not actually the protogerm of telescopic organisation and growth, this little glass is very near, indeed, to being so. The shattered lens is the actual glass with which Galileo on the 9th of January, 1610, discovered the satellites of Jupiter, and with which human eyes for the first time saw spots upon the sun. It is certainly the first glass window out of which human eyes looked into the infinite realms of space—the first lens that was used to any good astronomical purpose—if not the first employed in telescopic construction. The telescope of which it formed a part was made in consequence of Galileo's hearing when at Venice, in the month of May, 1609, that some instrument had been contrived in Belgium, or Holland, which caused distant objects to look near. Reflecting upon this rumour when he returned to Padua, it occured to him to try the effect of placing a plano-convex lens at one end and a plano-concave lens at the other end of a leaden tube. The result of that experiment was a telescope which magnified nine times. This first Galilean telescope was immediately afterwards given to the Doge Leonardi Deodati, of Venice, by the philosopher, and brought him an increase of one thousand florins a year to his salary as lecturer at the University of Padua. He soon afterwards completed another telescope, which magnified about 60 times (between seven and eight diameters), and it was most probably to this second edition of his inventive work that the lens now exhibited by the Academia del Cimento of Florence belonged. By the side of this lens are also deposited two scarcely less interesting objects, showing the form which the completed astronomical telescopes of Galileo had. One of these is covered with ornamented leather, and is about four feet long; the other is covered with paper, and is five feet long. In the first of this pair the object glass is just under one inch and a half, and the eye glass three-quarters of an inch, in diameter. In the second, the object glass is very nearly two inches, and the eye-glass nearly one inch. In the first the eye glass is a double concave, and in the second a plano-concave, lens.

It is now generally admitted that telescopes were constructed in Holland at least the best part of a year before the completion by Galileo of his first telescope, although of inferior finish and power. Henry Lipperhey, a spectacle maker, of Middleburg, having chanced to place a concave lens of glass in front of a convex one, noticed that this gave an enlarged image of a distant object. On the 2nd of October, 1608, he petitioned an assembly of the States-General of Holland to be allowed to reserve to himself the right of sale of "an instrument for seeing at a distance," and he received an instruction from the States to endeavour to improve his instrument so that it could be seen through with both eyes. In a letter addressed to the mathematician, Harriot, by Sir Wm. Lower, of Caermarthenshire, and dated Feb. 5, 1610—that is, just eight days after the discovery of the satellites of Jupiter by Galileo—there is an allusion to the performance of one of these Dutch telescopes which is so amusing that it is well worthy of quotation. The passage is to the following effect:—"According as you wished I have observed the moone in all his changes. In the new, manifestlie I discover the earth shine a little before the dichotome; that spot which represents unto me the man in the moone (but without a head) is first to be seene. A little after, neare the brimme of the gibbous parts towards the upper corner appeare luminous parts like starres; much brighter than the rest; and the whole brimme along looks like unto the description of coasts in the Dutch books of voyages. In the full she appeares like a tart that my cooke made me last weeke; here a vaine of bright stuffe, and there of darke, and so confusedlie all over. I confesse I can see none of this without my cylinder."

The next material step in the growth of the astronomical telescope is illustrated in a case standing only two removes towards the south from the venerable relics of Galileo, and belongs to a date that is some forty years later in time. This case contains a large series of object glasses of various dimensions made by the brothers Christian and Constantine Huyghens, Dutchmen born at the Hague, and one most interesting specimen of a complete telescope by the same famous makers (numbered 1,831). It will be observed that the tube of this telescope is rudely constructed of tinned iron, and it will be seen that there are no less than four draw tubes contained within the first outer case. When the whole of these are drawn out, the instrument is more than twelve feet long, although its aperture does not exceed two and a half inches. This at once expresses the leading characteristic of this stage of telescopic growth. Kepler had pointed out in the

year 1611, that astronomical telescopes might be made by using convex lenses for the eye power instead of concave ones, and shortly after Gascoigne had shown that such telescopes were infinitely superior to the Galilean ones for the use of astronomers; firstly, because they furnished a very much larger field of view, and secondly, because they enabled any measuring contrivance, such as a wire, or thread, to be seen magnified within the tube of the instrument simultaneously with the object that was under observation. The telescope, however, had to be of greater length, because in this form of construction the lenses required to be at the sum of their focal lengths asunder, whilst in the Galilean form the concave eye-piece was placed short of the focal length of the lens, as is still practised with opera glasses. The Huyghens were fortunate enough to observe that one of the leading causes of imperfect vision, namely, the irregular coloured dispersion of the luminous rays that fall upon the curved surfaces of the glass at different angles of incidence, was almost removed by lengthening the focus of the object glass. Hence they aimed at making their telescopes of the utmost attainable length. The telescope No. 1,831 is one of the early bold results of this notable generalisation. The focal length of this instrument is twelve feet and three quarters, and the aperture of the object glass only two inches and a half. The eye piece is made of three convex lens, which were placed about six and seven inches apart. This constituted the first form of the combination which has now come into universal use as the Huyghenian eyepiece. The object glass of this telescope was ground and polished by Christian Huyghens, and is inscribed with his signature. When, however, these ingenious philosophers had once grasped the idea of the power of lengthening the focus of an object glass to sharpen and improve its definition, their genius soon outran the limiting constraints of opaque and rigid tubes. In the very interesting series of lenses numbered 1,837, which are contributed by Professor Rijke, of Leyden, and are mostly the production of the Huyghens, the apertures extend from four to eight inches, and of these the focal lengths also vary from 10 to 120 feet. At the lower part of the same case are two very beautiful specimens of Christian Huyghens' work in the form of lenses nine inches in diameter, which were made by him for the Royal Society. One of these object glasses has a focal length of 210 feet. These long focussed glasses of the seventeenth century were, however, never intended to be used in tubes. The object glasses were mounted upon elevated pillars, or posts, and manipulated by cords or chains to give them the right direction, and the eye pieces were held below in the approximate adjustment required to view the images formed on their foci. Huyghens contrived some very ingenious pieces of mechanical apparatus to enable the larger lenses to be used conveniently in this way, and the combination of lenses thus formed without a tube, was designated on that account, the "aerial telescope." The object numbered 1,838, which is associated in this case with the Huyghenian lenses, is of marked historical interest. It is a photograph of the original lens of two inches and a quarter aperture, of Christian Huyghens, now preserved with jealous care at Utrecht, with which the ring of Saturn was first seen by this distinguished astronomer, who stood in historical sequence between Kepler and Newton. The lens bears the date February, 1855. Cassini, who printed the first tables of the elements of Jupiter's satellities at Bologna, in 1668, also successfully adopted these aerial telescopes of long focus. He had one object glass of 130 feet foeal length. His lenses were made for him by Matthew Campani, of Bologna, and afterwards of Rome, an interesting specimen of whose work is comprised in one of a group of four telescopes contained in a case situated between the Galilean relics and the Huyghenian lenses. Campani's telescope is numbered 1,820, and bears the date 1664. It is an octagonal tube built of wood, covered on the outside with marble paper. The object glass is a lens of two inches diameter.

In the wall case at the side of the room there are two fine old characteristic specimens of telescopes by Joseph Campani, the brother of Matthew, who was also a distinguished astronomer and made his own instruments. Ono of these has an octagonal tube of wood, and is furnished with several internal draw tubes capable of extension to 16 feet. The other is furnished with a very neat conical wooden tube. Matthew Campani, it may be remarked, was skilful in clock making, as well as in optical work, and constructed a famous clock with an illuminated dial. There are other telescopes in the collection illustrating the way in which the Italian opticians of this period followed the lead of the Dutch makers. No. 1,821 is a good specimen of the work of Eustachio Divini, of Rome, and bears the same date as one of Campani's instruments, namely, 1664. The lens, which is only one inch in diameter, is mounted on a well finished brass cell, and the eye glasses are also contained in a neat brass tube of conical form. The large tube is covered with dark brown leather, and is about four feet six inches long. No. 1,821 is a green leather-covered telescope of nearly the same date, by Amici. No. 1,816, also a turned wood tube, about four feet long, covered with green leather, is a telescope of Torricelli's, two and a half inches in aperture, bearing the date of 1666. In one of these cases there is a notable Venetian object glass of long focus, and large aperture, which belonged to Flamsteed, and which is now the property of the Royal Society. It has an aperture of ten inches in diameter, and a focal length of ninety feet. In the side wall-case there are four fine early telescopes by Elkan and Company, of Hamburgh, and in the open space at the side of the room there is a notable Dutch telescope of 1781 (No. 1,882), of about four and a half inches aperture, mounted upon its tripod. It is the work of Van Deyl, of Amsterdam.

It should, perhaps, be remarked, in regard to these long focussed glasses of the seventeenth century, that they are by no means of contemptible powers of performance, but, on the other hand, are capable, on account of their great length of focus, of giving images that are of an excellence which is altogether surprising when it is borne in mind that they belong to an era that preceded the discovery of compensation for optical imperfections by the combination of lenses of different refrangible powers and different curvatures. The large Huyghenian lenses belonging to the Royal Society were upon one occasion tested in the Royal Gardens at Kew upon terrestrial objects, and found to give very fair definition. Their figure, indeed, seems to be so good, that it is now contemplated turning them to useful account in some of the new processes of solar investigation.

Very nearly one century and a half after the invention of the Galilean telescope by the Dutch opticians and by Galileo, and almost exactly one century after the conception of the long focussed lenses by Huyghens, the next great revolution occurred in the construction of the refracting telescope. In the year 1753, Dollond was engaged in examining the action of media of different densities upon the vibrations of light, and this investigation led shortly afterwards to his discovery that the confusion incident to the unequal effects of prisms and lenses upon the different coloured constituents of light could be almost entirely removed by combining two lenses of different kinds of glass with duly adjusted curvatures of surface. He found as a result of direct experiments, that flint glass produced a very much larger dispersion of the differently coloured rays than crown glass, and that when the densities of these two kinds of glass were so planned that a concave lons of crown glass and a concave lens of flint glass, with focal lenses respectively in the same proportion as their dispersive powers, were combined in close contiguity in one cell, all the confusion from coloured irregularities were got rid of, and images at

short focal distances were formed of even superior sharpness and excellence to those which had been previously secured by use of the longest focussed lens of Huyghens. This is the great principle which is involved in the so-called achromatic telescope, of which Dollond is practically the parent. It appears, however, that twenty years before the application of his discovery by Dollond, a telescope of a similar character, in which colourless images were formed within short focal lengths by combining together lenses of different kinds of glass, had been constructed by Chester More Hall, a gentleman of Essex, who had been led to his method of construction by the consideration of the combination of the three kinds of humours in the organisation of the eye. It nevertheless does not appear that anything had become generally known of this plan of construction until after Dollond had matured his own investigations. Some telescopes in wooden tubes, which are placed with the Elkan and Campani telescopes, in the side wall case near the south end of the room, are characteristic specimens of Dollond's early work. These instruments are referred to as having belonged to Alexander Von Humboldt.

For a long series of years after the perfecting of the achromatic telescope by Dollond, the greatest difficulty vas found in procuring discs of dense flint glass of large size which were of perfectly homogeneous structure throughout. The slightest inequality, or irregularity, in the molecular condition of the glass was entirely fatal to the constitution of a clearly and sharply defined image. It was on this account that no astronomical discoveries of any moment were made by the achromatic telescope for a long series of years. The small compensated compound lenses of Dollond could not compete with the large uncompensated long focussed lenses by Huyghens and Cassini. And it hence happened, notwithstanding the great importance of the invention of Dollond, that most of the memorable discoveries of the seventeenth and eighteenth centuries were made with Huyghenian and Cassinian telescopes. What can now, however, be done in this particular is very interestingly exhibited in the upright wall case at the south end of the Astronomical Room (L). No. 1,835 shows two splendid discs of glass, manufactured by Chance Brothers, of Birmingham, for the construction of the object glass of an achromatic telescope, the one of hard crown glass of low dispersive power, and the other of dense flint glass of high dispersive capacity. These discs are sixteen inches and a quarter in diameter, and the flint disc is of good quality throughout, and of perfect homogeneity. In one of the horizontal cases near the south end of the room are three beautifully finished achromatic object glasses, composed of the crown and flint glass constituents, by Evrard, of Paris, in brass cells, which very well illustrate what the lenses of powerful achromatic telescopes of the present day are like. A smaller object glass close by is separated into its crown-glass and flint-glass constituent lenses. The different tint of these crown and flint lenses is, in these specimens, at once apparent to the eye. In the next room to that appropriated to astronomical apparatus (Measurement, K), and in a wall case immediately at the back of the one which contains the large discs of astronomical glass by Chance, is an achromatic telescope of moderate dimensions, by Browning (No. 1,765), which is an excellent standard specimen of this class of astronomical instrument, such as is now furnished by the most skilful opticians for general use; that is to say, in circumstances where the telescope is required to be portable in itself and easily shifted from place to place, and yet convenient to use, steady in mounting, and possessed of sufficient optical power to show the leading features of the various celestial objects that are within the reach of human observation. This instrument has an achromatic object glass of four inches aperture, and of sixty inches focal length, and it is furnished with eye-pieces that magnify up to two hundred diamoters, or forty thousand times of surface amplification. This, it will be observed, gives forty times more power than the largest telescopes made by Galileo, and virtually serves to show the moon as if it were only twelve hundred miles away from the earth, or a very litttle further away than the Rock of Gibraltar is from London. Portable instruments of this class are now sold by the best opticians at prices varying from £30 to £40, and mounted upon excellent steady tripod stands of wood, with convenient rack and pinion movements, for an additional charge of from £15 to £25. These telescopes define very beautifully, and are valuable and charming companions in any household of cultivated and intellectual tastes. It is quite worth while, in this exhibition, to glance at the unwieldly telescope of Huyghens, with its four internal draw tubes (No. 1,831), and then, immediately afterwards, to look at the neatly-finished and compactly-mounted telescope by Browning (No. 1,765), in order to get a clear idea of the service that has been rendered to astronomy by optical science during the last two centuries. The achromatic telescopes of larger size, such as are constructed out of the lenses of more considerable aperture, are all instruments needing to be solidly and permanently mounted in fixed observatories, and are of course comparatively costly pieces of apparatus. The refractor which Mr. Huggins employs in his spectroscope work, at his observatory, at Upper Tulse-hill, for instance, has an object glass of fifteen inches diameter, and has been erected there at a cost of about two thousand pounds. Achromatic object glasses of 27 inches diameter, that is more than one-half as wide again as the large glass discs of the Messrs. Chance, are now looked upon as quite reasonable and manageable lenses for important public observatories. There is a model of a telescope of this size which is in process of construction for the Imperial Observatory at Vienna, by Mr. Grubb, of Dublin, which will have to be alluded to hereafter in connection with the subject of mounting. The fine lenses recently made by Cooke, of York, for Mr. Newall, were 25 inches in diameter. An American object glass was ground for the United States Naval Observatory by Alvan Clarke, in 1873, which has an aperture of 27½ inches diameter, so that the era of large achromatic telescopes of comparatively short focus seems at last to have been fairly entered upon. The focal length of these 27 inch lenses is generally about 30 feet. It is, however, perhaps worthy of note that there is a sanguine expectation entertained that much of both the difficulty and the cost of these large instruments will yet be avoided by using the flint glass of the compensation far down in the tube where the cone of rays is already considerably diminished in the approach towards the focus of the crown glass lens. By this contrivance a comparatively small lens of the denser kind of glass, which it is more difficult to procure in a state of sound homogeneity when of large size, will efficiently perform the work that has hitherto been accomplished by a flint lens of considerable dimensions. Some experiments which have been made in this direction have, it is said, been attended with very satisfactory results.

A second point of departure in this survey of telescopic development is found in another remarkable object which is doubly enshrined in a case adjoining the one which contains the Huyghenian lenses; that is to say, that it is inclosed in an inner padlock octagonal cover of glass, which is itself deposited in the ordinary glass case of the exhibition. This object is the reflecting telescope which was invented by Sir Isaac Newton, and which was constructed by his own hand in the year 1671; that is, it will be observed, about sixty years after Galileo had been busy with his earlier invention. This notable instrument is about two inches in diameter, and about eight inches long, and the tube looks very much as if it might have been moulded from covers of old books in the library of the philosopher. It appears to be made of pasteboard, so far as can be determined by noticing its general aspect within its carefully closed shrine. The tube is, however,

carried upon an iron bar that runs along the whole length beneath, and then turns up into a ring-clip at each end; and this bar is mounted upon a very simple and remarkable stand to allow of free universal movement of the tube. The bar is fixed on the top of a turned wooden ball which rests in a shallow cup, and is supported there by a pair of iron braces, or clips, that are adjusted to the surface of the sphere, and press against it at opposite sides above. This valuable relic belongs to the Royal Society, and is of scarcely inferior consequence and interest to the Galilean relics contributed from Florence.

The same idea of constructing an enlarged image of an object by reflecting the divergent pencils of the emergent luminous rays into a focus from a concave reflecting surface, had occurred to James Gregory, a noted English mathematician, some seven or eight years before. He had described the arrangements necessary to accomplish this purpose by a concave surface of polished metal, and by eye lenses of glass, and he had attempted to get such an instrument made for him by a London optician in 1664, but had entirely failed to accomplish anything that would give satisfactory definition. When Sir Isaac Newton discovered the unequal dispersion of the coloured elements of the light-ray he conceived that this furnished an insuperable barrier to any material improvement in the construction of the refracting telescope, and he came to the conclusion that reflection from a concave surface must be adopted instead of refraction through a transparent lens. The accurate views that he had then arrived at of the nature of chromatic dispersion had enabled him to understand that there was no such injurious and confusing distortion in the case of the reflection of light from a curved surface. He therefore set to work and succeeded in making a mirror and tube that gave very fair definition of luminous objects, and then framed a second and somewhat improved duplicate of his first instrument, and sent it up to the Royal Society. This telescope, which was examined by the Society at its meeting on the 11th of January, 1671, is the one which is now exhibited at South Kensington. Gregory's original idea was that the rays of light which were condensed to a focus by the mirror near the outer end of the tube should be received there upon a small speculum fixed centrally in the tube and should be from that sent back through a hole in the middle of the large mirror to the eye lens. In Newton's construction an altogether different expedient was adopted. The concentrated rays brought back to a focus near the outer end of the tube were received upon a small flat mirror so diagonally placed as to throw the rays of light out through the side of the tube to the eye-piece. The small eye-piece will be observed looking diametrically into the tube near the top. It is essentially composed of a plano-convex lens of glass. This telescope magnified about 38 diameters, and the satellites of Jupiter and the phases of Venus were perceptible with it.

Notwithstanding the signal success of Sir Isaac Newton with these instruments, no further important advance was made with the construction of the reflecting telescope for half a century. Hadley then began to construct reflecting telescopes with mirrors of much larger dimensions. In the year 1723, he presented a reflecting telescope of the Newtonian form to the Royal Society with a mirror of polished metal six inches across. The mirror (No. 1,840) of this fine old reflector is contained in the South Kensington collection. This telescope of Hadley's was used by Pound and Bradley, and although the focal length of the mirror was only 63 inches, they saw all the objects they were familiar with in the use of one of Huyghens aerial telescopes which had a lens of 123 feet focal length, such, for instance, as the transits and shadows of Jupiter's satellites, the division and shadow of Saturn's ring, and five of the satellites of Saturn. A successful attempt to turn the idea of Gregory to practical account by placing the eye tubes of the telescope in an aperture left in the centre of the large mirror was first made by Hooke, in 1674, between two and three years after the completion of Newton's reflecting telescope. Hadley constructed some telescopes of this form, although he appears to have given a marked preference to the Newtonian instrument with the imperforated mirror. There is a very good specimen of an early Gregorian reflector by Hadley of about two inches aperture, and 15 inches of length, in one of the cases a little further south than the Huyghenian object glasses. This interesting specimen, which is not yet supplied with a reference number, bears the date of 1726, and is said to have been bequeathed to the Rev. James C. Wright, vicar of Barton, in Norfolk, and a Fellow of King's College, and to have been given by him to the Observatory at Cambridge. There is also a remarkable specimen of a very small Gregorian telescope, without maker's name, of somewhat later date, contributed by Mr. Robert H. Scott.

The next stage in the improvement of reflecting telescopes after the work of Hadley is illustrated by a series of three of the instruments of Sir William Herschel, which belong to a class nearly 60 years later than the work of Bradley, and which stand in a conspicuous group with only one case between them and Sir Isaac Newton's small telescope. These earlier telescopes of the elder Herschel were all of Newtonian construction. The three which are contained in the collection are typical forms, at once recognised by their characteristic tubes of mahogany, and by their rail stands, carried on rolling feet, with altitude frames, lifted by cord and winch. Two of these instruments are almost duplicates of each other, and have mirrors six inches and a-half in diameter. One (No. 1,833) belongs to the Royal Astronomical Society, and is in a somewhat dilapidated state; the other is the property of Mr. Edward Smith, of Bath, and was sold at Sir William Watson's sale, in Pulteney-street, in 1860. This instrument is in a very good condition, and there is a tradition in Bath that it was made by Herschel while acting as organist at the Octagon Chapel, and that it was the telescope with which the planet Uranus was discovered, in 1781. No. 1,834 is a larger telescope of the same class, which was made by Herschel for the Radcliffe Observatory, at Oxford, in 1812, and which was adjusted there by him in the following year. This instrument has a tube ten feet long, with a clear aperture of eight inches and a half in diameter. Between the group of Herschelean telescopes and the small original instrument of Sir Isaac Newton, the apparatus is placed which was used by Sir William to polish his six and a half-inch mirrors. It will be observed that this mechanical contrivance consists of a block carried round under the polisher by a ratchet and toothed wheel, whilst the inverted mirror was moved to-and-fro over this tool by a lever adjusted to its work by peg-and-hole connections. The polishing block is of lead, but near to this machine there is another form of polisher, which was afterwards adopted, consisting of a brass foot, with a grooved pitch surface. In the wall case which contains the large glass plates of Chance, there is a fine specimen of a metallic telescope mirror, of eight inches and a-half diameter, by Foucault, which well illustrates the work of a later date. These bright mirrors are all composed of an alloy of 128 parts of copper in 59 parts of tin, that is to say, they contain nearly half as much tin again as ordinary bell metal. Yet it is a curious fact that this speculum alloy is very much harder and more brittle than bell-metal, notwithstanding the larger portion of the softer metal that it contains. It so hard, indeed, that the grinding and polishing is a work of considerable labour.

It was in the year 1789 that Herschel astonished the world by the completion of a reflecting telescope 40 feet long with a mirror four feet in diameter. In this instrument he adopted the plan which he had conceived three years previously, of doing without the smaller mirror and

second reflection, and looking down directly into the tube from the upper end upon the great mirror, which was slightly inclined so as to throw the focal image to the edge of the aperture where it could be seen by the eye piece directed towards it, whilst the back of the observer was towards the object. By this ingenious plan a very considerable amount of light which was previously lost in the reflection from the smaller mirror was saved, and the telescope made to that extent more brilliant and penetrating. This great work of Sir William Herschel was not surpassed until the year 1845, when the late Earl of Rosse finished his still more marvellous telescope of 54 feet focal length, with a mirror six feet across, and containing in itself four tons of speculum metal. This telescope was of such unwieldy dimensions, and of such enormous weight, that it had to be mounted between two solid walls, which only allowed the tube a limited range of one hour from the meridian as it swept from north to south between the walls. There is a very complete model of the arrangements employed with this great instrument in the collection, showing the contrivance by which the observer has to be carried during his work upon a stage pushed out to the mouth of the tube from one of the walls. The mirror numbered 1,836, which is placed in the same case with Sir William Herschel's apparatus for grinding and polishing, is also an object of historical interest connected with the labours of this distinguished astronomer. It illustrates the attempt which was made by the late Lord Rosse to build up large mirrors out of separate pieces of metal. In the construction of this speculum, which is two feet in diameter, a square block of speculum metal was first cast, and this was then sawn into slices, which were afterwards laid side by side as a kind of mosaic, on a ribbed backing of alloy. The pieces were then connected together by melted tin, and the face was afterwards figured and polished in the usual way. This ingenious plan, however, was not found to give satisfactory results, on account of the dark lines of union which cross the polished face interfering with the sharp definition of the image. Lord Rosse conceived, when he planned this composite surface, that these lines would simply occasion a comparatively unimportant loss of light. But it was found that, besides intercepting some light, these opaque lines also produced a very injurious confusion in the image, in consequence of "diffractively" bending the rays which fell near their margins.

In the wall case at the south end of the Astronomical Room are a very beautiful series of seven telescope specula, which may be taken to represent the last stage into which the reflecting method. of construction has entered. These seven mirrors range from two and a half to fifteen inches in diameter, and they are specimens of the silvered glass mirrors of Browning and With. Shortly after the year 1732, James Short, of Edinburgh, a very skilful maker of reflecting telescopes, conceived the idea of constructing the mirrors of glass, and quicksilvering them at the back, after the fashion of the ordinary looking-glass. He soon, however, abandoned the glass, in consequence of finding that he had much less light from mirrors of this character than from those formed of the usual speculum alloy of copper and tin. The plan was also, it should be remarked, open to a still more grave objection than the loss of light. The luminous rays had to pass twice through the substance of glass, and in doing this were of necessity subjected to the same class of refractive disturbances and dispersions that are caused by ordinary lenses. The chief recommendation of the reflecting telescope, namely, that it is free from these chromatic dispersions in virtue of its primary condition of operation, reflection of the light from a bright opaque surface, instead of passage of the light through transparent media, was therefore absent in this method of procedure. Mr. With's silvered-glass specula are, however, of an entirely different character. On looking closely at these specula the observer will find that the silver is carried on the face instead of on the back of the glass; the glass does nothing more than form the foundation upon which the reflecting silver is laid. The glass is used simply and exclusively because it is easier to procure of large size, is lighter to manipulate, and is softer to grind and polish into reflecting form than the metallic alloy of copper and tin. The bright metal which is laid down upon the surface of the glass is also pure silver instead of quicksilver, and it is so fine a film that it of necessity assumes exactly the figure of the surface upon which it is spread. The glass disc having been carefully ground, at one surface, to the figure that is desired, is inverted into a solution of nitrate of silver, into which a peculiar chemical reaction has been set up by potash and milk sugar. If the edges of the glass discs are looked at attentively, it will be seen that the silver is deposited there over a depth of about a quarter of an inch. That indicates the extent to which the surface of the mirror is plunged into the silvering liquid. It is suspended with its face downwards, and dipping just so far into the solution, for an hour or an hour and a half. The glass is then taken out and washed, and is found to have a fine deposit of molecules of silver adhering closely all over its surface. When the silver is dry, it is carefully rubbed clean and bright with soft wash-leather and a little rouge, and it is then found to have a very much brighter reflecting face than the best polished surfaces of the old speculum metal. The work is so much more easily performed with these silvered glass mirrors than with the old intensely hard and ill-conditioned speculum metal, that telescopes with them are produced for a very much lower cost than the old metal reflectors. Thus a speculum eight and a half inches in diameter is produced for £16, and mounted in a rude, but nevertheless convenient form, it constitutes a telescope of very considerable power, equal to one costing £45, or if mounted in a more complete and luxurious way with graduated hour and declination circles, £105. The really noble instrument (No. 1,785) shown just within the "Measurement" room at the south end of the astronomical section, illustrates the form which the eight and a half inch silvered-glass reflecting telescope assumes, when permanently and steadfastly mounted in a fixed observatory. The question of relative cost is, however, perhaps most practically illustrated by comparing two of Mr. Browning's own telescopes of nearly equal powers. The four-inch achromatic telescope in the wall case of the "Measurement" room already alluded to (No. 1,765), upon its simplest form of stand, is priced in the maker's trade catalogues at £30. In the astronomical room is a small silvered glass reflecting telescope of four and a half inches aperture (No. 1,765), of very simple and excellent form, designed for educational purposes, which would be nearly of the same power. But this is priced in the trade catalogue at £17, thus furnishing a very large margin in favour of the silvered glass instrument, if it may be assumed, as is probably the case, that the power of the two instruments is nearly equal.

This small reflecting telescope, by Mr. Browning, is well worthy of attention as one of the most useful forms of cheap instruments for general use that has been yet produced. It is a marvel of excellence for its price, and capable of showing a large range of the most interesting objects in the extra-terrestrial fields of space. It is steady and convenient to manage, and easily removed from place to place. But it should be, perhaps, clearly understood that it is one peculiarity of the reflecting telescope in every form, that it needs to be freely exposed to the external temperature of the atmosphere to enable it to form steadily defined images. In that particular it requires more patient and skilful handling than the refracting telescope, in which the air in the tube is enclosed between the eye tube and object glass, and on that account is to a large measure protected from the capricious variations of density that layers of unequal temperature and different rarefaction are prone to

produce. The silvered glass instrument shares in this drawback, such as it is, and also the further one that the bright reflecting surface upon which the brilliancy of the performance of the instrument depends is apt to tarnish. On the other hand, the silvered glass mirrors can have their brilliancy restored any number of times at a very trivial cost. The old silver can be easily washed away by nitric acid, and the surface of the glass be so left clear for re-silvering by the nitrate of silver solution. A further very strong recommendation which applies to these instruments, and which should on no account be overlooked, is the very great convenience and comfort with which they can be used, on account of the eye tube always standing in very much the same position in regard to the observer's eye, whatever may be the elevation of the object that the telescope is directed to. With the ordinary achromatic telescopes, objects at great altitude in the sky can only be watched for any continuous period of time at the cost of distressing positions and painful constraint on the part of the observer. To look at a star near the zenith with an achromatic telescope he has almost to lie upon his back, or to crouch down in a very forced, unnatural, and uneasy position.

So far as the actual performance of these silvered glass reflectors is concerned, it may be at once said that they are capable of very beautiful definition indeed, and that they show the natural colours of the celestial objects, such for instance as the tints of the belts of Jupiter and of the shaded patches of Mars with remarkable vividness. A comparison was recently instituted by two experienced and competent observers, in which an achromatic telescope of three and a half inches aperture of very high character was tried side by side with a silvered glass telescope of 6½ inches aperture, during several successive nights, with a view to test the defining power of the reflector. It was found that with well lit objects, like the surface of the moon, nothing could be seen with magnifying powers up to 120 diameters with one instrument that could not be seen equally well with the other. But with magnifying powers of 230 diameters the silvered glass mirror of large aperture began to show objects that could not be seen at all with the refractor, and the fine definition was admirably maintained. Higher powers than this could not be applied to the refractor on the nights when the trial was made, but powers of 300 diameters, increased to 450 by the addition of a Barlow lens, were perfectly borne by the reflector; and on the highly and equally illuminated portions of the moon with even an advantage over the lower powers on account of the softening of the character of the image.

There was one notable peculiarity in the character of the image of the silvered reflector which became manifest upon this trial. The dark parts of the image, such as the black shadows of the unilluminated portions of the moon, were perceptibly lighter than they are when seen with the refracting telescope. The shadows in the two cases are as neutral tint in a drawing contrasted with lamp black; deep grays rather than absolute blacks. This peculiarity is most probably due to the molecular condition of the silver thrown down upon the glass to constitute the reflecting surface of the mirror. It not only reflects the main parcels of the rays to their appropriate foci to constitute the visible image, but it also, in some unascertained way, scatters a faint glimmer over the general surface of the field. Lord Rosse very aptly illustrates the probable cause of this peculiarity by conceiving the case of small fragments of white paper placed on the surface, first of a telescope lens, and then of a telescope mirror. In the first place, the fragments of paper intercept a certain portion of the light which, in their absence, would have passed through the lens to assist in the formation of the image; but that intercepted portion is simply scattered back to the sky, and in no way concerns the image that is formed in the telescope. In the other case, that namely, of the reflector, the light which is caught upon the fragments of paper and scattered back from them, is so scattered towards the eye piece and the eye, instead of away from them, and so in some way does concern itself with the image, although it does not enter into its primary and proper formation. The paper does not act upon the vibrations of light in the same way as the evenly polished surface of the mirror, because its surface is rough and dispersive, in place of being smooth, and evenly reflective. The paper is composed of an infinite number of rugosities and asperities which scatter light falling upon them in every direction, instead of reflecting it all in one particular course due to the general direction of its plane. The silvered surface most probably partakes in some very diminished and trifling degree of this dispersive character, over and above its more general power of direct and exact reflection as a polished layer. The proportion of that part of the light which is used for the formation of the image to that part which is lost by indefinite dispersion is, however, so large, that this peculiarity does not, in any way, detract from the clearness and definition of the light-picture. It simply clothes it with an especial tint of its own. This is not even noticed when the reflecting instrument only is used. But it becomes at once apparent in the general aspect of the image, as well as in the softened contrasts, when a close comparison is made between it and the corresponding image formed by a refracting telescope.

From the general description which has been now given, it will be gathered that in the particular of telescopes this collection is comprehensive as well as interesting. It very fairly displays the chief epochs of this noble instrument's history; so much so indeed as to make it in some measure tantalising that a few conspicuous gaps have been left unfilled. This, however, is said, not in any spirit of reproach, because it will be manifest on a moments reflection how difficult it must be to render such a vast series of illustrative objects as have been here brought together complete in all their relations and bearings. The collection, with all its imperfections upon its head, and with all the exacting discoveries of omissions that have been made by an omniscient criticism deserves very much more of praise than of reproof. The vacant gaps of most consequence may, nevertheless, be advantageously indicated, on account of the suggestion that is in this way supplied for any permanent museum of scientific apparatus that it may happily be found possible hereafter to institute. In such a museum it would be very desirable some specimen of the Pre-Dollond attempts at the construction of the achromatic refractor by Mr. More should be found. Other specimens of Dollond's own work, both in the earliest form preceding the epoch which is here illustrated and in the latter stage of more advanced fitting and mounting, would also be welcome. The French Cassegrainian form of the reflector with its extra short focal length and small mirror of convex shape should also be shown. One of the fine reflecting instruments of James Short, of Edinburgh, who was prince of his craft towards the middle part of the eighteenth century, is greatly to be wished for. The somewhat earlier reflectors of Hawksbee, of Bradley, and Molyneux, who were pupils of Hadley, and of Scarlett and Hearne, who were taught in their turn by Molyneux, would also be instructive links in the historical chain. A quick-silvered glass mirror of Short's early and unsuccessful design would be a worthy foil to the brilliant silvered mirrors of the With-Browning series if it could possibly be found. Specimens of the excellent optical work of Guinand, Frauenhofer, and Merz, and Mahler, of Munich, and of Lerebours, of Paris, would also be most valuable features in any extended collection. It will, however, probably be felt that the very narrow limitation of this list of desiderata in this particular range of the exhibition will be one of the best tributes that could be paid to the unquestionable wealth and excellence of the collection brought together at South Kensington.

THE STRUCTURE OF STEEL.

Remarks on the Manufacture of Steel, and the Mode of Working it.*

By D. Chernoff,

Assistant Manager of the Abouchoff Cast Steel Works, near St. Petersburgh.

From what has been said above, you must have perceived that the whole point lies in the structure of the steel, and that for successful forging the heated ingot, after it is taken out of the furnace, must be forged as quickly as possible, so as to leave no spot untouched by the hammer, no spot in which the steel might crystallise quietly, because, as I have said, the heated piece of steel must be considered in an analogous condition to a saturated solution of a strongly crystallising salt, which, the moment it is allowed to cool quietly, develops large crystals. (I repeat that this has reference to temperatures higher than *b*.)

To show you how great is the tendency to crystallisation in steel heated up to a high temperature, and allowed to cool quietly even for a short time, I have brought some specimens by which you can judge of this tendency. The larger specimen was obtained under the following circumstances: An ingot of soft steel prepared for forging was allowed to remain in the furnace for half an hour after it had been heated to a bright orange heat, because the hammer was occupied by another forging. But in order not to overheat the ingot the smith reduced the temperature of the furnace, and gradually let down that of the work to a bright red. If you will now call to mind what I have said about the tendency of steel to crystallise in cooling between the temperatures *c* and *b*, you will readily believe that during this half-hour the ingot had time to change its internal structure from the amorphous to the crystalline, a change which was greatly assisted by the extreme softening it had undergone at the higher temperature, which presented favourable conditions for the movement of the particles within the mass. As soon as the hammer was at liberty, the ingot was taken out of the furnace, and placed on the anvil; with the very first blow on its middle, the end of the ingot tumbled off from the effects of the concussion. The remaining samples are taken from other ingots under similar circumstances, and they all show how strongly the crystals have developed themselves; and, moreover, each crystal seems to have formed itself in an independent manner, with so little cohesion to the neighbouring crystals that one shock was sufficient to separate them, and allow the overhanging piece to detach itself by its own weight. The specimens show that fracture has taken place only along the surfaces of the crystals, and nowhere through the body of them.

It might be concluded from the incident above described that the ingot was completely spoiled and could not be forged again. But such a conclusion would be quite erroneous. It is true that the higher the temperature of the steel the more susceptible is it to the action of the furnace gases, and the quicker it changes its chemical condition, so that if kept at a high temperature in the furnace it will gradually lose its carbon, and be slowly converted into iron (burning). The example I have cited, however, is only a case of overheating; and in order to know how to correct the mistake made, we must turn to the conditions of crystallisation.

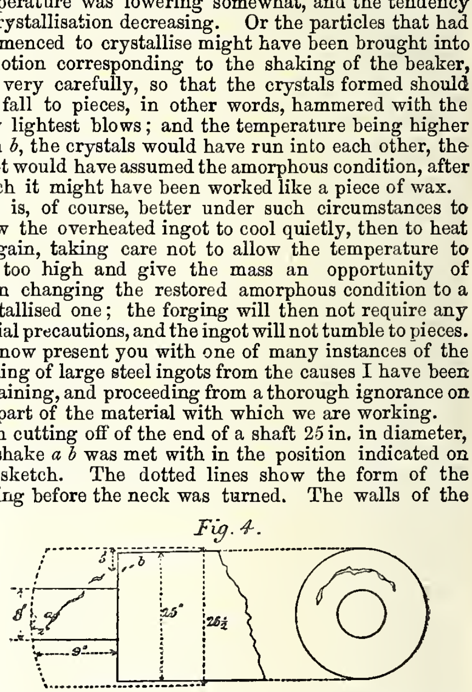
Let us, again, take the beaker of melted alum. Suppose the melting point to be t_o, and that the solution was further heated up to t_i under which operation it would continue liquid. Let the temperature fall gradually, keeping the solution perfectly quiet, then we shall find that at some temperature t between t_o and t_i the salt will begin to crystallise; but it is only necessary to shake up the solution to make the crystals dissolve again at the same temperature t. We shall notice, also, that there is scarcely any cohesion between the separate crystals so formed, and if we do not wish to disturb their mutual relations, we shall have to allow the crystallising solution to cool below the temperature t_o, and then, by a second heating up to t_o, we should again receive a fluid mass. The same result would be obtained by a simple single increase of temperature; the difference lies in this, that the liquid produced from the destruction of the incipient crystals in the three cases stated has three distinct temperatures. Applying this reasoning to steel, it is easy to see that, in the case cited, the temperature of the ingot should have been raised again before forging, so as to impart to it an amorphous structure; it should then have been quickly and unceasingly forged all over its extent while the temperature was lowering somewhat, and the tendency to crystallisation decreasing. Or the particles that had commenced to crystallise might have been brought into a motion corresponding to the shaking of the beaker, but very carefully, so that the crystals formed should not fall to pieces, in other words, hammered with the very lightest blows; and the temperature being higher than *b*, the crystals would have run into each other, the ingot would have assumed the amorphous condition, after which it might have been worked like a piece of wax.

It is, of course, better under such circumstances to allow the overheated ingot to cool quietly, then to heat it again, taking care not to allow the temperature to rise too high and give the mass an opportunity of again changing the restored amorphous condition to a crystallised one; the forging will then not require any special precautions, and the ingot will not tumble to pieces.

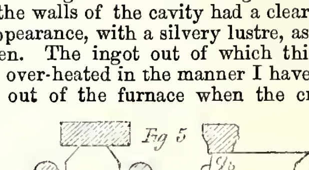
I now present you with one of many instances of the spoiling of large steel ingots from the causes I have been explaining, and proceeding from a thorough ignorance on our part of the material with which we are working.

On cutting off of the end of a shaft 25 in. in diameter, the shake *a b* was met with in the position indicated on the sketch. The dotted lines show the form of the forging before the neck was turned. The walls of the

Fig. 4.



cavity were lined with well-developed crystals, the size of some of which—as you may see by the specimen before you—reached ½ in., and between the large crystals were interposed smaller ones about $\frac{1}{10}$ in. in diameter; the crystals projected only half their height into the cavity, and on breaking the sample at right angles to the crystalline surface, the prolongation of the crystals into the mass of steel could not be traced; the fracture, though crystalline, was of a totally different nature from that forming the surface of the cavity, and similar to that of the mass of the ingot in the same neighbourhood. The surface of the walls of the cavity had a clear unoxidised metallic appearance, with a silvery lustre, as you see by the specimen. The ingot out of which this shaft was forged was over-heated in the manner I have described, and taken out of the furnace when the crystals had



already begun to form. At the first blows of the hammer on its end, the part *c*, which received the full force of the blow, was separated from the mass on account of the

* Concluded from page 840. Reprinted from *Engineering*.

want of cohesion caused by the crystallisation, and formed the internal inclined plane *a b*; and as the forging proceeded, the outer layers, being more acted on by the blows, were more extended, and the cavity considerably increased. The fact that, on striking the end of an ingot the force of the blow is taken up by the wedge-shaped piece *c*, may be easily demonstrated to the eye, because in those places were swelling, compression, or tension follows the blows of a hammer, a dark shade is soon produced by the partial detachment of thin plates of scale. The same result will be arrived at by an analytical investigation of the effect of a blow on *c*.

The appearance of the crystallised surface of the specimen is, as you see, completely analogous to that of every other specimen of over-heated steel; the difference lies only in this, that the surface is not oxidised, because the air could not penetrate into the cavity while the shaft was in a heated state.

It is worthy of remark, that if a piece of steel be so greatly overheated as to assume a strongly crystalline structure, and become liable to destruction at the least shock, and is allowed to cool quietly, then the separate crystals, if they have not been separated by external forces while in a heated state, become so joined or grown together that the fracture of the cold piece takes place, not along the surfaces of the separate crystals, but indifferently through their mass, through the junctions of the fractures of individual crystals generally taken place along their planes of adhesion, owing to which such fracture is always very sparkling.

From this it is evident that the close contact of two surfaces of metals of the same nature heated to a higher temperature than *b* is sufficient to produce union. This is, in fact, welding; and if, in welding, hammering is always necessary, it is only because, in the first place, it is very difficult without hammering to press two pieces one against the other; and, secondly, that it is otherwise difficult to free the surfaces to be welded from the slag which alone protects them from oxidation during the heat. Of course the more homogeneous or analogous the structure of the two pieces, the more perfect will be the union; but one of the first conditions is that there should be the fullest contact between the unoxidised metallic surfaces.

Up to the present we have been discussing the forging of steel only at temperatures higher than the point *b*, and we have stated that the aim of the workman must be to change the form of his ingot in such manner as to keep all its particles in constant motion, and so hinder the formation of crystals, which materially lower the tenacity of the steel. Let us now see what circumstances arise in forging below the temperature *b*.

The fracture of a piece of cast steel presents a rough surface consisting of groups, as it were, or crystalline débris (so-called grains) piled one on another, and generally of a very irregular form. Under the microscope it is easy to see considerable interstices between the groups of grains, and, on more minute examination, spaces may be observed between the grains themselves, which form with each other various interlacings and combinations. In a word, steel, under the microscope, has more or less porous structure, at first sight, destructive of any belief in the tenacity ascribed to it. Time will not permit me to enter into details relating to the appearance, size, and arrangement of the grains; it answers my purpose simply to draw attention to the fact that among the grains of steel there are numerous vacant spaces—pores. The question arises: What becomes of these pores when the steel, being heated up to the temperature *b*, acquires the amorphous condition? In all probability, during the rise of temperature from *o* to *b*, the expansion of each individual grain (formerly in itself a compact body) goes on incomparably faster than the increase of the external dimensions of the piece of steel, so that the period at which it assumes the amorphous condition coincides with the movement when the atoms composing the individual grains, moving away from each other under the influence of heat, fill up these spaces; it is therefore conceivable why steel becomes at this stage incompressible—why it is impossible to increase its density by hammering, no matter how heavy the blows may be.

It is evident from the above reasoning that if we wish to increase the density of steel, to approach its component grains to each other and so to bring them to a more energetic cohesion, we must do so when not opposed by the force of heat, that is only at temperatures below the point *b*.

Thus, forging at temperatures below the amorphous condition has the important advantages we are in the habit of ascribing to it. We never forge large ingots below the temperature of amorphous structure, and guns never were and never are forged below that point, because for gun steel it lies, as I have already stated, at a dull red heat, that is, within limits below which, with the mechanical means at our disposal, we can produce no effect on large steel masses. It would be necessary to forge small ingots under our largest hammers, and what an exhibition of inadequate mechanical appliances would be presented if a 4-pounder gun were forged under a 35-ton hammer! The practice now is to forge the 4-pounders under the 3-ton, and sometimes the 5-ton hammer, while the 35-ton hammer is used for the 6 in., 8 in., and 9 in. guns, in which the diameter of the cast ingot reaches up to 40 in.; but if you picture to yourself such a large mass of steel heated to a non-sparkling red heat, you will perceive that the utmost efforts of the heaviest hammer would remain inoperative—it would be impossible to forge it.

Forging is carried on at points below the amorphous condition, but it is only in very small pieces, and by those who have some knowledge of the influence of heat on steel.

If a cast ingot of any given structure is heated not higher than the point *b*, then in its heated state it will retain its structure. If it was crystalline, then in a heated state it would be composed of the same crystals, which, however, would be considerably softened. If the piece of steel be forged in this condition, then its crystals or grains, being driven against each other, will change their shapes, becoming elongated in one direction and contracted in another, and the increase of density becomes so considerable that I have found the specific gravity rise as high as 8, which I have never yet found in steel forged at temperatures higher than *b*. This comparatively cold forging communicates to the metal great clearness of ring, it is no longer so easily worked with the file, weak sulphuric acid produces hardly any effect on it, and so on. With regard to its absolute tensile strength, I regret very much that I have been unable to make any experiments; but there can be no doubt that it is very high.

The fracture of such steel has a silky lustre, and under the microscope it is very difficult to trace the limits of the individual grains; they present the appearance of whole groups of waxy little balls squeezed together under a powerful press. If you cut off and polish the surface of a piece of steel so treated, and then immerse it in weak sulphuric acid, after a time a pattern will form on the surface, which presents the appearance of an irregular interlacing of crooked lines, the size of the network depending on the original size of the crystals, the manner of forging, and so on. I have already stated that the tendency to crystallisation, as well as the form of the crystals and their relative positions, depends on the purity of the steel, and the conditions under which the cast ingots are poured and cooled. In the higher qualities of "boulat," the tracery developed by acid is of remarkable beauty and regularity.

The cause of the patterns appearing is the various groupings of the crystals during their formation. These crystals have not the same chemical composition; the lighter parts of the tracery contain much more carbon than the darker parts—a fact which I have demonstrated—and consequently, simultaneously with the grouping of the crystals or grains, there is a segregation

of like chemical compounds. If you heat the piece of steel thus marked (damascened) up to the temperature *b*, or a little higher, and allow it to cool again, you will no longer be able to obtain any pattern by the action of acids. From what has been already said, the cause of this must now be quite plain, and I need not dwell on it any longer.

In conclusion, I will show in what manner the properties of a cast-steel ingot may be best taken advantage of.

With respect to forging at temperatures below the amorphous condition, we can only, as I have already stated, make the smallest guns under the largest hammers. We have at present no mechanism capable of dealing with large masses at low temperatures; but if it were possible, there can be no doubt that guns so forged would be of the very best quality, and their reception into the service would be facilitated by the appearance of the patterns brought out by weak acids, because of the close connection which exists between the quality and the appearance of the steel so treated.

To adapt ourselves to the means possessed by our steel works, we must strive to obtain our material as much as possible of a fine-grained structure; and with this view it is necessary, as we have already seen, to heat the ingots to a high temperature, and to keep forging them until they cool down below the temperature *b*, because, by so doing, we shall be giving the work the required form, and at the same time prevent its structure becoming crystalline, but rather make it approach the amorphous condition. But if we examine the circumstances attending the practical application of this rule to the forging of ingots intended for heavy guns, we shall find that, in many cases, it will be impossible to carry it out, and a forging will be obtained the structure of which is far from uniform, and more likely to be coarse crystalline than fine-grained. We shall attain our object more easily, and with more certainty, if after having given the forging the desired shape, we alter its structure to the homogeneous amorphous condition by heating it, and then fix that condition by rapid cooling to a temperature lower than *b*. For this purpose, it is of course necessary to surround the ingot, after heating, by some rapidly cooling medium.

From what has been said above, it is evident that, with the same rate of cooling, we shall fix the amorphous condition of the steel with the greatest certainty when we exceed the temperature *b* as little as possible; and for that reason it is well to determine that temperature for each ingot beforehand.

Having, therefore, heated the finished forging, or better still, the rough turned and bored gun, to a temperature somewhat higher than *b*—a point which ought to be determined by the pyrometer—let it then be plunged as quickly as possible into the cooling medium, be it water, oil, or what not, and having reduced the temperature of the work to below the point *b*, allow it to finish cooling gradually, so as to prevent, as far as possible, internal strains due to sudden and unequal contraction.

To show you what changes may be produced in the structure of steel by the operations described, I lay before you three specimens.

They are all broken from the same piece of steel. The first specimen exhibits the coarsely crystalline, porous structure that characterised the ingot, notwithstanding that it was well worked under the 35-ton hammer. The second sample was heated to a little above a bright red non-sparkling heat, and then allowed to cool in the open air. Comparing the fractures of these two pieces, you perceive the structure is totally different, though offering one surface to the other proves by the fit that the two pieces were at one time united, and that neither piece has been touched by the hammer since they were broken asunder. The third fragment of the same piece was heated to a bright red heat, and then quickly plunged into water, and left till the temperature sank to a reddish-brown heat; it was then taken out and allowed to cool in the open air. The fracture shows that on the external surfaces, for a depth of 0·1 in. the amorphous condition has been completely preserved. In the centre of the piece the mean diameter of the grains, as measured by the microscope, is 0·004 in., while the mean diameter in the first piece was 0·15 in., and in the second, 0·005 in. To this I may add that to break the first piece one blow of a hammer was sufficient, to break the second required five such blows, and the third piece had to be broken under a steam hammer, because the strength of the smith was inadequate for the work.

A similar experiment was made with the tyre of a railway wagon wheel. A piece of an ordinary tyre was broken by a 5-ton hammer into three pieces. One of them was heated to a light red, and then thrown on the floor to cool in the open air to the ordinary temperature. It was then put under the 5-ton hammer, and required four heavy blows to break it, whereas the first piece broke under one blow of the same hammer. The third piece I heated to a bright red heat, plunged it quickly into water, and took it out again when cooled to a reddish brown heat, and then found that it required five heavy blows of the 5-ton hammer to break it.

Therefore I say that in order to fix the amorphous condition, and thereby to increase the tenacity of steel, it is necessary to plunge it, after heating, into water. It may be cooled in oil, but, in the first place, this is expensive, and, in the next, numerous precautions have to be taken to prevent the oil catching fire. With respect to cooling in water, I must add that the conductivity of hot metal is very small, and that although the external visible parts soon show the desired fall of temperature, yet the central portions remain very much hotter; it therefore requires care, experience, and many precautions to avoid the too rapid cooling of the outer layers, and the consequent development of severe internal strains.

Time will not permit me to treat this subject in greater detail. I can only state my opinion that not only should every gun be subjected to the treatment above described, but also every article made of steel, as, for example, tyres, axles, shafts, &c.*

It follows, from the principles laid down, that any steel article having, from constant work and concussion, lost its original strength, that is, assumed a crystalline structure, as happens to wagon axles, engine shafts, &c., can, by the help of the process above described, be completely restored by having communicated to it if not an amorphous structure, at least one so finely grained as to be nearly equal to it, and, at the same time, a compactness and tenacity it very likely did not possess when newly taken into service.

I trust that you will now find it easy to understand the circumstances and facts which I brought under your notice at the commencement of this paper.

I have heard with pleasure, from a friend just returned from England, that at the Woolwich Arsenal they have adopted the practice of heating their steel gun linings, after forging and rough turning, and plunging them into oil; he was unable to give me any details of the operation, as he only noticed it in passing, but the object of the treatment was, he ascertained, to give the steel greater tenacity. It is possible that I may soon obtain information as to the reasoning which led to the adoption of this practice, and I shall be exceedingly pleased if I find it is based on theories similar to those I have had the honour of laying before you this day. With respect to the doctrines I have been advocating, I have been accused of being too bold in my conclusions, but I am prepared to take a still more decisive step, and to announce the opinion, resulting from my observations, that "future investigation into the question of forging steel will not deviate from the path into which we have this day directed it."

* 1875. A wagon axle treated in the above manner, and cooled in water, withstood twenty-two blows of ½ ton weight falling 14 ft., and remained unbroken.

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FRIDAY, JULY 28, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

DRILL INSPECTION OF BOARD SCHOOL BOYS.

The second annual drill inspection of boys from the various schools in the several districts under the supervision of the London School Board took place on Thursday, the 20th inst., in Regent's-park, on the western side of the Zoological-gardens. Upwards of 9,500 boys, representing the districts of Tower Hamlets, Southwark, Chelsea, Lambeth, Greenwich, Finsbury, Hackney, and Marylebone, were present, drawn up in 238 companies, each under its own leader. The bands from the Caledonian Asylum, Feltham, Strand Union, and Forest-gate District Schools performed in turn. The principal part of the performance consisted of a "march past," during which the respective merits of the schools were noted in turn by the judges, chosen from a body of gentlemen, who included Mr. E. Chadwick, C.B., Lord Alfred Churchill, Sir Henry Cole, K.C.B., Sir Edmund Currie, Earl Fortescue, Mr. Le Neve Foster, Mr. John MacGregor, Sir Charles Reed, the Rev. J. Rogers, Rev. T. B. Stephenson, Mr. E. C. Tufnell, and others who were assembled to witness the proceedings. After the march past a few evolutions were performed *en masse*, under the direction of the drill-instructor to the School Board, Mr. Sheffield. The leaders having then been summoned to the front rank, Lord Alfred Churchill, on the part of the Society of Arts, presented to Sir Charles Reed, as President of the School Board, the banner which the Society has given for proficiency in military drill. Sir Charles, in returning thanks for the Board, spoke of the benefits, both physical and moral, which he believed to result from an efficient system of drill, and proceeded to award the banner to the leader of the Kender-street School of the Greenwich Division, to be held for one year, at the expiration of which period it will be again competed for. After some further speeches of brief duration, the assembly dispersed.

The banner has at the top a representation of the Union Jack, with V.R. and a crown at one side, and A.E. with the Prince of Wales's feathers at the other. Below this is an inscription, "Society of Arts Challenge Banner for Excellence in Military Drill." Below this, again, are on one side the Society's Seal, on the other the arms of the City of London. On the staff is the following inscription:—"This Challenge Banner is the gift of the Society of Arts to the School Board of London, and accepted by the Board to be Awarded Annually in Competition among Public Elementary Schools, for the Encouragement of Military Drill. MDCCCLXXVI." The banner was embroidered at the School of Art Needlework.

HEALTH AND SEWAGE OF TOWNS.

Sewage Gases in Houses.

On Friday, 21st July, a deputation from the Council of the Society waited on the Metropolitan Board of Works to bring under their notice the recent report of the Committee on the above subject. The deputation consisted of Lord Alfred Churchill (chairman), and Sir Henry Cole, K.C.B., with Mr. Le Neve Foster (secretary).

The following memorial was presented by the deputation, and read by the clerk of the Board:—

To the Metropolitan Board of Works.

The Memorial of the Society for the Encouragement of Arts, Manufactures, and Commerce.

Sheweth—

That there has lately been held, under the auspices of this Society, a Conference on Health and Sewage of Towns, very numerously attended by representatives from various localities in different parts of the kingdom.

That the Executive Committee of this Society, to whom were entrusted the management of the Conference, have passed the following resolutions in reference to house-drains and the connection of such drains with the main sewers:—

"1. That the protection of public health from typhoid and other diseases demands that an amending Act of Parliament be passed, as soon as possible, to secure that all house-drains connected with public sewers in the metropolis, and towns having an urban authority, should be placed under the inspection and control of local sanitary authorities, who shall be bound to see to the effective construction and due maintenance of all such house-drains, pipes, and connections. Provisions having this object in view exist in the Act constituting the Commissioners of Sewers in the City of London, in the Metropolis Management Act, 1855, and in the Public Health Act, 1875, but practically they seem scarcely sufficient for the purpose.

"2. That plans of such drains and connections be deposited in the charge of the respective local authorities, who shall be bound to exhibit them and supply copies of them to the public on payment of a moderate fee.

"3. That the owners of houses be compelled by law to send to the respective local authorities, within a specified time after the passing of the Act, plans of all house-drains on an appointed scale."

Your memorialists desire to point out for the consideration of your honourable Board, that although considerable powers in this direction have been conferred by law upon local authorities, yet that in practice such

powers are not sufficiently carried out at the present time, and require to be amended and enlarged, in order efficiently to attain the important sanitary objects for which they have been granted.

By Order of the Council.

P. Le Neve Foster, Secretary.

20th July, 1876.

In answer to the invitation of the Chairman, Sir James Hogg, M.P.,

Sir Henry Cole said—Mr. Chairman, I shall be as brief as possible, and not occupy your time more than is absolutely necessary. The precise object which we have in view is to request you to do your best to prevent typhoid fever in the metropolis arising from sewer gases. I live in a neighbourhood where typhoid is almost chronic—a neighbourhood which has been rated four or five times more than it was twenty years ago; and yet, notwithstanding its being, perhaps, naturally the healthiest suburb of London, we are always hearing of typhoid and scarlet fevers. There is a set of houses which I will not particularise, which are scarcely ever free from typhoid fever and scarlet fever. Now, we conceive that the Legislature, in 1855, did intend to do something for the purification and drainage of houses in the metropolis, and certain laws were laid down and put in practice, but they have been found to be more or less inoperative. In my own case, for instance, I take a house. I go to the Vestry, and ask what is the state of the drainage; but, my house having been built before 1855, they can give me no information about it. Of course, they can tell me whether or not there is a main sewer, but whether I have any connection with the main sewer they cannot tell me. I then get into the house, and, after having been there three weeks, I am so affected with stinks and prostrated with ill-health that I am obliged to have my drains inspected. I had them inspected before I went in by what was supposed to be a sufficient authority. The drains were afterwards opened, and it was found that they were of a low antiquated character—a kind of brick drain, in which I daresay there was no mortar used to put the bricks together. The floor of one of the rooms was completely saturated with the sewage. Further, it was found that there was really no connection between this drain, such as it was, and the main sewer. Well, that was the state of my house, and it cost me nearly £100 to put it in order after I had been in it for the first three weeks. A neighbour of mine, within 120 yards or so, got into his house, and his servants began to be sick, and he, too, had his drains examined. His drains were also made before 1855, though a very little before, and they were made of drain pipes; but instead of being properly cemented together they had only been put together by earth. He called in the clerk of the works, and said to him, "What would be the saving in cost, in a house costing two or three thousand pounds, supposing you used earth for fixing together the drain pipes instead of Portland cement?" And the clerk said that the saving would be about two shillings a house. My neighbour said, "Is it worth while to use earth for the sake of a saving of two shillings upon a house of this character?" "Oh, sir," the clerk replied, "You must consider that the contractor has a thousand houses to save two shillings each upon." Well, my neighbour went through all the irksomeness of this. Within the last two or three days, going only 500 yards down the road I heard the same story. A house is let, guaranteed to be in good order, and the tenant comes in and finds that he is turned out by the stenches. He makes inquiries and he finds that the noses of the former inhabitants were not so sensitive as his. And although it was a supposed sanitary authority that lived in that house, he did not smell the stinks, and the drains were there found to be in the same bad condition. And, again, in another direction in South Kensington, the same thing is found, and that two or three houses are affected by typhoid fever. The drains are examined, and it is found that the levels are all wrong. Well, then I go to the vestry of my parish, and say to them "What can you do for us?" They reply, "All that we can do under the Act is to compel our surveyor to see that there is a proper opening into the main sewer." "But," I asked, "do you know that the drainage, before it gets to the main sewer, is all properly regulated?" Their answer is, "No, it is not our business. That is not within our power. All that we are able to do is to see that there is a proper aperture, and all that is behind the aperture may be all wrong." I make no complaint of the parish. I complain of the law. Now, the Society of Arts had a Conference which lasted for nearly a week, and it was attended by people from all parts of the country. Hence this memorial. The prayer of the memorial is that the Metropolitan Board of Works, having in its charge the main sewers, and the local authorities having the power to see that the main sewers are properly pierced, will go farther and see that the internal dainage of the houses is what it ought to be to prevent typhoid fever. I need not trouble the Board with any detail of the ins and outs of the Acts relating to the present powers; but here is the fact that the people of this metropolis are rated four millions or more—I believe a little more—for having their main sewers all right, and all the rest of the drainage system is higgledy-piggledy, and nobody knows anything about it. As to the parish where the Society of Arts is, our parish is a perfect nest of stinks always, and nobody can go down into the basement of the Society of Arts house without wondering how the people can continue to live there. We have investigated the subject again and again, but we are just as bad as ever we were. Now, having been taxed this great sum to get the main sewage all right, we do think that it is the duty of the local authorities to have proper rules, so that a person going into a house should have a guarantee that the whole system is right, just as in the case of water. If you merely laid the water in the streets and did not see that it was carried into the houses, and if you laid gas mains in the streets and left the ignorant ratepayer to find out how to make the connections, the water and gas supply would be as bad as the sewage. We, therefore, venture to submit to you these proposals and trust that you will give effect to them. It is our intention during the autumn to endeavour to persuade the Local Government Board to take up the subject for the whole country; but as you represent the metropolis we thought it right to come to you and present this memorial.

Then followed some brisk cross-examination and condemnation of the memorial, which, after a division of 16 to 3, was referred to the Works and General Purposes Committee for consideration and report.

CANTOR LECTURES.

The third lecture of the second course of Cantor Lectures for the past Session, on "Iron and Steel Manufacture," by Mr. W. Mattieu Williams, was delivered on Monday evening, January 31st, as follows:—

Lecture III.

In the last lecture I stated generally the actions that occur within the blast furnace, following the charge in its downward course. It would be interesting, if time permitted, to repeat this exposition in opposite order, by following the blast upwards,

but I must not be tempted further in this direction than to describe briefly a few supplementary actions not yet explained.

As already stated, the water which, in the form of vapour, accompanies the blast is dissociated or reduced—dissociated so far as the force which holds its elements together is loosened by the merely repulsive agency of heat; reduced when its oxygen is taken from it to combine with the carbon of the fuel.

I doubt the possibility of the simple complete dissociation of water in the blast furnace, the temperature demanded for this being about 5 000° Fahr., but vapour of water heated to the highest point attainable in the blast furnace holds its elements together with such an enfeebled grasp, that the carbon readily appropriates the oxygen, and sets free the hydrogen, as already stated. But something more accompanies this action. You are doubtless familiar with what is called the "latent heat" of steam—with the fact that to convert water into steam we have not only to raise it to 212°, but, over and above this, to supply it with nearly a thousand degrees more to convert it into steam, *i.e.*, to convert 1 lb. of water at 212° into 1 lb. of steam at 212°, as much heat is necessary as would raise nearly 10 lbs. of water 100 degrees, and all this heat is so fully occupied in doing work of gaseous elasticity that none of it can show itself as temperature.

The dissociation of water into its elements is attended with a similar disappearance of sensible heat or temperature, but the amount is far greater than disappears in the conversion of water into steam. Besides raising the vapour of water to a temperature of 5,072° Fahr. we have to supply it with 2,153 "calories," *i.e.*, sufficient heat to raise it another 8,158° Fahr., in order to drive its elements asunder and maintain their separation. These 8,158° disappear as temperature, being fully occupied in the work of overpowering chemical attraction, just as in the case of vaporisation the 1,000° are overpowering cohesion, and effecting the self-repulsive energy of a gas.

From this it will be understood that the vapour of water which enters the furnace with the blast has an important influence in cooling the lower or hottest part of the furnace. Assuming that, in ordinary working, 2,000 lbs. of such vapour is daily pumped into the furnace, this, in becoming dissociated, takes up sufficient heat to raise itself from the temperature of the blast to above 13,000° Fahr., no inconsiderable amount of heat, seeing that the specific heat of steam is more than four times that of iron, or, that to raise 2,000 lbs. of steam to the extent stated, as much heat is demand d as would equally raise 8,000 lbs. of iron in the same degree.

So far I have stated the case of simple dissociation by heat alone. When, however, the water is decomposed by heat, plus the chemical energy of the carbon, and the oxygen of the water combines with the carbon at the moment of its liberation, we must subtract from heat which is taken up for the dissociation of the water, the amount which is given out by the combination of its oxygen with the carbon, to form carbonic oxide. This is but a small fraction, about $\frac{1}{14}$; thus, $\frac{13}{14}$ of the above stated quantity of heat actually disappears as temperature.

But is all the heat thus expended upon the separation of the elements of water entirely lost? A little reflection will show that such is not the case. It is for the most part only redistributed, for the hydrogen and carbonic oxide, on their way upward, encounter the oxygen of the ore, that which is combined with the iron itself, and with the silicates, phosphates, &c., and in reducing these a recombustion of both hydrogen and carbonic oxide occurs, and in this recombustion they give out the heat that was abstracted for their dissociation, minus the heat similarly abstracted in dissociating the oxygen from the oxides of iron, silicates, phosphates, &c. This minus quantity is, however, but a small one, compared with the heat developed by the energetic combustion of the hydrogen and carbonic acid. Thus, the heat which is lost by the dissociation of water in the hottest part of the furnace is carried upwards, and more or less restored in the upper regions of the furnace. The amount which is not thus restored within the furnace is indicated by the quantity of free hydrogen passing out at the top of the furnace.

It will be seen from this that the vapour of water introduced with the blast performs an important function in effecting the distribution of heat throughout the furnace, and some of the curious differences in the quality of pig iron, which are known to follow variations of the weather, may, I think be thus explained. In humid weather, when the air is saturated with moisture, the quantity of water entering the furnace is much greater than in dry weather, and this excess of water must lower the temperature of the hottest, and raise that of the higher regions of the furnace, thus modifying the reactions described as occurring in the different zones marked on figure 8.

I cannot here help stepping a little aside, to recommend those who have any idea of using "water gas" as fuel, to reflect on what I have stated. If they do so, and understand it, they will perceive that they must of necessity expend just as much heat in dissociating the water to produce the water gas as the water gas gives out in its combustion or recombination.

Very little disturbance of temperature attends the dissociation of the carbonic oxide into carbonic acid and carbon, as the thermal effects of the oxidation of carbon to carbonic oxide, and this to carbonic acid, are nearly equal.

The nitrogen of the blast acts like the aqueous vapour in distributing the heat. It is heated and expanded at the hottest part below, at the expense of the temperature of that region, and it gives out a portion of this heat as it ascends.

I must now proceed to the main product of the blast furnace, viz., the "pig," or crude iron. This, as I have already intimated, is iron plus many impurities. The first tabular diagram shows the mean of my own analyses of thirty brands of high quality pigs, used at the Atlas Works for making best iron:—

Combined carbon	0·916	Total Carbon 2·834
Graphitic carbon	1·918	
Silicon	1·810	
Phosphorus	0·332	
Sulphur................	0·253	

Manganese	1·280
Titanium	0·073
Iron by difference	93·418
	100 000

These analyses were made for commercial purposes, and therefore minute traces of unimportant impurities, as calcium, copper, arsenic, the alkalies, &c., were not sought for.

The second shows the composition of a common pig from the Cleveland district, where, as already stated, ores containing much phosphorus are worked, and the third is the composition of a "cinder pig" made chiefly from the tap cinder of a mill forge used instead of ore.

	2.	3.
Combined carbon	0·80	0·38
Graphitic do.	1·00	2·00
Silicon	2·23	2·52
Sulphur	0·27	0·31
Phosphorus	1 30	0·40
Manganese	0·71	1·50
Iron	93·69	92·89
	100·00	100·00

The "combined carbon" and "graphitic carbon" may require some explanation. The appearance and hardness of pig irons vary very considerably, as may be seen by the specimens before you. The fracture of some of these is almost silvery and crystalline, the crystals usually more or less radiating from the centre of the transverse fracture of the pigs. These are so hard that they cannot be cut by any ordinary steel tool; they are steely in their composition and properties, but harder than steel. Though they cannot be cut with a file they may be crushed by a hammer. These are called "white pigs" or "white iron."

In contrast with these is another specimen, the fracture of which is very dark and granular—almost spongy. If carefully examined, small, glistening scales of a black micaceous substance may be seen in its pores. In some of these dark coloured pigs the pores enlarge to considerable cavities of various sizes, up to half an inch in diameter and above an inch in depth. When these pores are thus developed, we may scrape out from within, with a penknife or similar tool, a quantity of this very beautiful substance, these delicate, glistening, iridescent scales which stain the finger when they are rubbed. The workmen call them "kish," and iron containing them is said to be "kishy." They are scales of graphite. When washed with dilute acid to remove adhering iron they are nearly pure carbon. They are larger specimens of the minute glistening scales before described, as barely visible to the naked eye in the other samples where the pores are not thus developed into considerable cavities.

These pigs with the dark section, and the scales of graphite distributed throughout them, are so soft that they may be drilled or filed very easily. They are called "grey irons" or "grey pigs."

Here is an intermediate specimen, intermediate in colour, in hardness, and general physical properties. This is called "mottled pig." From grey to mottled and mottled to white there are unbroken gradations. These are commonly divided into eight, and numbered accordingly, the greyest, that is the darkest, softest, and most kishy being No. 1, and the whitest, hardest, and most crystalline No. 8. This numbering, I should add, is rather arbitrary and irregular, the No. 3 of one district may correspond with No. 4 of another, and so on.

These differences depend upon the carbon, not upon the total quantity, but upon its condition. If we dissolve a white iron in dilute acid the solution has a dark brown colour; this colour being due to the suspension of a resinous substance, a peculiar hydrocarbon, having many resemblances to paraffin, derived from the carbon contained in the iron, combining with some of the hydrogen of the acid or of the water. The action is analogous to that which occurs when sulphide of iron is similarly treated. In this case we obtain a compound of sulphur and hydrogen, sulphuretted hydrogen, corresponding to the compound of carbon and hydrogen which is formed by the acid acting on the carbide instead of the sulphide of iron.

If we treat grey iron in a similar manner, the solution is nearly free from the brown colour, but a residue remains which consists partly of silica and partly of minute scales of graphite, which evidently existed as such in the iron, mixed but not combined with it.

The carbon thus existing is usually described as graphitic or uncombined, that in the white iron as combined carbon. Hence the distinction made in the analysis, a distinction of considerable importance, though neglected in many analyses.

In No. 1 pigs I have found three-tenths to one-half per cent. of combined carbon, with two to four per cent. of graphitic. In white No. 8 pigs, from two to four per cent. of combined carbon and about one-half per cent. of graphitic carbon. In mottled or intermediate pigs the combined and graphitic carbon are nearly equal.

The cause of these differences has been the subject of much speculation and discussion, and certainly is rather puzzling. If No. 1 grey iron is melted and kept at a high temperature, more or less of the graphite combines, and the iron on cooling becomes whiter or mottled. If on the other hand a white iron, such as spiegeleisen is melted in like manner, some of its combined carbon separates as graphite. Beautiful specimens of "kish" thus produced may be obtained from the lining of the furnaces in which spiegeleisen has been melted for Bessemer steel making.

Some have attributed the condition of the carbon in pig iron to the action of sulphur, but this idea is contradicted by the facts revealed by analysis of a large number of pig irons. These show no connection between the proportion of sulphur and greyness or whiteness of the pig.

The same furnace using the same materials may produce white or grey iron with any of the intermediate gradations, by merely altering the conditions of heating, or the pressure, or composition of the blast. The varying humidity of the atmosphere produces sensible changes in this respect, due, no doubt, to the action of aqueous vapour in distributing the heat of the furnace.

A furnace producing grey iron, on being fitted with an apparatus for carrying off the waste gases, immediately changed its product to white iron. On opening the mouth of the furnace, and thereby removing the pressure due to resistance of free passage of the gases, the furnace at once returned to grey iron.

As already stated, the pig iron produced by the modern blast furnace contains more impurities than the crude iron of the ancient iron maker. I may even say that modern English pig iron—excepting that now made especially for Bessemer purposes—has progressively advanced in impurity as it has increased in quantity. This, however, only applies to the product of the blast furnace, which has now become a sort of intermediate raw material instead of being as formerly the ultimate or nearly the ultimate product; for just as its quality has deteriorated, the processes for its final purification have been improved.

During many years after the re-invention of Dudley's invention, foreign charcoal iron was still imported into this country, and used for most purposes demanding malleable iron of superior quality; and even up to the commencement of the present century our home production had not overtaken the home demand. It is but quite recently that we have become exporters of iron. Something was necessary to supplement the blast furnace when pit coal was used instead of charcoal. Dudley evidently understood this, for in his "Metallum Martis," published in 1665, he describes correctly the defects of different kinds of iron, and refers to his modified methods of refining to suit the special varieties of the pig.

The "finery," or "refinery," shown in section in the diagram (Fig. 9), is a tall, open-topped

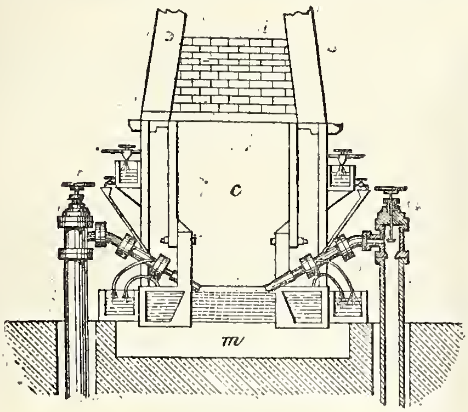


Fig. 9.

furnace in which the pig iron is melted by charging it with a sufficient quantity of coke into the space c, and when it is all melted and resting on the hearth m, blowing air upon its surface by means of the inclined twyers shown in the diagram, as just touching the surface of the bath of metal.

The action of this, when a grey iron is used, is first to convert the graphitic into combined carbon, or grey iron into white iron, and simultaneously to oxidise some of the silicon. As the blowing proceeds, and as the unoxidised silicon diminishes in quantity, the combustion of the carbon commences, and continues increasing. In this manner nearly all the silicon, and the greater part of the carbon, may be removed if desirable, the silicon forming fusible silicic acid, which usually combines with some of the iron, and with most of the manganese or any calcium that the pig may contain, and forms a glassy cinder floating on the top of the melted iron. When the blowing is carried as far as may be deemed necessary, the refined metal is run out into a long, shallow trough, usually of cast iron, in order that the cast may be rapidly chilled and easily broken up.

The refinery is still in existence, but its use is by no means general; is, in fact, quite exceptional in this country, and of questionable advantage except for the preparation of foundry iron from pigs containing too much silicon, or an excess of both silicon and carbon. Some iron makers mix a little refined iron with the pigs used in the puddling furnace, and believe that they improve the make or facilitate the puddling process thereby.

Formerly, however, the refinery was of far greater importance, as it supplied the only available means of purifying the pig iron, which was effected in the old charcoal "running out" furnaces, practically equivalent to the refinery as now used.

So long as silicon and carbon were the chief impurities this method was sufficient, for by continuing the blast, or by remelting two, three, or even four times, the iron could be rendered infusible and malleable, brought to the condition of spongy iron, in the form of a ball or bloom, to be hammered out as required.

The introduction of increasing qualities of sulphur and phosphorus, however, rendered this simple method less and less effectual, for although these are combustible substances they are not fully removable from iron by mere burning out. Large quantities may be considerably reduced thereby, but the last residues of these impurities hold to the iron so firmly that we may burn all the iron itself into an oxide without removing them by the simple action of oxygen. Their removal is nevertheless quite necessary to the production of good iron, as sulphur renders iron "red short," *i.e.*, brittle when heated, and thus unfit for forging, and phosphorus makes it "cold short," that is brittle when cold. $\frac{1}{1000}$ part of phosphorus renders steel quite unfit for tools with keen edges, and about double this quantity of sulphur is ruinous to iron that has to be forged to any considerable extent. Steel will bear more sulphur than phosphorus, and malleable more phosphorus than sulphur. It is possible that, to some extent, they may neutralise each other; that a little phosphorus, for example, may diminish the red shortness due to a given quantity of sulphur. This, however, is by no means certain. If iron contains a considerable quantity of both, say $\frac{1}{4}$ per cent., it is both hot short and cold short, and of little value.

Some means of removing these impurities has thus become a necessary supplement to the modern applications of Dudley's invention. Only forty years elapsed, after the revival of this invention by the Darbys of Coalbrookedale, when this great desideratum was supplied by Cort's invention of the "reverberatory refinery," or "puddling" process. This specification is dated Feb. 13, 1784. This invention was second in importance to that of Dudley, and was, in fact, a necessary adjunct to it. The history of Cort and his invention is another story of industrial martyrdom, too long to be narrated here. It has been said with truth that the only man of Cort's generation who

did not receive benefit from Cort's invention was Cort himself, for had he made no such invention he would probably have been a prosperous ironmaster; but, as it was, his invention and its proceeds were stolen by rich men, and the consequent litigation ruined him.

Cort's puddling furnace was similar to the modern furnace presently to be described, in all respects except that he used sand bottoms. These continued in use until 1818, when Samuel Rogers, of Nant-y-glo, proposed iron bottoms. He offered his invention to Mr. A. Hill, of Plymouth Iron Works, to Mr. Forman, of Pendarren, Mr. Hall, of Rhymney Iron Works, Mr. Homfray, of Tredegar, and Crawshay, of Cyfartha, and all received it "with sneers and ridicule" as impossible. It was finally adopted by Mr. R. Harford, of Ebbw Vale, and soon became general, increasing the weekly yield of each furnace from 8 tons to 20 or 24 tons.

This great difference is due to the saving of time otherwise lost in the renewal of the destroyed bottoms, and to the absence of restraint upon the puddler's efforts, who is no longer required to use the extreme care formerly demanded to save the bottoms from destruction.

Rogers died about fourteen or fifteen years ago in extreme poverty, at the age of eighty-five.

The ordinary puddling process consists of melting the pig iron in a reverberatory furnace, which is lined with some compound of iron and oxygen, and stirring the melted metal until its impurities pass off, partly as gases and partly into the cinder; then collecting the infusible iron and separating more or less completely the remaining entangled impurities by hammering or squeezing and rolling.

Two processes of puddling have been adopted, first, with refined iron, and free oxidation by means of an oxidising flame reverberated upon the surface of the melted metal. This is called "dry puddling," and removes silicon and carbon effectually, and the sulphur and phosphorous but very imperfectly. It is, therefore, only fit for superior pigs, especially charcoal pigs. It is still used by some continental ironmakers, but is practically abandoned in this country in favour of the second process, called the "pig boiling" process, which I will describe more in detail.

A vertical section through a puddling furnace is shown in the diagram (Fig. 10) where *p p p p* are

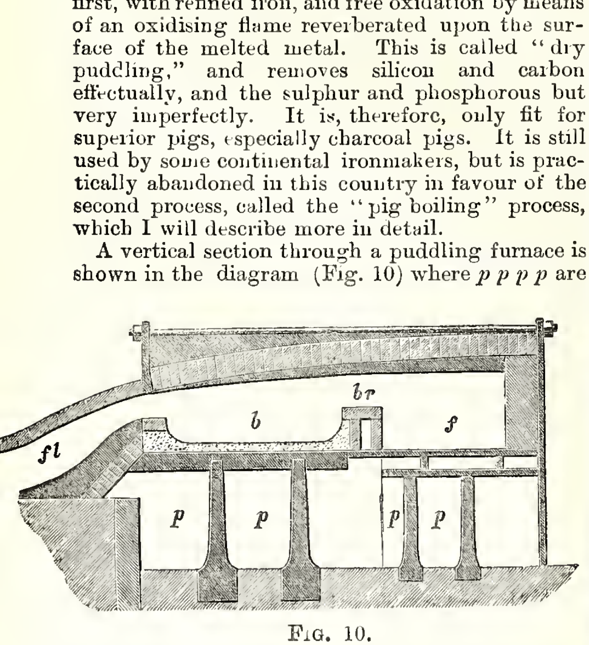


Fig. 10.

pillars supporting the bottom, and leaving air cavities between them; *f* is the fire-place, *br* the bridge, *b* the furnace bed upon which the pig is melted, and *fl* the flue. A horizontal section, with the same lettering, is shown in Fig. 11. The

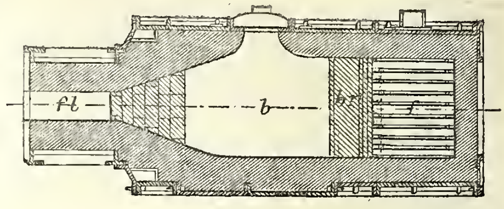


Fig. 11.

whole structure of fire-brick, excepting the flue, is encased in strong iron plates, which are strapped together by iron rods.

The openings to the fire and to the bed of the furnace are both on the same face. That to the fire has no door, but merely a shelf or bracket below the opening, the use of which will presently be described. The door of the furnace bed, by which the pigs and lining are charged, and the balls of spongy iron withdrawn, is a cast iron box filled with fire-brick, and raised or lowered by means of a lever. An arched notch at its lower part forms the "stopper hole," or rabble hole, through which the stirring tool is worked, and below this is the "tap hole," stopped with sand during the working, but opened afterwards to permit the outflow of the liquid cinder.

The stack, or chimney, is provided with a damper for regulating the draught. The residual flame is now commonly utilised for heating boilers. When this is not the case, the flame pours out from the top of the low stack, except when checked by the damper, which in these cases is at the top of the stack.

Two men work at each single furnace, the puddler-in-chief or "forehand" and his "underhand." The fire is lighted, and the roof, walls, and bed of the reverberatory chamber, *b*, are made red hot. Before charging the pig iron, the furnace is "fettled" or lined with material called "fettling." This fettling is essentially an oxide of iron, but varying considerably in respect to the impurities it contains. Red hæmatite is the best fettling that is practically used on a large scale, but cheaper materials more commonly take its place, or are mixed with it.

The most important of these is "bull dog," which is made by roasting refuse tap cinder, or impure silicate of iron, in an oven like a lime kiln. By this means the silicate is converted into sesquioxide of iron and uncombined silicic acid. Various kinds of roasted ores and other refuse containing peroxide of iron are also used; local facilities, which rule the cost of such things, usually determining the choice.

The fettling, ground to powder, and mixed with a little water to render it plastic, is applied like mortar to the sides and bed of the furnace where required, and pressed into its place with a suitable iron tool. Besides this wet fettling, a certain quantity of loose iron scale and "hammer slag," the nature of which I shall presently explain, is commonly thrown upon the furnace bottom.

The furnace being thus prepared, lumps of pig iron are thrown in and arranged upon the furnace

bottom in such a manner that they shall receive the utmost heat of the reverberating flame. The door is closed, a piece of iron or "stopper" put against the stopper or rabble hole, the fire is made up, and the damper raised to obtain full combustion of the coal and as much heat as possible; $4\frac{1}{4}$ cwt. of pig is an ordinary charge. The charge is usually a mixture of grey and white iron, or an intermediate or mottled iron only. A little refined iron is sometimes mixed with the pigs, and iron scrap occasionally introduced.

The selection of suitable pigs for the production of special qualities of iron is a matter of considerable importance, and demanding much skill. Additional display of cleverness is frequently made by using complex mixtures, rather than the one single brand that would directly meet the requirement. There is pedantry even in puddling, and solemn mysteries are maintained concerning the efficacy of certain secret "blends."

I have been much interested in penetrating these arcana, learning what particular brands are successfully used for special purposes, then analysing the pigs thus used, and comparing their composition with their special suitabilities. I am sorry that time does not permit me to state the details of these investigations, which although far less extended than they should be, have been sufficient to satisfy me that if our forge managers had sufficient knowledge of chemistry to understand the composition of the pig irons they use, and to apply that knowledge in their selection, some hundreds of thousands of pounds would be annually saved by their employers, who now have to pay for the mistakes that are made in consequence of a want of this knowledge.

I have seen large quantities of pig iron, costing £5 or £6 per ton, used for purposes which might have been equally well served by brands of similar composition that would have cost £3 per ton or even less. With a reliable table of the composition of all the available brands, with the prices of each affixed, and a sound knowledge of his chemical requirements, the forge manager might select those required for each specific purpose with regard both to quality and price, without the necessity of expensive trials. In some iron works that I could name, a saving of at least 20 per cent. upon the annual outlay for pig iron might thereby be effected.

But I must proceed with the work of puddling. The fire being made up and the furnace charged, as already described, the melting proceeds gradually, ordinarily occupying about half an hour to 40 minutes, the time varying with the state of the furnace and the quality of the pigs. Grey pigs require more time than white.

During the melting the underhand turns over the lumps, exposing them to the strongest heat, and stirs the liquid with a long iron rod.

In some cases the time and fuel for melting is saved by arranging the puddling furnaces near the foot of a blast furnace, and tapping the crude metal directly into the puddling furnaces. I have seen this successfully done with double puddling furnaces at the Chillington Works, near Wolverhampton.

When the melting is completed, the "rabble," a rod, or bar of iron flattened, spread out, and bent at the working end, is used with the bent or hook end downwards, to stir the melted mass. This stage of the "rabbling" is usually conducted by the underhand, and it mainly consists of a groping or cautious scraping along the bottom of the furnace. Presently the surface of the pool of metal becomes curiously agitated, small bubbles rising and bursting. This agitation, at first merely superficial, gradually deepens, till the whole mass of liquid seethes, heaves, bubbles, and spirts out jets of blue flames, mainly composed of burning carbonic oxide.

This is the "boiling," as the puddler calls it. The fire is well kept up, and the puddler-in-chief now takes the rabble. He no longer gropes leisurely about the bottom, but furiously stirs the liquid throughout, working so hard that the "mop" or towel hung loosely round his neck becomes soaked with the perspiration that he wipes from his face. When he is exhausted the underhand takes his place and continues the work with similar energy. As the rabble becomes heated and softened it is plunged into an iron water-tank and exchanged for a cold one. The "boiling" increases meanwhile, the liquid thickens, becomes gruelly, swells considerably, and often overflows the rabble hole. From gruelly it becomes almost porridgy (excuse the coinage) owing to the gradual formation of solid particles of infusible iron. As these become more distinctly separated, the liquid ceases to be a homogeneous fluid or even an uniform paste or porridge. It is now distinguishable as a liquid containing sandy looking particles diffused throughout it. The puddler describes this as "coming to nature." From the commencement of the boiling up to this point the rabbling has been conducted with the utmost vigour, the sides of the rabble hole being frequently used as a fulcrum to aid the dashing action of the rabble.

The granules of infusible iron are now fully formed and quite distinct from the liquid silicates or "cinder" surrounding them. If left to themselves they would settle down upon the bed of the furnace and form a tough cake not easily removed. To prevent this the puddler skilfully collects and heaps them together, feeling all round the bottom and sides of the furnace as he proceeds, and thus with the aid of a little pressure between the flat of the rabble and sides of the furnace, he forms these granules into one or more balls or blooms. This he calls "balling up."

While balling up the dampers are put down, the fire is choked, and a smoky carbonaceous reducing flame is produced and maintained till the iron is all fairly out. This is to prevent what the puddler calls "cutting," by which he means oxidation, to which spongy iron—for such he has now re-obtained—is so especially sensitive when heated.

The balls thus gathered are grasped by large tongs, and with considerable muscular effort hoisted on to a "trolly" or iron barrow, and speedily run to the helve or steam hammer or squeezer. Three or four balls are commonly made from each heat.

The steam hammer has now in this country almost entirely superseded the old helve or shingling hammer for this purpose. The helve was raised by a cam, and fell with its whole weight, admitting of but little modification or "humouring" of the force of the blow. With charcoal iron and dry puddling this was of little conse-

quence, as the balls thus produced were sufficiently solid to stand a first heavy blow. This is not the case with modern iron, which comes from the puddling furnace in a very soft and very porous condition, so much so that in some cases a full force blow struck from the hammer would splash it out on all sides from the anvil.

The steam hammer deals with it tenderly at first, falling upon it with a merciful, noiseless pressure, which crushes it down to a limited extent, and squeezes out some of the yellow, hot, fusible, siliceous juice contained within its pores. Then the ball is turned round, and receives another moderate crush, then another, and another, with increasing force and suddenness as it consolidates, until at last, when it can bear such treatment, the hammer comes down with a thumping smash that shakes the solid earth-crust around, and dashes out from the now resisting mass radial volleys of sparks, which sometimes betray the uninitiated spectator who is tempted by the mildness of the previous proceedings to approach within range. Those with more experience retire behind the shields erected for the purpose when the first heavy crash is approaching. The "shinglers" who handle the ball, during its torture, turning it over and over, and tilting it upright upon the anvil, are protected by heavy iron armour on the legs and feet, iron gauze and wet cloths over the face and body.

The object of this shingling is to weld together the separate granules of metallic iron, and to squeeze out from between them the fusible silicates or slag by which they are enveloped. In doing this the bloom is brought into a convenient shape for subsequent treatment, and when used for large work several balls are welded together, in order to produce a heavy "puddled bar."

Squeezers of various forms, such as the "crocodile" squeezer, a pair of serrated jaws; the rotatory eccentric squeezer, &c., are sometimes used instead of the hammer, the object being the same, and the mode of action similar.

The bloom thus hammered or squeezed—the "shingled bloom"—is now rolled roughly into "puddled bar;" these are rough, scaly, oblong plates or bars, usually about three-quarters of an inch thick and three to fifteen inches wide, but modelled according to the final destination of the material. The rolling squeezes out a little more of the siliceous impurities. In some cases, for best iron, the shingled blooms are re-heated especially for this purpose, and re-hammered, usually with a tilt hammer this time; such re-heating is called a "wash heat." These re-heated blooms are then rolled, and produce a smoother and more compact bar.

These bars, whether re-heated or not, are further rolled, first through roughing rolls, then through finishing rolls that shape them as required into rails, angle iron, T iron, bars, plates, sheets, wire, &c. Plates and sheets are finished between plain cylinders, instead of grooved rolls.

Every rolling squeezes out a further, but diminishing, quantity of fusible impurity, and when high quality of iron is required, as in best boiler plates, &c., the device of piling is adopted. For this purpose puddled bar or rough plates are sheared into strips, and these are piled cross-wise on each other, scrap iron from the cuttings of finished plates being commonly introduced to further improve the quality. These are raised to a welding heat in a re-heating furnace, and re-rolled into plates of required dimensions.

I shall have to refer again to this device when I come to the subject of armour plates. The time occupied in producing the puddled ball from the pig varies from 1 to 3 or 4 hours; it is greatest with grey iron. Two hours is a fair time for working out a heat. A charge of $4\frac{1}{4}$ cwt. (long weight of 120lbs. to cwt.), ordinarily yields about 4 cwt. of iron, the loss varying from 5 to 15 per cent. It is quite possible to make the product exceed the charge, as I shall explain presently. 20 to 22 cwt. of coal is used to each ton of bar. The puddlers are paid by weight of product if good iron is made, but have no pay if they produce a bad ball or "cobble." The men who do this are called "cobblers."

MISCELLANEOUS.

BRUSSELS HYGIENIC AND LIFE-SAVING CONGRESS.

This congress is announced to be held in the Ducal Palace, from the 27th Sept. to the 4th Oct.

The programme has just appeared, and is divided into three sections—Hygiène, Life-saving, and Social Economy.

FIRST SECTION.—HYGIÈNE.

This section comprehends—1. Public health and salubrity. 2. Hygiène, as applied to industry. 3. Domestic and private hygiène. 4. Medicine, surgery, and chemistry, in relation to hygiène.

Questions Proposed for Discussion.

1. What are the advantages of water supply, and the best means of obtaining it in populous centres?

What is the effect of taking the water from hydrographic basins; and what is the consumption of water per head of the inhabitants?

2. Which is the most practical system of removing fœcal and putrescent matters and mud from towns? Means of purifying sewage, of utilising drainage waters, of preventing the pollution of watercourses by the refuse of factories and works, and of neutralising the bad effects of dungheaps near dwelling-houses; the choice of disinfectants and antiseptics.

3. How to ascertain easily and surely if death have taken place? Should permission to bury be preceded by examination by a competent person? Is the institution of the English coroner's inquest to be recommended?

What measures can be adopted which will be a guarantee against precipitate burial, without keeping corpses too long unburied? If mortuary depôts be recommended, what is the best plan for them, and what are the precautions to be taken in the transport of the dead?

What are the advantages and inconveniences of ordinary burials, and of the various modes of cremation?

4. What are the causes of the excessive mortality of new born infants and young children, legitimate and illegitimate?

Discuss the supply of nurses in great towns, and the subject of infants brought up by hand; the advantages and the inconveniences of the use of perambulators; the utility of special hospitals at the sea-side for scrofulous children, and the opportunity of establishing special schools for ricketty children.

5. How is it possible to reconcile the interests of liberty and of the public health—(1) in the case of quarantine and lazarets; (2) in that of hydrophobia and other diseases which may be transmitted from animals to man; (3) What are the best precautions against epizotic diseases?

What are the precautions to be taken in the transport, killing, and burying of animals attacked by contagious diseases? Is cremation to be recommended in such cases?

What are the means of disinfecting stables, cattlesheds, ships, waggons, and houses that are contaminated?

What are the rules to be observed in the transport of cattle intended for slaughter, as regards the public security and the health of the animals?

6. What are the best systems of heating and ventilating places to receive a great number of persons, such as factories, theatres, schools, hospitals, &c.

7. What are the proper conditions of salubrity for (1) hospitals, infirmaries, and lying-in hospitals; (2) temporary hospitals and civil ambulances?

8. What are the means of obtaining—(1) uniformity in all countries in the statistics of mortality for the various professions and occupations, taking account of the habits of the working classes and of the substances with which they have to deal; and (2) of employing the means at the command of the State in obtaining such statistics?

9. What is the hygiènic value of woods and plantations, and of the reclamation and drainage of marshes and other lands?

What are the means of preventing insalubrity in retting pits, rice grounds, and lands irrigated with muddy waters?

Second Section.—Saving of Life.

This section includes the means of saving life from fire, at sea, in railways, in mines, &c., and in time of war.

1. What are the means of preventing—(1) collisions on land and sea; (2) spontaneous combustion on board ship; and (3) of diminishing the cases of shipwreck and abandonment of vessels?

2. What additions are required to maritime codes and regulations for the security and comfort of passengers, especially in the caso of emigrant ships and military transports?

3. What abuses exist in the system of maritime insurances, and how are they to be removed?

4. What precautions can be taken against extraordinary high tides and the sudden swelling of watercourses?

5. What are the means of preventing explosions and flooding in mines, and of diminishing their effects? What system of lighting mines presents the greatest security?

6. What are the means of preventing accidents in earth work, and what are the best means of saving life in such cases?

7. How should life-saving committees bo organised before or during war? (1) What is the duty of the State; (2) What staff and materiel are required; (3) What are the means of preventing such abuses as have appeared in late wars; (4) The federation of committees.

8. What should be the organisation of the medical service on the battle field during and after action?

9. What are the best means of transport from the battle field:—(1) To flying ambulances; (2) To temporary fixed ambulances; and (3) To hospital and lazarets?

10. What are the best modes of construction, installation and management of tents and huts?

11. What care can be taken of corpses on the battle field:—(1) Means of preventing marauding and other abuses; (2) Means of preventing or delaying putrefaction; (3) Temporary and definitive burial; (4) Cremation; (5) Institution of auxiliary corps of the "Black Cross?"

12. Question of wounded or stray animals on battle fields.

13. What are the means of revictualling ambulances in war time? Requisitions, transports, gratuities, and rights and duties of convoys.

14. Organisation of information in armies during campaigns? Offices, registers of wounded and killed, correspondence with families and with prisoners, and depôts for property found on the battle field.

15. Prisoners of war, aid, transport, and internments; conveyance home.

Third Section.—Social Economy.

This section comprises institutions for improving the condition of the working classes.

1. To consider the conditions of private houses, with regard to morals and health, aspect, heating, ventilation, lighting, water supply, and drainage?

To seek the economic solution of the above in relation to houses for the working classes, the best types and the best mode of enabling workmen to become owners; and to compare the results of co-operative and limited liability societies, and private firms.

2. To what extent should instruction in gymnastics be introduced in primary and middle schools for girls and boys (1) in towns; (2) in the country?

3. To study the causes of the depopulation of country places, and seek means for remedying it? To ascertain the best method of combining the primary education of children and adults, with industrial instruction of girls and boys in the country and in towns.

4. Danger of the abuse of intoxicating drinks, and modes of prevention? Statistics relating thereto. Are legal regulations necessary, and, if so, to draw up a scheme of such law or regulation?

5. Examine the question of the labour of women and children in mines and factories. Is it necessary to regulate the conditions? If so, to draft a plan.

6. What is the organisation of bureaux of information for workmen and employers, masters and servants? What are the results obtained by these institutions, and what improvements might be introduced?

7. By what means may the provident spirit be developed amongst the working classes? What are the peculiar functions of savings banks, pension societies, life insurance companies, mutual aid societies, and co-operative associations? Examine the results of these various institutions.

8. What is the organisation of arbitrations established in England, and of the syndical chambers of employers and workmen existing in France and Belgium? What results have flowed from these institutions?

9. In what manner can aid be best given to liberated prisoners?

Subjects Proposed for Conferences.

1. To discuss the report of the River Pollution Commissioners in England with regard to the oxidation of contaminated waters.

2. What substances can be found to take the place of lead and arsenical compounds employed in manufactures?

3. Means of preventing danger from petroleum:—(1) in wholesale quantities; (2) in apparatus; or (3) as used for lighting.

4. The causes of boiler explosions, and the means of preventing them. To what authorities should boilers be submitted?

5. Medical regulations applicable to various occupations, for aid in case of accident. First thing to be done:—(1) in the case of burns of various degrees, and caused by different means; (2) in cases of asphyxia from divers causes.

6. Means of preventing accidents on railways and tramways. Prevention of accidents and maladies in the case of engineers, stokers, guards, and others.

7. How to render the materials of shipping, houses, theatres, and powder magazines incombustible.

8. Means of rendering textile fabrics, and particularly those used for scenery and firemen's dresses, incombustible.

9. The use of steam in extinguishing fires.

10. Means of preventing accidents:—(1) from poison in food; (2) from dangers caused by adulteration or corruption of food and drinks.

11. Organisation of eating and lodging-houses for workmen, without the introduction of the charitable element.

12. The moral and wholesome effect of the use of motors, adapted to small workshops and domestic purposes. The advantages, &c., of the sewing machine.

13. In what way does treatment affect animals as regards their temper, their health, and the work they perform.

M. Auguste Couvedar is the secretary of the Congress, and his address is 17, Rue de la Pépinière, Bruxelles.

CORRESPONDENCE.

THE ORDER OF ST. JOHN OF JERUSALEM.

Sir,—In the *Journal* of your Society for the 7th inst. is a very interesting article on the Brussels International Exhibition, which contains a reference to the revival in 1826 of the English branch of the Order of St. John of Jerusalem, where your correspondent states that "Sir Robert Peat, one of George IV.'s chaplains, with some of his friends, undertook to resuscitate it. This was done, not, it would appear, without some doubts on the part of the other 'langues' as to the propriety of recognising a Protestant branch of a Catholic Order, and since then the Knights of St. John of Jerusalem in England have pursued their career of usefulness with considerable success."

Will you permit me the opportunity to explain, 1. That the revival of the English branch of the Order was projected before Sir Robert Peat's name was allied with the intended revival. 2. That such revival, far from being carried out amidst the doubts of the other "langues," was projected and decreed by a Council of the Order assembled in Paris, representing five out of the seven then existing branches or "langues" of the Order, and thus acting with the weight of an overwhelming majority. 3. That another —the Roman—branch of the Order, claiming much representative authority, was made fully aware of the revival, and for a period of thirty years did not express any of those "doubts" which it suddenly became convenient to propagate. 4. That the terms of the revival provided for and recognised the religion of the Church of England, although several Roman Catholic members have been admitted. 5. That, as many Protestants in England and in Germany, as well as many of the Greek Church in Russia, were received into the Order of St. John prior to the dispersion consequent upon the capture of Malta, and as the Roman Catholic branches have since hailed a member of the Greek Church as Grand Master, there could be but little occasion for exception to be taken to the Protestant branch, long happily established in England, and striving to represent the Order worthily in works of which every member of the venerable fraternity ought to be thankfully proud.
—I am, &c., Edmund A. H. Lechmere,
Secretary of the Order of St. John of Jerusalem in England.

Chancery of the Order of St. John of Jerusalem in England, St. John's-gate, Clerkenwell, 17th July, 1876.

As has long been expected, the Patent Bill has been withdrawn, following the fate of its predecessor of last year.

GENERAL NOTES.

Olive Oil.—This oil, says the *English Mechanic*, has been made in Greece for years in a very primitive way, and the refuse from the rude screw presses was used for fuel or as manure. Although not actually wasted, the refuse was not fairly treated; and some one having discovered that it contained about 3 per cent. of pure oil, works were put up for extracting it by means of bisulphide of carbon. The machinery required involved the outlay of considerable capital; but the speculation has proved a comple success, a profit of about 25 per cent. being made annually. The oil is mainly used for the manufacture of fine soaps, nearly all the produce of the works being consigned to Marseilles.

Saving Life at Sea.—On Thursday, the 20th inst., a trial of life-saving appliances was made in the Channel from the *Castalia*. The principal invention tried was Mr. G. F. Parratt's "Deck-seat Life-raft." This is a tubular life-boat with three keels. The central cylinder is composed of metal, for the stowage of provisions, signals, and gear, while the outside cylinders are filled with cork shavings. Mr. Parratt claims for it that it can be compressed into a deck seat of 2½ or 3 feet wide, but when expanded the raft has a beam of 10 or 12 feet. When shut this raft serves as a deck seat. Besides this, a reversible life-boat was shown. This was the invention of Messrs. Anderson and Burkenshaw, of Bridlington, and was exhibited by Captain West. A number of life-saving dresses were also tested, and a berth capable of being formed into a small raft.

National Penny Bank, Limited.—Thirty branches of this penny bank are now in operation in London, and over £9,000 is the amount remaining in hand, though it is only nine months since the first branch was opened. Ten of these branches are open every evening from 6.30 to 9 p.m. The total number of accounts already opened is over 21,000, and the number of payments made more than 120,000. A promising branch was commenced on the 17th June, in High-street, Woolwich, owing to the interest taken in the movement by Mr. Paine. This gentleman has a large business in Woolwich, and was returned at the head of the poll at the last election for guardians of the poor. He is so convinced of the use and benefit which a penny bank will be in his district, that he has fitted up excellent premises, and formally handed them over to the National Penny Bank, besides himself supplying part of the staff necessary for carrying on the work until it has become a success. The bank is opened on Saturday and Monday in each week, and already £184 15s.2d. has been taken and 258 accounts opened. It is hoped employers of labour in all parts of London and suburbs may follow Mr. Paine's example. Communications should be made to the manager, Mr. G. C. T. Bartley, National Penny Bank, 270, Oxford-street, London. Application should also be made as above by those wishing to take some of the few shares in the bank which are not yet allotted.

NOTICES.

SUBSCRIPTIONS.

The Midsummer subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

HEALTH AND SEWAGE OF TOWNS.

The Report of the proceedings at the Conference on the Health and Sewage of Towns, held by the Society on May 9th, 10th, and 11th, has been published, and can be had on application at the Society's House. Price 2s. 6d.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,237. Vol. XXIV.

FRIDAY, AUGUST 4, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The second Sandwich Scholarship, recently founded by the inhabitants of the town and locality, has been awarded, after competition, to Miss Amy Emma Cooper. The Examiner was Dr. Longhurst, organist of Canterbury Cathedral.

GROSVENOR-HOUSE GALLERY.

The Duke of Westminster is desirous that designers, artisans, and the like, employed in any branch of art applied to productive industry, should have the opportunity of inspecting Grosvenor-house, with its works of Art, daily, including Sundays, during the months of August and September, 1876, from 2 p.m. to 6 p.m. He regrets that, for want of room, he cannot extend the admission beyond the persons specified.

The following manufacturers and others engaged in the production of decorative art, have consented to issue tickets of admission, according to the restriction which it has been necessary to lay down:—The Secretary of the Society of Arts, 18, John-street, Adelphi; the Secretary of the Working Men's Institute, 150, Strand, W.C.; the Secretary of the Artisans' Institute, 7, Upper St. Martin's-lane; Messrs. Crace and Son, 38, Wigmore-street, W.; Jackson and Graham, 38, Oxford-street, W.; Howard and Sons, 26, Berners-street, Oxford-street; Holland, 23, Mount-street; Trollope, Halkin-street West, S.W.; Gillows, 176, Oxford-street; Bantings, 26, St. James's-street, S.W.; Leonard Collman, 19, Mount-street; Goode, Gainsford, and Co., 167, Borough High-street; Hampton and Sons, 8, Pall-mall East; Morant, Boyd, and Co., 91, New Bond-street; Wilkinson and Son, 8, Old Bond-street; Cottier, 8, Pall-mall; Simpson and Sons, 456, Strand; Colnaghi, 13, Pall-mall East; Hogarth, 96, Mount-street; Graves, 6, Pall-mall; Morris and Company, 26, Queen-square, Bloomsbury, W.C. There will be no admission on wet afternoons.

CANTOR LECTURES.

The fourth lecture of the second course of Cantor Lectures for the past Session, on "Iron and Steel Manufacture," by Mr. W. Mattieu Williams, was delivered on Monday evening, February 7th, as follows:—

Lecture IV.

From what I have already stated you will easily perceive that the puddling process presents an interesting chemical problem.

The chemistry of the refinery is very simple. It is a matter of mere oxidation. The oxygen of the blast combines with the silicon, forming silicic acid, and with the carbon, producing carbonic oxide and carbonic acid. When the pig is rich in manganese that is oxidised also, and its oxide forms a fusible glass with the silicic acid.

For a long time mere superficial oxidation by the flames and air was regarded as a sufficient explanation of the puddling process also; the puddling furnace was described in many works as the "reverbatory finery," as distinguished from the open finery. So long as dry puddling was only used, this explanation might have stood, as the sulphur and phosphorus difficulties still remained but very partially solved.

Further study of the pig boiling process of puddling revealed the action of the fettling by the evolution of the jets of carbonic oxide so evidently rising from the bottom. Then internal oxidation came to the theoretical rescue, and the superior efficacy of puddling to refining was supposed to depend upon the oxygen combining with the sulphur and phosphorus, when brought thus in such direct contact with all the material by actually bubbling through it.

Assuming the correctness of this theory, Mr. Bessemer determined to carry out its principle directly and effectually by simply blowing atmospheric air through melted pig iron. He constructed a finery in which the air, instead of being blown merely over the surface of the melted pig, was poured in abundant streams through the bottom, and thus driven through the whole thickness of the melted metal. He thus succeeded in effecting a most vigorous oxidation, accompanied with a tremendous evolution of heat, but without the expected result. He produced iron free from carbon and silicon; he removed these effectually, and also the manganese; but the iron broke under the hammer, and between the rolls, could not be forged, and when cold was too brittle for the usual purposes of malleable iron. It was both hot short and cold short, the sulphur and phosphorus remained as in the pig.

In modern puddling, both of these are removed, and are found in the cinder, or fusible silicates, that are run from the tap-hole under the furnace-door, after the puddled balls are taken out. This was very puzzling, and rendered some further explanation necessary.

Dr. Percy has suggested that a "liquation," or sweating-out, of phosphide of iron may occur. He says that, "Owing to the formation and persistency of these pasty lumps in the puddling furnace, which, when collected into balls, extend considerably above the surface of the bath of

cinder, opportunity is afforded for the liquation or sweating-out of any fusible compounds of iron, such as the phosphide; and it is in this manner that I conceive the removal of the phosphorus may, in a great measure, be effected. The following fact, confirmed by the experiments of my friend, Mr. Abel, at the Royal Arsenal, Woolwich, would seem to favour this view. When pig iron, containing phosphorus in sensible quantity, is re-melted and cast, that portion of the metal which is solidified last will be found to be richer in phosphorus than the other portion of the casting."

I have devoted some attention to this subject, and offer the following as my own theory of the process of puddling:—

1st. That pure iron, itself practically infusible, becomes, when sufficiently heated, soluble in its own more fusible compounds, such as its silicides, carbides, phosphides, &c., and that pig iron is mainly composed of such a solution.

2nd. That the carbon and silicon are oxidised in the early stages of puddling, and thus the solvent is diminished, and the iron is precipitated as granules; but it is not yet pure, each granule being enveloped in fusible sulphide and phosphide, too small in quantity to effect solution of the iron, but adhering to it so firmly as to resist oxidation.

3rd. That when the iron is "coming to nature" the puddler washes this adhering film of sulphide and phosphide into the cinder, just as a laundress washes adhering greasy dirt from the solid fibres of linen, &c., into soapy or alkaline water, grease being diffusible in such water, as liquid sulphides and phosphides of iron are diffusible in the cinder. This diffusibility is proved by analysis of the cinder wherein the phosphides and sulphides are afterwards found, just as the dirt from the clothes is found in the soapy water that has been used by the laundress. The action of the squeezer, hammer, and rolls, in removing the still adhering portions of fusible cinder is thus strictly analogous to the "wringing" of the laundress.

Another analogy will further illustrate my meaning. Here is a specimen of crude paraffin scale, as obtained by the distillation of cannel coal or bituminous shale. This, as you will see, is very different in appearance and physical properties from this refined paraffin. The crude scale is soiled and greasy. It leaves a dirty film upon the fingers, while the refined paraffin is a beautiful, hard, pearly substance, that may be handled freely, and leaves no mark behind. Besides this, the melting points of the crude scale and the refined paraffin differ considerably, the scale being fusible at a much lower temperature than the refined paraffin, just as pig iron fuses at a lower temperature than finished iron. How, then, is this crude paraffin converted into refined paraffin? By a process curiously resembling puddling. It is fused in a bath of liquid hydrocarbon (like the liquid cinder bath of the puddler) and is then allowed to cool. On doing so "it comes to nature" like the iron, *i.e.*, granules of infusible paraffin separate gradually from the liquid paraffin oil. By agitation of these they are washed in the liquid, and the adhering and more fusible impurities are diffused through this liquid. The solid paraffin is now separated from the liquid by a straining process, like "balling up," and is then squeezed, just as the puddled balls are squeezed, only that the squeezing is done in bags and under hydraulic presses instead of steam hammers and rolls. By this means the fusible impurities are removed, and this beautiful substance, now so largely used in the manufacture of candles, is produced. The more frequently it is thus washed and squeezed, the purer, harder, and less easily fusible it becomes, its value being tested by its melting point and freedom from adhering greasiness or other impurities.

I have been led to this rather simple theory by carefully watching the work of a good puddler, and learning as much as possible from his unlettered wisdom, which I profoundly respect in spite of its crudity.

In the first place, when the iron is first melted, he gropes about the bottom of the furnace with his rabble. Why? In order to promote oxidation. Scraping away the film of fettling that has been reduced by the carbon and silicon of the pig, he exposes a fresh surface of oxide that shall similarly become reduced, by giving up some or all of its oxygen to oxidise the carbon and silicon of the melted pig. Thus he promotes the boiling, and when this is fairly started, the separation of granular iron commences. He now rabbles with increased energy, bringing fresh portions of melted pig in contact with the oxidising fettling, and washing the granules as they are formed, or "come to nature." The climax of his efforts is made when this coming to nature is maturing or about matured. If I am right, the reason for this is that, just when the granules are formed, and before they agglomerate into larger grains, the greatest surface is exposed to the washing action, and the efficiency of such washing is the greatest, and therefore his success depends largely upon violent agitation just at this stage of most effective washing.

When the iron is "dry," *i. e.*, deficient in silicon or silicates, he adds more hammer slag or cinder in order to obtain a good "bath," and the more liquid his cinder the better results he expects to obtain. Additional cinder is to him what rinsing water is to the laundress, and I have no doubt that if it were practicable to re-wash the ball in fresh silicates quite free from sulphur and phosphorus, the iron would be improved in quality.

I should add that the bath of cinder serves another purpose, viz., that of protecting the spongy iron from oxidation, and accordingly the puddler, when he has balled up and is waiting for the hammer, *i.e.*, while the first and second balls are being shingled, carefully covers the later balls with as much cinder as possible.

There is another device of the puddler which I had never seen explained in any published description of iron making, but which struck me as particularly interesting. When balling up, he not only lowers his dampers and piles fresh coal upon the fire, but he also places on the shelf or bracket below the firing hole a lump or lumps of coal, nearly filling up the opening. This, at first sight, appears a clumsy substitute for a door, and has thus been described, but, instead of this, it is really a very elegant device. The coal thus placed becomes heated, and the air entering the fire place must pass round it. On its way it meets the heated coal, and its oxygen goes to the carbon and forms carbonic oxide—a reducing agent, and, besides this, the coal is distilled, as in a gas retort, to hydro-

carbon gases and vapours. Thus, no active oxygen enters deeply into the furnace, and the ball, when placed near the bridge, is enveloped in a smoky lurid flame of reducing gases and particles of unburnt carbon. It is thus kept hot, but combustion of the iron, that would take place so readily in presence of free oxygen, is effectually prevented.

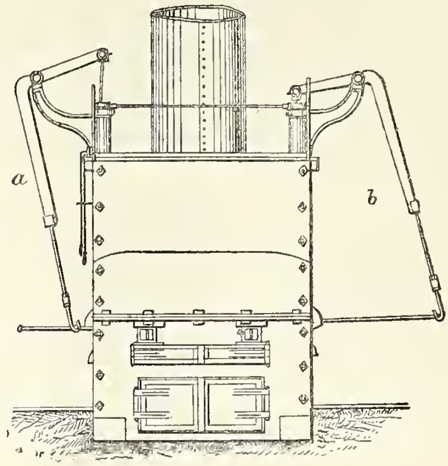
A Fellow of the Royal Society once came from London to the Black Country to teach the puddlers and other black-faced fellows the principles of combustion and economy of fuel. He pointed to the volumes of black smoke issuing from the stacks of puddling furnaces as evidence of the ignorance of these men, and their wasteful use of coal. The ignorance was in this case on his side, not on theirs; had he condescended to take lessons from puddlers on the subject of puddling, he would have learned that the dense smoke of which he complained is never seen when the puddler is using coal simply as a source of heat, but only when he requires just such a reducing agent as the smoky flame affords. In this case the puddler is learned in action, though ignorant in words. There is, however, a curious case, in which he and his fellow black-faced workmen display superior learning, even in this matter of mere words, to which expensively-educated people devote the best years of their grammar-school and college life. In all the treatises published before I pointed this out, a few years since, we may read of blast furnace "slags," of the slag from the puddling furnace, &c., the same thing being also called cinder occasionally. The workman perpetrates no such confusion of terms; he consistently applies the word cinder to all those silicates that drop, trickle, or run from any kind of furnace, in strict accordance with the derivation of the word from *sintern*, to trickle or drop; and with equal consistency he only speaks of "slag" as that portion of the silicates which are thumped out by the blows from the hammer, the word being derived from the Scandinavian "slag," or German "schlag," a thump or blow.

Many attempts have been made to supersede the work of the puddler by mechanical contrivances. They may be divided into two classes, those that merely aim at substituting steam power for the muscular labour of the puddler, leaving his intelligence still as a guide, and those which are intended to do all the work of puddling by mechanical devices.

As a typical example of the first class, I may select the "Joe Pickles" mechanical rabble, which has been used with some degree of success. It is shown in the diagram Fig. 12.

I should have mentioned already that puddling furnaces are sometimes made double, with a furnace and bed of double the usual width, and doors on opposite sides, from the stopper-holes of which a double set of men work in co-partnership. The Joe Pickles furnace is of this double construction, and acts, as the diagram shows, by means of the bell-crank levers *a* and *b*, which are directly worked by the pistons above. This effects a reciprocating movement of the rabble to and from the faces of the furnace, while a lateral movement is obtained by means of the brackets supporting the bell-cranks, these brackets being hinged where they are shown as attached to the small cylinders. Thus the puddler has only to guide the rabble and change it when necessary, the steam-power doing the hardest work. Many other similar devices for effecting similar movements of the rabble have been used with varying success.

Fig 12.



Dormoy's rotating rabble has a pulley-wheel attached to that part which is between the hand of the puddler and the furnace door; an endless band passes under this pulley, and the weight of the rabble resting upon it keeps it tight enough to actuate the rabble by friction. Overhead is a wheel, over the top edge of which the band passes. When this wheel turns, the band of course rotates the rabble in precisely the same manner as the mechanical hair brushes are worked. The rabble has an Archimedean screw-shaped blade that violently agitates the melted metal, the puddler merely guiding it. Looking at this device theoretically, and seeing it worked at Millwall, I was very hopeful of its success, as it aids the muscular efforts of the puddler, and yet leaves him such absolute control over the guidance of this freely suspended rabble; but I am told that it has failed. Mr. F. A. Paget has kindly sent me a list of fifty-nine places where these rabbles have been tried and abandoned. This looks very much like a hopeless failure, but I should not give it up as quite hopeless until it has been placed in the hands of a skilful, intelligent, practical puddler, with full liberty to make such alterations in the rabble or otherwise as he may see desirable, and a pecuniary interest in the royalties if he makes it succeed. I say this, because when I saw it at work, and asked the opinion of the puddler concerning it, he immediately pointed out a serious defect, viz., the great weight and clumsy shape of the working end of the rabble, which, as he justly stated, would, when rotating, destroy the furnace bottom. This practical hint was but little heeded by the projectors or proprietors of the patent, who seemed to regard the puddling process as a mere matter of splashing and oxidation. The workman, upon whom the success or failure of such an apparatus entirely depends, being merely treated as a machine for the use of projectors and patentees, naturally regards their inventions as rivals to himself, introduced for the purpose of superseding his labour and lowering his wages, and therefore is not

likely to exert himself to secure their success. If he were treated more respectfully, and had some beneficial interest in the working of such an invention, its success might be very different. Without this, failure is a simple matter of course.

Perrot's rotating bowl was merely a device for splashing the metal upwards into the flame, and exposing a greater surface to oxidation. It is based on the theory that puddling is all effected by oxidation, and mainly by the superficial oxidation of the flame and air. It failed, as may be supposed.

Another device for agitating the melted metal is the introduction of a steam jet below its surface. This has failed.

The second class of puddling machines are those which are intended to do all the work mechanically, except the mere charging and drawing. In the most important of these it is not the rabble but the furnace itself that rotates. They nearly resemble washing machines.

Walker's patent for a rotatory puddling furnace was secured in 1853. His invention consisted of a drum-shaped furnace, the axis of rotation of which was oblique to the axis of the drum, and hence the metal was dashed from one end to the other, as well as rolled over by the rotation. The flame from the fire entered this chamber at one end and passed out at the other.

Tooth and Yates' patent, 1859, was for a similar contrivance without the obliquity—a drum-shaped furnace chamber rotating on friction rollers. This was worked at Dowlais by Mr. W. Menelaus, but failed on account of the instability of the lining, which wore away and mixed with the iron. The lining was of ganister, fire-clay, hard cinder, and red ore mixed. The mischief was done chiefly by the granular iron, the action at that stage being both mechanical and chemical.

Dank's rotatory furnace is an American modification of this, with improvement of details, the drum about five feet diameter, and four feet long inside. The lining is first a layer of lime and powdered ore, made into a thick paste and laid as a basis. Then the furnace is heated, and powdered ore is thrown in while the furnace slowly revolves. By the fusion of this the initial lining is glased, and a pool of melted ore rests on the lower side. Lumps of ore large enough to project from three to six inches above this are now thrown in and left to set. Then fresh ore is added and fused, and a fresh pool formed, which is treated in like manner till the chamber is fettled all round with a rough broken surface. By this means a fairly durable lining is obtained. It requires continual renewal or refettling, but provided the basis stands, this is no disadvantage, such renewal of fettling with oxides of iron being, as already explained, an essential element of the puddling process. In this lining Mr. Danks made an important step in advance of his predecessors.

The charge is about 10 cwt. This is melted in 30 or 40 minutes, with very slow rotation, merely for stirring the pigs. When all is melted the rate is increased to one or two rotations per minute, and a stream of water injected through the stopper-hole upon the edge of the descending side, in order to solidify some of the descending cinder.

When the iron comes to nature, the engines are stopped, and the heat is raised to liquefy the cinder, which is then run out. After this the rotations are raised to six or eight per minute. This dashes the granular iron about, and partly welds it together; then a slower rotation rolls the iron together into a ball, or rather cylinder.

The swinging neck, or head-piece, forming the flue connecting the furnace with its stack, is now removed, throwing open the flue end of the drum. From this the ball or cylinder of spongy iron is removed by means of a large fork, worked by an overhead crane, and it is transferred to a specially constructed rotatory squeezer.

The sanguine expectations that were raised in this country by the report of Messrs. Snelus, J. A. Jones, and Lester, who were deputed as a special commission to investigate the action of this furnace in America, have not been confirmed by subsequent results, furnaces having been erected at great expense in several places, and afterwards abandoned. What I have seen of their working has been by no means satisfactory. The wear and tear is seriously great, involving frequent stoppages and costly repairs, and the iron produced was not clean but "cindery," *i.e.*, a mischievous quantity of silicates still remained entangled within it, even after rolling into plates. This renders the iron irregular in quality.

The Spencer and the Seller's furnace are other modifications of the rotatory principle. The most important further step in this direction is that made in Mr. Crampton's rotatory dust fuel furnace.

This is a large rotating drum, 6ft. 8in. outside diameter, and same length. It turns on rollers, and is capable of moving at any rate up to 15 revolutions per minute. The moveable flue-piece turns down. One of the most important features of the construction of this furnace is the water casing which surrounds it, keeping down the temperature of the outside and thus retaining the solidity of the initial lining, and also cooling the bearings at the revolving faces, otherwise subject to very costly wear and tear.

Besides this improvement in construction, there is another in the means of applying the heat. Coal is ground to a fine dust by means of millstones (ordinary slack or screenings may be used for this), then sifted through meshes of 2,500 to square inch. This is delivered to an agitating chamber by means of an Archimedian screw, where it is mingled with air by the action of a rotatory stirrer, and forced onward by air pressure through an injecting pipe, which blows it directly into the drum where it burns like gas, exactly where the heat is required. By regulating the quantity of air to that of the coal dust, a reducing "neutral" or oxidising flame may be produced, and the quantity of fuel regulated in all respects by the mere turning of cocks.

The fettling consists essentially of molten iron ore, which may either lie directly on the bare iron of the drum, which is cooled by the water casing, or upon a thin foundation layer of fire bricks or bricks made of oxide of iron. The fettling is allowed to set in pools, thus giving the interior of the drum a pentagonal section, which favours agitation.

The refettling is done in sections, one of these pools being renewed at each heat, and the furnace thus relined throughout once in every five heats.

The charge is from 8 to 10 cwt. of pig, which is melted by injection of the dust fuel with full supply of air. The rotation and balling is managed nearly the same as in Danks's, but Mr. Crampton does not rely upon squeezing; he maintains the necessity of hammering to remove impurities.

There can be little doubt that Mr. Crampton has overcome the difficulty of the costly wear and tear of the other revolving puddling furnaces, and by means of the dust fuel has complete control over the temperature and chemical action of the source of heat; but to what extent he has practically overcome the other weak point of pure mechanical puddling, viz., the absence of the modifying or "humouring" of the process which depends upon the intelligence and "feel" of the puddler, I am not able to say. This feeling of the work is very important in the balling up, as upon it the initial squeezing out of the great bulk of the cinder depends. The small size of the ordinary puddle ball renders this separation easier than from the large single cylindrical ball six or eight times heavier than the ball of the puddler.

The advocates of mechanical puddling contend that this large ball is advantageous, by giving superior homogeneity to the iron. This is doubtless correct, providing the rinsing out of the entangled cinder can be as effectively done in the large ball. I am far from asserting the impossibility of this, but do regard it as a serious difficulty, and one that must be fairly faced. Success in overcoming it must be tested by average quality of make, rather than by small selected specimens.

We may safely anticipate extensive and important applications of the dust fuel, over and above its use in rotatory puddling furnaces. At first sight it appears liable to do mischief by the deposition of some of the dust in the furnace, but when we take into consideration the smallness of the particles of the original coal, small enough to be suspended freely in the injected air, that their combustion is remarkably complete on account of the envelopment of each particle in air, and that with such complete combustion only two to four per cent. of ash remains, the lightness of this ash renders its removal with the gaseous products of combustion a very simple problem.

A great deal has been said about the yield of these rotatory furnaces; the quantity of finished iron turned out exceeding that of the pig iron charged into them; but there is no conjuring in this. The ordinary puddler can do the same if he chooses, and he would always choose to do so if it were worth his while, *i.e.*, if he were paid a premium upon an extra yield. As it is, he would lose wages by gaining iron, although he is paid at a fixed rate per ton of iron turned out.

This may appear contradictory, and it is not at all understood by iron-masters, though it is by puddlers, as I have learned by discussing the subject fully and patiently with them in their own language.

The extra yield is obtained by the use of additional fettling, and if this fettling is of good quality—such as hæmatite—the quality as well as the quantity of the iron is improved. The increase is due to the reduction of the ore by the carbon and silicon of the pig. By skilfully availing himself of this, the puddler can turn out $4\frac{1}{2}$ cwt. of puddled bar from $4\frac{1}{4}$ cwt. of pig instead of the customary yield of only 4 cwt. Thus, he will gain one-eighth more wages on each heat than if he worked as usual. But what will this one-eighth cost him? To get it, he must add large quantities of fettling, cool down his furnace considerably while doing so, and afterwards must work more slowly, thus making about five heats in the time for six.

How stands his Dr. and Cr. of wages in this case? Simply, that he gains one-eighth by losing one-sixth. Ignorant as he is, he knows sufficient arithmetic to understand this, has understood it, and worked accordingly, for about half a century, as nearly as I can learn, but his master has not yet discovered it, although it so materially affects his interest.

I dwell upon this, as it is one of many interesting lessons that I have learned by becoming a puddler's pupil, and I think it is worth the consideration of employers whether they should offer their puddlers a premium for extra yield, by paying double or treble tonnage on all above the customary yield of 4 cwt. upon a $4\frac{1}{4}$ charge. I believe they would gain thereby, as they would thus be making a considerable quantity of finished iron, of superior quality, directly from the ore in the puddling furnace.

As puddling is essentially a chemical process, it is rather surprising that the conversion of pig iron into malleable iron has not been effected by simple chemical agency, *i.e.*, by the unaided action of chemical reagents, but such is the case. At present, practically and commercially speaking, we may say that the modern chemist, with all his molecules, has been beaten on this ground by the unlettered puddler, not because the chemist has made no attempt to supersede the puddler, but in spite of many such.

The only purely chemical process, as far as I have learned, that has to any extent practically solved this problem, is that of Mr. James Henderson. I have seen him make excellent malleable iron in a puddling furnace without the aid of the rabble, by spreading on the bottom of the furnace chamber a layer of loose dry dust composed of powdered fluoride of calcium mixed with some oxide of iron, such as hæmatite, ilmenite, &c. (He tells me that any other oxide will do, but the above were those used in the experiments I made and witnessed.) The pig is thrown in upon this powder, some pieces of wood being previously laid over it to prevent the dispersion of the powder by the pigs. When the pigs are melted, a violent agitation is produced by the gases evolved by decomposition of the fluoride and oxide. The conditions of the evolution of these gases are such that the quantity gradually increases up to the time of the complete granulation of the iron; thus, there is the usual boiling, with an unusual and increasing degree of agitation, which reaches its maximum just when the puddler works his rabble most energetically, and appears to do the work of the rabble. The effervescence is so violent that the gruelly mixture pours over the stopper-hole in considerable quantity. Finally, the agitation partially subsides, and the iron settles down on the bottom of the furnace covered with a bath of liquid cinder. The iron is so compact, that its removal is a matter of some difficulty when thus left untouched until finished. An evolution of gases continues even after the iron

leaves the furnace; they jet out while the ball is under the hammer.

Excellent iron was thus produced, but complaint was made of the yield. Whether this arose from the overflow or otherwise I cannot tell, nor whether the value of the cinder—which is very probable—may have increased sufficiently to cover the loss. This is worthy of further investigation, and this process should be worked in a specially constructed furnace of greater depth than a puddling furnace.

A multitude of oxidising agents have been used for the refining of pig iron, all in fact that are obtainable, and some so expensive that the idea of their practical application was ridiculous. Mr. Heaton's process may be taken as a typical example of the most promising. He poured melted pig upon a perforated cast iron plate which rested on a bed of nitrate of soda. A brilliant pyrotechnic display immediately followed, the plate was rapidly melted, violent oxidation of the carbon and silica occurred, the silica acid combining with the liberated soda, and forming a very liquid and fusible glass, probably of some commercial value.

I examined the working of this process at Langley Mills, analysed the results, and found that the silicon was sufficiently removed, considering that my samples had not been shingled, that varying proportions of the carbon were also oxidised, and all that remained was combined, though a grey pig was used. The sulphur and phosphorus were partially, but not entirely, removed. The result was an impure steel of irregular composition.

The defect of the process, as it appeared to me, was its extreme rapidity; the action was explosive, not allowing sufficient time for effecting the required changes. As far as the work was done it was in the right direction, but did not go far enough. I saw sufficient at Langley Mills, and in the course of other experiments, to satisfy me that if nitrate of soda can be procured cheaply in large quantities, it may be used with great advantage in the purification of iron, not merely by its oxidising agency, but by this in combination with the detergent properties of the alkaline glass which the soda forms with the silica; a cinder which, with a little management, may, I have no doubt, be made an important source of profit as a bye product.

But the experiments necessary for carrying out such a project must of necessity be very expensive, and I recommend nobody to attempt them unless he is supplied with abundant means. Mr. Heaton failed mainly for want of these, although I believe a good deal was expended. Others have failed in like manner, and many have been ruined.

It is a serious misfortune for any man—not a millionaire—to make any invention in connection with the manufacture of iron. If his invention is a very stupid one, he may escape with but little loss, as he will not be encouraged to proceed with it; but if it is at all promising and valuable, it will probably ruin him.

Before leaving this part of the subject, I must say a few words about puddler's "physic." This is mighty mystery. Forge managers and foremen commonly have some secret of this kind. A big oaken box, with ponderous hinges and padlock, is often to be seen, and is the abode of the great arcana. It is the "physic box." The physic is usually applied by wrapping it in a paper packet, and casting it, like the incantation materials of "Macbeth's" witches, into the melted metal.

I have been quite bored with surreptitiously-obtained samples of such physic, brought to me for analysis, and have examined several of them. They all consisted of common salt, mixed, in some cases, with a little washing soda, and more or less disguised with garden mould, iron scales, or other rubbish.

There is little doubt that chlorides do act beneficially on some kinds of iron, but the absurd mystery of their nse has kept us in ignorance of their real value. When the iron trade shall rise to the dignity of instituting a national technological laboratory of its own, the true action and value of puddler's physic should be one of its first subjects for investigation. In order that this, or any other subject, may be fairly studied, the investigator must own no patent, nor have any kind of interest in the success of any particular process, physic, or device. Hitherto, experimental investigations in the chemistry of ironmaking have, for the most part, been made only by inventors, who are already committed to a particular project, and, therefore, naturally work for the demonstration of its importance, or for its special improvement only, and thus have conducted no broad, impartial investigations. Mr. Lowthian Bell's admirable studies of the action of the blast furnace, and a few other similar public-spirited investigations, must, however, be excepted.

MISCELLANEOUS.

HOUSE-DRAINS.

The following article is taken from the *Lancet*, of July 29th:—

A deputation from the Society of Arts introduced a memorial on the subject of house-drainage, on the 21st inst., to the notice of the Metropolitan Board of Works. The memorial pointed out that, although considerable powers have been conferred on local authorities with regard to the enforcing the proper construction and due maintenance of all house-drains, pipes, and connections, yet in practice such powers are not sufficiently carried out at the present time, and required to be amended and enlarged. The memorialists therefore urge that an amending Act of Parliament he passed as soon as possible, to secure that all house-drains connected with public sewers in the metropolis, and towns having an urban authority, should be placed under the inspection and control of local sanitary authorities. Sir Henry Cole pointed out that, with respect to houses built before the Metropolitan Management Act of 1855, it had been found that the powers conferred by that Act were inoperative, and that the vestries could not intervene. Sir Henry instanced the case of some houses in Kensington which were never free from typhoid and scarlet fever. The question is a very important one, and we think that many houses of Marylebone, St. Pancras and other old London parishes would he very much astonished, if any inquiry were made into the condition of their house-drains, to find over what pestilential sewers they had been living. We believe there is no exaggeration in saying that the house drainage of nearly two-thirds of the houses in the old London parishes is defective. The drains, originally constructed of brick, through age and the undermining activity of the rats, have become extensively pervious, and the domestic

sewage passes out freely into the basements, and but a small proportion reaches the sewers. There can be no doubt that such elongated cesspits ought at once to be swept away, and earthenware pipe-drains substituted. We would suggest, in addition to the proposal to submit the plans of house-drains and connections to the local authorities, that power should be given for the authorities to appoint an inspector to see that all such sanitary work was properly carried out out. A case which came under our notice the other day shows the necessity of such an officer. A gentleman took a large house in a fashionable street, which was stated to be well drained, as the previous tenant had removed the old house-drains and laid down pipe-drains. Notwithstanding, a disagreeable smell was constantly experienced in the house. In vain were the water-closets ventilated, and the stable drainage, which was suspected, isolated by the introduction of concrete walls; still the smell remained. At last a spot of suspicious dampness over one of the flags of the basement offices attracted attention, and it was then found that the workmen who had laid down the pipe-drainage had been content simply to lay the pipes in juxtaposition without cementing them together; consequently the house-sewage was finding its way freely out under the basement offices. Had it been compulsory on the contractor to have had his work passed by an official surveyor before it was covered over, such a piece of "scamping" would have been detected, and much annoyance, expense, and probably ill-health, prevented.

THE SPECIAL LOAN COLLECTION AT THE SOUTH KENSINGTON MUSEUM.

Electricity.

There are few, if any, sciences that have made such marked rapid progress within the last few years as that of electricity, not simply in a scientific point of view, but also as regards their utilisation in the manufactures and commerce of the country; take for instance, the very extended scale on which electro-metallurgy is at the present day employed in a variety of industries and manufactures, a science that a few years ago was hardly known, while the rapidity with which the system of telegraphy has been extended and brought into general use all over the globe, whether by submarine cables or the vast network of land lines met with in every direction, is perhaps even still more marked. In fact, such a recognised important part does the telegraph now exercise in all commercial pursuits, that by its introduction the very system in which formerly much commercial business was carried on has been changed, and probably there are now few people who would be desirous of returning to the slow going ways in use but a few years ago previous to the introduction of telegraphy.

As illustrative of this rapid progress in the application of electricity, the collection of electrical apparatus and instruments at the Loan Exhibition at South Kensington stands prominent, and although it can hardly be said that among the collection there is anything very remarkable for novelty, yet the collection, including as it does the various apparatus and instruments that have been in use from the introduction of telegraphy up to the present date, can hardly fail to prove interesting and instructive to those who are possessed of a knowledge of the subject. It is to be remarked that the more modern instruments are, for delicacy of action and finish, far in advance of such as were used in the earlier days, but still in very many instances, with the exception of a superiority of construction, they are very slight modifications of some of the first instruments used for telegraphic signalling.

In the special collection lent by the Post-office, illustrating the history of electric telegraphy in England, are a number of the earlier forms of instruments, including those of Cooke and Wheatstone, and as to the ingenuity of these two gentlemen we are indebted for the introduction of the first telegraph in anything like a practicable form, as far as the public generally are concerned, their original old five-needle instrument (1837) as tried on the London and Birmingham, and Great Western Railways, marking as it does the first step towards the establishment of the electric telegraph in England, is deserving of notice. With this instrument five-line wires, embedded in grooves cut in triangular pieces of wood laid underground were used, the circuit being completed by a sixth wire; the letters of the alphabet were marked on a triangular dial, the desired letter being indicated by the deflections of two of the needles. This instrument, after a fair trial, was found in practice too expensive, and so in a short time was given up.

About this date Steinheil, while experimenting on the Nürnberg and Fürth Railway, in endeavouring to make use of the rails for his return circuit, made the important discovery that the earth could be employed in the place of a second wire for completing the circuit of a voltaic current, a discovery of the greatest importance in the progress of telegraphy, and one that has since been made use of in all subsequent systems, although in the earlier attempts and experiments with frictional electricity the earth had already been utilised for the return circuit.

The practicability of the telegraph having once been established, it was not long before numerous improvements were introduced, as is demonstrated very forcibly by the numerous exhibits of some of the principal instruments that were used by many of the old telegraph companies. To look back at Henley's "Thunder-pump," as it was called, used for ringing alarums, &c., one of the earliest adaptations, and perhaps the simplest possible form of a magneto-electric machine, who would have imagined that it would ever have been developed into the present compact A. B. C. instrument, now well known from its being used on most of the private lines, an instrument worked on precisely the same principle, viz., magneto-electric induction?

It would not do to pass over the various exhibits of the Post-office without saying a few words on the Wheatstone automatic system, as it was, to some extent, from the high speed of working obtained by means of this system, that the Post-office, on taking the telegraphs under their control, were enabled to carry out in so satisfactory a manner the great increase of work resulting from the facilities then offered to the public, by the reduced tariff for telegraph communication, besides that resulting from the extension of the telegraph system. The Wheatstone automatic apparatus—to some extent a modification of Bain's system, although not like it an electro-chemical instrument—consists of three instruments; the automatic puncher, by which the messages, represented by series of perforations, are punched in a paper ribbon; the automatic transmitter, for transmitting the messages by contacts regulated by these perforations; and the receiving instrument, a sensitive direct ink-writing instrument. The puncher has three small keys, placed side by side; these keys are made to act upon the valves of three small vertical cylinders fitted with pistons, the rods of which protrude through the bottom of the cylinders, terminating in small punches; so that, on depressing any one of the keys, compressed air, with which the cylinders are worked, is admitted, the piston descends, and a hole is punched in a ribbon of paper that is made to traverse below these punches; the punches are arranged side by side across the paper. The two outside keys are for making the perforations which form the letters, the middle one for spacing, whilst at the same time it forms a central row of holes, by which the paper is drawn through the transmitter; by the action of the punch, on rising after having perforated the paper, the required movement to the paper ribbon is given, so that it is shifted automatically into the proper position for receiving the next hole.

The automatic transmitter that transmits the currents forming the letters to the line, by an arrangement of clockwork draws the paper ribbon through the instrument. There are two small vertical pins placed transversely to the paper, and to these, by a rocking piece in connection with the clockwork, a continued uniform up and down movement is communicated; on either of the pins passing through the perforations in the paper, or being prevented by the absence of a hole from doing so, the required contacts are made, or rather they control a series of reversals that would otherwise pass out to lines were there no paper in the instrument. The great difference between this instrument and Bain's transmitter, besides many others of early date, is that the contacts are not made through the paper, but mechanically, the action of the pins passing through the paper being simply that of controlling the contacts.

The receiving instrument, as already stated, is simply a sensitive direct ink writer. By this instrument the signals are received and printed in the Morse alphabet on paper slip in the ordinary manner; the instrument is fitted with an arrangement by which the speed of the instrument can be regulated to suit that of the signals.

Although Sir Charles Wheatstone is deserving of every credit for the very ingenious and skilful manner in which he has perfected his system, still it is a curious fact that, with but slight mechanical alterations of the Bain's chemical telegraph, which was the first form of recording instrument used in England (1846), not only the same high rate of speed, but even greater can be obtained, and with far less complicated mechanism, than employed in the Wheatstone.

Probably one of the great drawbacks and reasons for the abandonment of the Bain in favour of the Morse was the inconvenience in having to keep the chemically prepared paper slip in a proper state of moisture and sensibility; it must not be lost sight of, that the requirements of the telegraph had not then reached their present gigantic dimensions, and that the rate obtained by hand manipulation would therefore then have probably been quite sufficient to meet all practical purposes, besides the advantages in doing away with the chemically prepared paper, and many other mechanical details.

The Morse being then so far superior to the Bain, it is not to be wondered that the former was gradually improved whilst the Bain got thrown on one side; although when great speed became necessary, why attention should have been directed to the scheming of the many ingenious devices for reducing the loss of time that naturally occurred in de-magnetising the coils of the electro-magnets as well as reducing the inertia of the moving parts to a minimum, instead of endeavouring to bring the principal of the Bain system, a system in which the current had simply to decompose the salt on the paper, no magnets to demagnetise, and no inertia to overcome, into a more practicable form, it is difficult to say. On its introduction, the advantages to be derived from an electro-chemical system were certainly not fully appreciated, although latterly the Post-office electricians appear to have become aware of the gain that might be obtainable under certain circumstances by employing some modifications of the Bain system, and are now working some of the Post-office circuits on this principle; with what result it would be premature to say, yet it would not be at all surprising to find, with our present knowledge of electricity, that, before many years have elapsed, the electro-chemical system should have supplanted in a great measure the Wheatstone, thus eventually returning to the principle of the first recording instrument used in this country.

While looking at the exhibits of the early forms of electric instruments used in train signalling, viz., Cooke's first block instrument, used on the line between Norwich and Yarmouth about 1845, by which the signals were formed by a single needle deflected to either the right or left, the step by step train indicator used on the London and South-Western Railway, and a similar instrument used on the South-Eastern, not forgetting the signalling instrument used for starting and stopping the endless rope by which the old Blackwall Railway was first worked about the year 1840—one can hardly help remarking that one of the very first applications of telegraphy was to train signalling, and that even then, in those early days of telegraphy, when our railway traffic had not reached anything like its present dimensions, and when trains were not run at such frequent intervals as is now the case, the advantages to be derived from working a block system in connection with our railway traffic seem to have been fully appreciated.

There are, however, but few exhibits of the more modern forms of block and train signalling instruments; and, when we recollect the variety of systems in use, with the ingenuity displayed in the scheming and construction of many of these instruments, the object of which are to reduce railway accidents to a minimum—for the most perfect system is not infallible—it is an omission to be regretted, as probably the public in general are hardly aware to what a great extent they are indebted to the development of telegraph engineering, and the important part that electricity has taken in the safe working of almost all our railway traffic.

Various forms of low tension electric fuses are exhibited, including the form of fuse used in removing the wreck of the *Royal George*, Spithead, 1839. These consist, generally speaking, as in the earliest forms, of a fine platinum wire, suitably arranged and surrounded with either gunpowder or some other explosive compound, so that, on a current of electricity being sent through the fine platinum wire, the wire becomes red, or even white hot, ignites the gunpowder surrounding it, and so fires the charge in which the fuse has been placed.

The War-office contributes a very interesting series of specimens, illustrating the development of the application of electricity to the explosion of mines, guns, &c., dating from the old original form of wire fuse in use about the year 1839, to those employed at the present day in the service of the Royal Engineers.

Among the special collections of apparatus, some of the original apparatus of Faraday are well deserving of notice, as by their aid a number of his experimental researches into magneto-electric induction were made, and when we remember that to him are due the discoveries of volta-electric induction and magneto-electricity, discoveries that have since played such an important part in the development of the electric telegraph, they cannot fail to be of interest. Notably, the original apparatus with which he obtained the magneto-electric spark, 1831. This consists of simply a soft iron ring about six inches in diameter; the ring is covered by two insulated copper wire helices, the extremities of which are separated by about half inch of the uncovered iron ring; with this he found that on passing a current through one helix a current was induced in the other each time the battery circuit was either completed or broken, and at the same time a small spark was seen between the two carbon terminals that were attached to ends of the wire of the helix in which the current was induced. Faraday's original apparatus for magneto-electric induction by a permanent magnet is another exhibit, the discovery that on a permanent magnet being introduced into a helix of insulated wire a current would be induced in the wire of the helix each time the magnet was introduced or withdrawn, being made by him in 1831.

Not without interest are a number of electrometers exhibited by Sir W. Thomson, whilst amongst these stands prominently forward his quadrant electrometer, one of the most delicate instruments that has yet been constructed for the measurement of electric potential. The general principle on which this instrument is based, is that when a light easily moveable conducting body is charged with electricity and suspended between two conducting systems, the difference of electric potential between these two systems will cause a deflection of the suspended body, the direction of this deflection denoting

the kind of this difference, whilst the amount of difference of potential between these systems will be indicated by the extent of the deflection. The instrument, as at present constructed—although a variety of forms were made, many of which are exhibited, prior to its being brought to its present state of perfection—consists of a cylindrical Leyden jar of glass, encased in a brass frame; the jar is fitted with a brass cover, to which is attached the mechanism of the instrument; below the cover are placed the four brass quadrants, from which the instrument derives its name; to each of the quadrants is fixed a glass rod by which means they are separately attached to the cover and insulated. The opposite quadrants are connected by means of a wire, so as to form two separate conductors; suitable adjustment is provided for their regulation in the desired position. Beneath the quadrants is suspended a flat aluminum needle, fixed to an axis of platinum wire, the wire projecting to nearly the bottom of the jar; the wire and needle are supported by means of a bifilar suspension passing through the cover to which they are attached. On the end of the wire, which projects above the cover and immediately below the point of suspension, is cemented a small mirror, from which when the instrument is at work a beam of light from a lamp placed at a short distance is reflected upon a graduated scale, in a similar manner as is done with ordinary reflecting galvanometers, so that the slightest deflection of the needle will be clearly indicated on a scale usually placed at between three and four feet distance from it.

The jar is partially filled with sulphuric acid, by which means, from its power of absorbing moisture, the air and various parts of the instrument are kept perfectly dry; at the same time, by aid of the platinum wire, which dips into the acid, the aluminium needle is always kept in the same electrified state as the interior of the jar. The charge of the jar is adjusted to a constant potential by means of the replenisher, a small instrument acting on the principle of static induction, so that by the simple turn of a small milled head that projects above the cover of the jar, the charge can either be replenished or diminished at will. The instrument is supplied with a very pretty arrangement and index for enabling the observer to determine when the charge in the jar has passed or fallen below a required standard. Each pair of quadrants is connected to an electrode that passes through the cover, terminating in a small binding screw; both the electrodes and the quadrants being perfectly insulated from the rest of the electrometer. For increasing the sensibility of the instrument an induction plate of sheet brass is fixed a small distance above one of the quadrants.

Now, supposing, after charging the jar and suitable adjustment of these quadrants and aluminium needle, &c., a difference of potential between each pair of quadrants be established, a field of electric force will be set up which will therefore cause the needle charged by means of the platinum wire to the potential of the jar to be deflected and take up a new position, and as at the same time the mirror which is attached to it will also be deflected, the ray of light thrown upon the scale will have moved a proportionate distance, and the number of divisions of the scale through which the ray of light has moved will consequently measure the difference of potential between the quadrants. The instrument, as at present constructed, is very sensitive, and by the aid of it very small differences of potential may be measured. For testing the insulation of submarine cables, it has been most successfully employed, as well also as for the continuous test during manufacture, as by aid of it the rate of loss of potential in the cable can at once be determined. It is quite unnecessary to mention the numerous uses to which the electrometer may be employed, embracing as it does the whole range of electric science; for meteorological observations it is unequalled, whilst in electrical research its advantages are fully recognised.

As Sir W. Thomson has also exhibited a number of his instruments both for testing and signalling, it is to be regretted that his "siphon recorder"—an instrument that stands alone as being the only one that has been successfully used as a recording instrument on long telegraph cables—was not included amongst his exhibits. Conspicuous, therefore by its absence, perhaps a brief description of its action may not be deemed out of place.

The instrument consists of a light coil of fine insulated wire, delicately suspended between the two poles of a powerful electro-magnet, so as to be free to move on a vertical axis. On a current from the cable being made to pass through the coil, hanging as it does in a strong magnetic field, it will be deflected either to the right or left, in accordance with the current being either + or —. To the coil is attached by a fine silk fibre a delicate glass siphon, suitably suspended in front of the coil, one end of which is made to dip into a reservoir of ink, the other being slightly bent so as to nearly touch a slip of Morse paper that is made to traverse in front of it, on which slip the signals are recorded; when the coil is at rest, if the paper be moved, a straight line would be marked on the slip, but on a current being passed from the cable into the coil, which is in direct communication with it, the line will be made to deviate to either one side or the other by the movement of the coil to which the siphon is attached; from this it is easy to conceive how these deviations may be utilised for signalling the Morse alphabet, the deviations marked above the line representing the dots, while those below the dashes. In order to prevent any friction between the point of the siphon and the paper slip, the instrument being so delicately constructed that this would retard its action, whilst at the same time to ensure the flow of ink through so small a tube as is used for the siphon, the ink is electrified by static electricity; this causes the ink to spurt out on the paper, while it prevents the siphon from actually touching it. An instrument called the mouse mill placed on the top of the apparatus is used to electrify the ink; it is simply an electro-static induction machine, driven by a small electro-magnetic arrangement. The power required for moving the paper slip is also derived from the same source.

The recorder is very sensitive in its action, it can be employed in almost all cases where the mirror instrument is used, and, as it can be worked with weak currents, proves, to a certain extent, a useful instrument on long telegraph cables. Still, it must not be lost sight of that, from the very fact of its delicacy, it requires a great amount of attention and careful adjustment in actual work, and the drawback and expense in maintaining the large local batteries required for the electro-magnets, and electric engine, must not be overlooked.

Among the various batteries exhibited, there are many well adapted for the particular purposes for which they have been designed, whether for research, telegraphy, the lecture-room, or medical use, yet, as has already been pointed out in the Handbook to the Special Loan Exhibition in the notice on electricity, none since Daniel in 1836, showed how to make constant batteries, are of a fundamental kind. However, in speaking of the subject of batteries the thermo-electric generator of Clamont must be noticed. To Lubeck is due the discovery of thermo-electricity, since which date the subject has been investigated by a number of distinguished physicists, amongst these Becquerel, whose minute researches into the laws of thermo-electric currents, although not resulting in bringing the thermo-pile into a form of practical utility, are not the less deserving of recognition. Mr. Farmer was the first who constructed a thermo-pile of any practical value; it was exhibited in the Exhibition of 1867, the apparatus gaining considerable notoriety; it was, however, defective, for besides there being a difficulty in construction, from the bars breaking in cooling after casting, its action was not sufficiently constant for general requirements.

In May, 1860, M. Clamont, in conjunction with M.

Mure, brought their first pile, the couples consisting of galena and iron, before the Institute in France, since which date, after having undergone a number of modifications and improvements, has resulted in the Clamont thermo-electric generator, a battery that has latterly been introduced to a very considerable extent in some of the largest electro-plating houses, as well as for telegraphic and other purposes. In the present form of battery, the galena used in the earlier batteries is replaced by an alloy of zinc and antimony, this having been chosen as being a good conductor of electricity. Thermo-electric bars or couples, formed of this alloy and iron, are joined up as radii of a circle, in the centre of which is placed the gas burner, or some other suitable means of heating. Series of these couples, usually consisting of ten, are insulated from each other by means of asbestos rings, forming a cylinder, the interior of which is also luted with asbestos. In the centre of this cylinder is a clay or porcelain tube, pierced with holes, through which the gas and air admitted at the bottom of the tube escapes into the annular space between the tube and the asbestos luting of the couples, where it ignites, as in a Bunsen burner, the air to support its combustion being admitted from below; by this means a temperature of about 400° Fahr. may be maintained at the inner ends of the couples, whilst the outer ends remain at about 200°, the regulation of the heat being thoroughly under control. The burners are usually arranged to consume about 8 ft. of gas per hour, depending on the size of the battery; this is regulated by a Giraud's regulator, so that a constant supply, independent of variations of pressure, is admitted. On the outside of the cylinder are copper terminals, to which the extremities of the couples are joined; these may be connected up for quantity or in series. The batteries are sometimes arranged for burning either coke or charcoal, in lieu of gas.

It is stated that with these batteries the cost of depositing copper is about 11d. per lb., that the current is constant, and that the batteries require very little attention, the cost of working being simply that of the fuel or gas used in heating the couples, as the loss of metal of which the couples are made from oxidation is too small to be taken into account. For some months past trials have been made on the postal telegraph lines with these batteries, and, it is stated, with fairly satisfactory results; for besides the advantage derived from the small attention they require, when compared to the mumber of cells of an ordinary battery they would replace, there is a great gain in the space occupied.

It seems a pity that, with the numerous forms of lightning conductors exhibited, many of them very admirably suited for the purpose for which they have been designed, *i.e.*, that of protection from lightning, some mention should not have been made as to the manner in which it is proposed to make the connection between the rod and the earth, a connection of such vital importance in the efficacy of any lightning conductor, and one to which, unfortunately, sufficient attention is rarely paid; now whether the rod itself is composed of highly polished copper or plain galvanised iron is in itself very immaterial, and in one sense, perhaps, even a galvanised iron rod of a suitable size is preferable (it requiring in the case of iron about five times the sectional area to that of copper), as it offers a much smaller inducement to the thief; on the other hand, it would certainly require more frequent inspection, for let it be galvanised ever so perfectly there is almost sure to be some weak point where oxidisation, from some cause or other, would be set up, and show itself sooner or later. It is not, however, the object of this notice to set forth the particular advantages to be derived from the use of either copper or iron, but rather to point out the necessity for a suitable earth connection.

To the uninitiated in such matters, and perhaps a very large proportion of those who have lightning conductors erected for protecting their property may be classed among these, many of the exhibits of lightning conductors are very apt to mislead, as they might probably infer that so long as they caused one of these conductors to be nailed against a tall chimney or building, &c., they had done all that could be required to protect it from the effects of lightning, and as to whether on reaching the ground it terminated in a pail of water or a properly constructed earth connection it was quite immaterial. Now the principal points to be borne in mind when constructing a lightning rod, whether it be of iron or copper, are, that the rod, which ought in all cases to project a few feet above the highest point of the building, should have a sufficient conductive capacity, attention paid that proper metallic joints are made in joining the rods, and that, above all, a good earth be made. In speaking of a good earth what is meant is that the resistance offered to the electric current between the rod and the earth be reduced to a minimum, which in a great many instances, at a very small cost, can very readily be done by connecting the rod to the water and gas mains at a very small expense, thus distributing the surface of connection between the earth and the rod over a large extent. Were these points in all cases of high buildings, &c., more generally carried out, and lightning conductors erected, and these in the first instance could be done at a small cost, we should seldom hear of the now not unfrequent occurrence of buildings being struck by lightning.

Amongst the foreign exhibits, the Imperial German telegraph department shows a copy of the electro-magnetic telegraph apparatus of Gauss and Weber, as used by these physicists for communicating between the physical cabinet and observatories of Göttingen. The instruments were connected by double line wires over the houses of the town; the whole apparatus was successfully worked between the years 1833 and 1838, when it was unfortunately destroyed by lightning. Now, although it is unnecessary to give a description of this well-known apparatus, yet it is, nevertheless, interesting as being the first utilisation of Faraday's discovery of magneto electricity for telegraphic purposes, while in the receiving instrument the mirror was here employed for the first time in electrical instruments for rendering the small deflections of the suspended magnet observable, and when we remember that the present mirror galvanometers, instruments that play such an important part in telegraphy, whether for electrical testing or signalling purpose, are simply delicate modifications of this same receiving instrument, the apparatus is well worthy of our attention.

A compact form of military telegraph for field purposes is exhibited by M. Trouvé, of Paris. The apparatus and cable are so arranged that they can readily be carried on a man's back, in a similar manner to a soldier's knapsack; the Morse sounders, on which the signals are read off from by sound, are neat little instruments, and one would imagine quite capable of fulfilling all the requirements of military field telegraphy.

The competition between granite, asphalt, and wood, as materials for paving the City of London, has at length been finally decided in favour of wood, after many experiments and careful consideration. Mr. Haywood, the City Engineer, calculates that a horse can go 132 miles on granite before being exhausted, 191 on asphalt, and 415 on wood.

The receipts of the Suez Canal show a considerable increase each month. In January last £110,400 were taken on 142 vessels passing through. The following is the number of vessels which have passed through the canal since it was opened:—1869, 10 vessels; 1870, 486 vessels; 1871, 765 vessels; 1872, 1,082 vessels; 1873, 1,173 vessels; 1874, 1,264 vessels; 1875, 1,494 vessels.

The Prussian Government has opened credits for the construction, &c., of railways to the amount of about £24,000,000. Of this amount £5,000,000 is expected to be at once raised by a 4 per cent. loan.

SCIENCE MUSEUM.

The memorial to the Government for a Physical Science Museum (see p. 818 of the *Journal* for the 7th inst.), was signed by persons remarkable not only for their scientific eminence but for numbers. The subscribers were as follows :—J. D. Hooker, President of the Royal Society; John Evans, F.R.S., Chairman of the Conferences in the Geographical Section ; E. Frankland, F.R.S., Chairman of the Conferences in the Chemical Section ; J. Burdon Sanderson, F.R.S., Chairman of the Conferences in the Biological Section; C. W. Siemens, F.R.S., Chairman of the Conferences in the Mechanical Section ; W. Spottiswoode, Treasurer and Vice President R.S., Chairman of the Conferences in the Physical Section ; Charles Brooke, F.R.S. ; Lord Alfred S. Churchill, Chairman of the Society of Arts ; William Kitchen Parker, F.R.S. ; H. W. Bristow, F.R.S., Director of the Geological Survey of England ; William B. Carpenter, F.R.S ; Latimer Clark, late President Soc. Tel. Engineers ; W. H. Flower, F.R.S., Conservator Hunterian Museum ; J. H. Gilbert, F.R.S.; Robert Main, F.R.S., Radcliffe Observer ; Capt. Fredk. Jno. Evans, V.P.R.S., R.N., Hydrographer of the Navy; Sir P. de M. Grey Egerton, F.R.S.; Lord Hampton, F.R.S., President of the Institute of Naval Architects ; Joseph Prestwich, F.R.S. ; T. M. Goodeve, M.A. ; Capt. W. de Abney, R.E., F.R.S.; G. W. Royston Pigott, M.A., M.D., F.R.S.; Robert H. Scott, F.R.S., Director Meteorological Office ; George Robert Stephenson, F.R.S., President Institute Civil Engineers ; F. H. Wenham; George Bentham, F.R.S. ; Nevil S. Maskelyne, F.R.S.; H. S. Eaton, President of the Meteorological Society; E. Atkinson, Treasurer of the Physical Society; F. A. Abel, F.R.S., President of the Chemical Society ; T. Hawkesley, President of the Institute of Mechanical Engineers, past President of the Institute of Civil Engineers ; William H. Stone, F.R.C.P., &c. ; W. J. Russell, F.R.S. ; David Forbes, F.R.S. ; Richd. Collinson, Vice-Admiral, Deputy Master of the Trinity House; B. Woodcroft, F.R.S., late Superintendent of Patent-office Museum ; C. W. Merrifield, F.R.S. ; Andrew C. Ramsay, F.R.S., Director General Geological Survey ; C. P. B. Shelley ; James Baillie Hamilton ; Major-Gen. F. Eardley-Wilmot, F.R.S.; Sir Henry Cole, K.C.B.; Warren De La Rue, F.R.S. ; Frederick Guthrie, F.R.S., Prof. Physics, Royal School of Mines ; C. O. F. Cator ; Thomas Savage ; Alfred Barry, D.D., Principal of King's College ; Wm. Chappell, F.S.A.; A. J. Mundella, M.P.; William C. Unwin, Prof. Engineering, Indian C. E. College ; George T. Clark ; Joseph Woolley, LL.D. ; John F. Twisden ; Major-General Richard Strachey, F.R.S.; Frank Bolton; D. Glasgow ; William Rutherford, M.D., F.R.S. ; Henry E. Roscoe, F.R.S. ; J. Hopkinson ; A. W. Reinold ; John Tyndall, F.R.S. ; John Torr, M.P. ; Lord Aberdare, President of the Royal Horticultural Society ; Robert Jamas Mann, M.D. ; Albert Günther, V.P.R.S. ; Sir H. C. Rawlinson, late President Royal Geographical Society ; W. B. Baskcomb; Sir James K. Shuttleworth ; Geo. Busk, F.R.S. ; Geo. J. Allman. F.R.S., President of the Linnean Society; J. Arthur Phillips ; T. H. Huxley, Sec. R.S. ; E. Ray Lankester, F.R.S. ; H. C. Sorby, F.R.S., President of the Royal Microscopical Society : W. T. Thiselton Dyer, Assistant-Director, Royal Gardens, Kew ; Henry W. Ackland, F.R.S., President of Medical Council ; H. W. Chisholm, Warden of the Standards ; D. T. Ansted, M.A., Cant., F.R.S. ; J. H. Gladstone, F.R.S., Fullerian Professor, Royal Institution ; J. Scott Russell, F.R.S. ; Colonel A. Lane Fox, F.R.S. ; Lord Rayleigh, F.R.S. ; Robert S. Ball, LL.D., F.R.S., Astronomer Royal, Ireland ; H. C. Seddon, Major, R.E. ; Charles V. Walker, F.R.S., President of the Society of Telegraphic Engineers ; Sir Joseph Whitworth, F.R.S. ; G. Carey Foster, President of the Physical Society ; Balfour Stewart, F.R.S. ; R. B. Clifton, F.R.S., Professor of Experimental Philosophy, Oxford ; W. F. Barrett, Prof. Physics, Royal College of Science, Dublin ; J. Norman Lockyer, F.R.S. ; Francis Galton, F.R.S. ; Major-General J. Cameron, F.R.S., Director Ordnance Survey ; M. Foster, F.R.S. ; E. A. Schäfer; B. Samuelson, M.P. ; E. Klein, F.R.S. ; W. N. Hartley ; Francis Guthrie, LL.B. ; P. Martin Duncan, F.R.S. ; President of the Geological Society ; P. L. Sclater, F.R.S. ; Capt. J. E. Davis, R.N., Hydrographic Department, Admiralty ; H. Dent Gardner ; John Allan Brown, F.R S. ; William Hackney ; Ettrick W. Creak, Staff Commander, R.N. ; W. H. Preece ; W. Chandler Roberts, F.R.S. ; A. B. Kempe, B.A., Barrister-at-Law, Western Circuit ; Alex. Crum Brown, Professor of Chemistry, Edinburgh University ; James Dewar, Professor of Mechanism, Cambridge ; Urban Pritchard, M.D. ; R. H. M. Bosanquet, M.A., F.R.A.S., F.C.S., Fellow of St. John's College, Oxford ; Sydney H. Vines ; Alfred E. Fletcher ; Herbert M'Leod, Prof. of Experimental Science, Indian C.E. College ; Alex. B. W. Kennedy, C.E., Prof. Engineering, University College ; Arch. Geikie, F.R.S., Director, Geological Survey, Scotland ; Cornelius B. Fox, M.D., F.M.S. ; Nicholas Brady, M.A. ; Thomas Stevenson, F.R.S.E., F.G.S., M. Inst. C.E. ; John Jellett, D.D., F.R.S. ; Thomas Pigot, Prof. Engineering, Royal College of Science, Dublin ; J. P. O'Reilly, Prof. Mineralogy and Mining, Royal College of Science, Dublin ; T. Lauder Brunton, M.D., F.R.S. ; J. E. H. Gordon ; W. Galloway, Prof. Chemistry, Royal College of Science, Dublin ; Henry E. Armstrong, F.R.S. ; Thomas Andrews, LL.D., F.R.S., President of the British Association ; James Thomson Bottomley, M.A., F.R.S.E. ; W. F. Donkin ; Claude R. Conder, Lieut. R.E. ; Charles E. De Rance, F.G.S., H.M. Geological Survey ; Nathl. Barnaby, Chief Constructor of the Navy ; W. Topley ; J. Clerk Maxwell, F.R.S., Prof. of Experimental Physics in University of Cambridge ; G. G. Stokes, Sec. R.S. Lucasian Professor, Cambridge.

SILK CUTURE IN AUSTRALIA.

Mrs. Bladen Neill has received the following communications on the subject of her endeavours to promote silk culture in Australia :—

(COPY.)

House of Commons, London,
June 26th, 1876.

Dear Mrs. Neill,—I have been requested, as President of the Chamber of Commerce at Macclesfield, to express to you the gratification which your visit in the spring of this year afforded to the members, especially connected as it was with the production of silk, which is the material on which the staplo trade of the town and neighbourhood entirely depends.

Your specimens of Australian silk were submitted to practical manufacturers, and were unanimously pronounced to be fully equal, if not superior, to the best productions of Italy and France. It was agreed that such descriptions and qualities could only have been produced in a climate and in a soil pre-eminently suited to the growth of the mulberry and the rearing of the silk worm.

Under these convictions, the Macclesfield Chamber wish me to express, through you, their hope that they may be allowed to impress upon the various Chambers of Commerce in Australia, the desirability of giving all the encouragement and assistance in their power to introduce and establish so valuable an industry as that of sericiculture.

The failure of the crops of silk in France and Italy, and in Europe generally, has of late led the Chamber to the conclusion that this would be a most opportune time for the Chambers to seek for material assistance from Governmental departments of the colonies.

The supply of silk from China and the East seems

likely to be of an unusually limited extent, during the next twelve months. This is an additional reason why the present favourable opportunity should not be lost sight of.

In the hope that the efforts which are already being made, may be still further strengthened,

Believe me,

Yours very truly,

(Signed) W. C. Brocklehurst, M.P.

French Commercial Report on Mrs. Bladen Neill's Australian Cocoons.

(Translation.)

"Mrs. Neill has had the goodness to submit to me some yellow Australian cocoons, which have been used for graining; that is, the cocoons were pierced. These cocoons were of a very good quality as regards fineness of texture, fibre, and amount of produce. I calculate to be able to sell such cocoons, provided they arrive in good condition—that is to say, non-pierced cocoons—at from 16 to 18 francs the kilogramme, at a fixed produce of four kilogrammes of cocoons for one kilogramme of raw silk. For this purpose it is necessary that the cocoons should be desiccated, well-packed, pressed and packed dry, and not damp, so that they should arrive in a sound condition.

"In addition to this, I could reel the same cocoons into any thread required by consumers, and obtain a good price for it according to circumstances. The price of reeling varies from 7 to 9 francs the kilogramme of silk, according to the fineness of the thread, the waste being left for the benefit of the reeler.

"These silks are now worth from 75 to 80 francs the kilogramme, well reeled.

"These yellow cocoons are, I repeat, of so beautiful a quality that the preference would at once be given to them as soon as tried in the mill. The sale of them is consequently assured in advance.

"The cocoons employed for the grain would be of an equally easy and advantageous sale. I could sell them now from 7 to 8 francs the kilogramme. For their transmission, care must be taken that the cocoons are perfectly dry, and packed in a compressed bale, so that one bale of 60 to 80 kilogrammes should not exceed one metre in bulk.

"The cocoons, whether whole or pierced, should be sent by steamer, and not by sailing vessel, as the interest of money, and the chances of fall or advance, would compensate ten times for the difference in the cost of freight.

"The commission on sales is 3 per cent. The sales are made by bills at 90 days' sight at Lyons or Esk, or $1\frac{1}{2}$ per cent. commission and bills at 10 days' sight. The storage, insurance, and such like charges are not included, but they are of little importance.

"I can sell each year the produce of 50,000 or 60,000 kilogrammes of cocoons, or about 20,000 kilogrammes dried cocoons, or about 5,000 kilogrammes raw silk.

"The silk harvests of France have been so reduced for some time, and the quality of the yellow cocoons leaves much to be desired, that it would be of great importance to push forward this production as fast as possible, as the result would be immediate, and of an incontestable advantage.

"We must bear in mind, it is true, that there are the productions of Italy and the East, which are of great importance, but their yellow silks are not applicable to every purpose, from the nature of the cocoons and the manner in which they are reeled.

"(Signed), Peltereau.

"Paris, 20th June, 1876."

Mrs. Neill has opened a depôt at 7, Charles-street, Grosvenor-square, where information respecting the Australian Silk-farming Association may be obtained. The depôt has been assisted by gifts of machines from Mrs. Frank Morrison and Mr. Daniel Cooper.

ON THE AMALGAMATION OF IRON AND OF SOME OTHER METALS.*

By P. Casamajor.

At the last meeting of this Society I was to speak to you on amalgamation of iron, but was prevented by the lateness of the hour from reading the paper I had ready for you. Since that evening I have learned a great many things about iron amalgam, one of which is that most of the processes that I was to describe had already been published, although in a very succinct form, about nineteen years ago. This discovery would have prevented me from appearing before you to-night if I had not found that the subject is deemed by chemists, to whom I have shown samples of amalgamated iron, to be not only new, but very interesting. I have, besides, much new matter to communicate, among which is a new process for amalgamating iron, which is so simple and economical that all the other processes are rendered obsolete and useless.

That iron will combine with mercury is known to all chemists, although it is not deemed an easy operation, and we may find in the books several processes for accomplishing the combination. One of these, which I believe is due to Sir Humphry Davy, consists in immersing sodium amalgam in a saturated solution of ferrous chloride or sulphate. In another process zinc amalgam is brought in contact with iron filings, in presence of a solution of ferric chloride. The filings become coated with mercury. In still another process, the electrolysis of ferrous sulphate gives iron amalgam when the negative electrode is formed of mercury. By subjecting the resulting amalgam to enormous pressures a residuum of pretty firm consistency is obtained, which is composed of about equal parts of iron and mercury.

The processes of amalgamation which I am to describe to you this evening give products which have nothing in common with these iron amalgams. The samples of iron amalgam, such as I have here, are obtained from commercial wrought-iron, from cast-iron, and from steel, without altering the original shape of the material, and are analagous to the amalgam made from commercial zinc which we use in voltaic batteries.

Before giving you the results of my labours I must give you a succinct account of the researches of Cailletet, which came to my knowledge as follows:—Before presenting myself before you at the regular meeting it had been my endeavour to ascertain whether the results I was to announce were really new. Neither by my own exertions nor by inquiry from other chemists had I been able to discover that I had been forestalled, and had I confined my attention to iron I would not have been aware—perhaps even now—of the existence of a prior claimant.

Having turned my attention to aluminium, I had occasion to consult Watts's "Dictionary of Chemistry," on the subject of aluminium amalgam, and came upon the following:—"According to Cailletet (*Comptes Rendus*, vol. xliv., p. 1250) aluminium (also iron and platinum) may be superficially amalgamated by contact with ammonium or sodium amalgam and water; also when it is immersed in acidulated water in contact with metallic mercury, forming the negative electrode of a voltaic battery."

On consulting the 44th volume of the *Comptes Rendus*, I found, at p. 1250, a memoir presented to the Academy of Sciences by Messrs. Chevreul and Dumas, at the sitting of June 15th, 1857, the title of which is "On the Influence of Nascent Hydrogen on Amalgamation," by M. L. Cailletet. The author uses ammonium amalgam, with which he agitates pieces of iron, aluminium, or platinum, and he finds that these metals become coated with mercury. The amalgam of sodium produces the same effect, only water is necessary to the

* Read before the American Chemical Society, June 1st, 1876. Communicated by the author to the *Chemical News*.

reaction. If the surface of the sodium amalgam is covered with naphtha no action take place, but one drop of water is sufficient to produce the desired effect.

If in a vessel containing mercury and acidulated water we place the electrodes of a battery, and if the negative electrode be a piece of sheet iron in contact with mercury, the iron will be amalgamated as soon as hydrogen appears on this electrode.

From these experiments Cailletet concludes that amalgamation in these cases is due to nascent hydrogen, and he seems throughout his memoir to be so intent upon proving this point that every other circumstance is mentioned in the most cursory manner. We may be allowed to doubt whether by covering sodium amalgam with naphtha, so that when iron comes in contact with the amalgam it is already covered with a film of naphtha, we have placed the iron in the best condition to combine it with mercury, and whether the non-combination under these circumstances is very conclusive of the necessity of nascent hydrogen to determine the combination between iron and mercury.

The following experiment with a mercuric salt carries more weight with it:—The author wishes to show that amalgamation, in the case of iron and platinum, is due to nascent hydrogen, and not to the electrical condition of the iron or platinum electrode. He takes the case of the electrolysis of salts of copper, silver and mercury, and recalls that at the negative electrode we obtain metallic copper, silver, and mercury, but no hydrogen. If we have a salt of mercury subjected to a voltaic current, the negative electrode being made of iron or platinum, we may notice after a while that globules of mercury appear on this electrode, but they show no tendency to combine with it. If, now, the electrodes are withdrawn from the mercury salt, and placed in a vessel holding acidulated water, as soon as the voltaic current passes and hydrogen escapes at the negative electrode, the globules of mercury spread on this electrode, and it becomes amalgamated.

The above account of the memoir presented by Cailletet contains substantially everything there is in it. The circumstance mentioned in "Watts's Dictionary" that the amalgamation obtained on iron and platinum is merely superficial, does not appear, even by implication, in the original paper.

Amalgam of sodium and ammonium, and the voltaic battery, these are the agents mentioned by Cailletet; these were also the agents that I used a month ago to determine the combination of iron with mercury. Although I now use a much simpler and a cheaper process, which I propose to describe in a few minutes, there are some points in connection with the alkaline amalgams and with the action of the voltaic current which may be studied with advantage.

Amalgam of potassium, which I first used for amalgamating iron, behaves in every way like amalgam of sodium. Sodium, however, behaves somewhat differently from potassium towards mercury, the combination with sodium taking place with greater violence, being accompanied by a flash of sodium light, and the escape of alkaline vapours which are far from agreeable. These unpleasant manifestations may be reduced to a minimum by combining sodium at first with a very small quantity of mercury—a quantity not more than a fifth of the weight of the sodium. This gives rise to a violent reaction, but subsequent additions of mercury produce less and less effect, while, by bringing small pieces of sodium successively into a comparatively large mass of mercury, every fresh piece of sodium produces the same effect as its predecessor.

If the sodium amalgam has sodium enough in it to make it pasty, it will cover iron with a silvery coat. This coat may be rubbed off, leaving the oxidised surface unaltered. If brought in contact with water, or, still better, with a solution of sal-ammoniac, the sodium amalgam is decomposed and the mercury will sink into the iron. If the sodium amalgam is liquid it will adhere in little drops all over the surface of a piece of iron shaken up in it; by the action of water, of acids, or of sal-ammoniac, the droplets will spread on the iron, which will become amalgamated.

Ammonium amalgam will give up its mercury to iron when rubbed with it very persistently. Even then there are in every piece of iron certain spots where the mercury will not adhere. The intervention of acidulated water, by decomposing ammonium amalgam with great energy, facilitates the amalgamation of iron in these difficult portions.

From the foregoing remarks you will understand that the maximum of good effect may be obtained from a certain amount of sodium by the following method of procedure, while the combination of iron with mercury is very thorough and rapid:—We take four porcelain dishes and place them in a row, so that the piece of iron to be amalgamated may be placed successively in each. The first dish contains a liquid sodium amalgam; the second a solution of sal-ammoniac; the third water, acidulated with either sulphuric or hydrochloric acid; and the fourth aqueduct water. The piece of iron to be amalgamated is taken up with tongs, and agitated in contact with the sodium amalgam of the first dish. The operation covers it with liquid mercury containing sodium amalgam. When the surface seems sufficiently coated the iron is left for a few seconds in the solution of sal-ammoniac, on emerging from which it is found covered with the curious and interesting compound which we call ammonium amalgam. The piece of iron is placed next in the acidulated water, and finally in aqueduct water, to wash off the acid.

This series of operations is generally sufficient to leave a good coat of mercury on a piece of iron. If there should be spots left bare, a second series of immersions is generally sufficient to leave the surface perfectly covered. I need not say that the surface of the iron must be previously made clean by immersion in diluted acid.

By making the negative electrode of a voltaic battery of iron, and placing it in contact with mercury and with acidulated water, the iron will, after a time, become amalgamated. I have obtained the same result by a single voltaic element, the positive plate of which is a piece of zinc and the negative plate a piece of iron, one portion of which is in contact with mercury at the bottom of the cup, the exciting fluid being acidulated water. An addition of chloride of sodium to the liquid in the cup seems to hasten the reaction.

Iron may be amalgamated also by the use of zinc amalgam. This process gives the best results, and renders superfluous all the other processes we have mentioned. The use of zinc amalgam for the purpose had been attempted before, as, for instance, in the process I have mentioned where iron filings are rubbed with zinc amalgam in presence of a solution of ferric chloride, the reaction being assisted by heat. I also find in "Watts's Dictionary" that, "according to Aikin, iron amalgam is formed by the action of zinc amalgam on ferrous chloride." No particulars are given about this process, but the results must have been, to say the least, difficult to obtain, as we find, immediately after that, "according to Damour, it cannot be obtained in this way."

I came upon the process I am about to describe by a mere chance. I was trying to test the soundness of the theory of Cailletet, which attributes the amalgamation of iron to the presence of nascent hydrogen. In a beaker glass I had placed mercury, and over it acidulated water, and also a horse-shoe nail of Norway iron, which rested on the mercury. A moderate escape of hydrogen took place from the surface of the iron nail; but after twenty-four hours no trace of amalgamation had appeared, which showed very conclusively that unassisted nascent hydrogen was certainly not sufficient to do the work. Having to amalgamate a small piece of zinc for another experiment, I found that I had no other mercury within my reach than the one on which the nail of Norway iron rested. As I had given up hopes of accomplishing any-

thing by this arrangement, I had no scruple to use the mercury in this beaker glass, and in it I placed my piece of zinc; the result was that the escape of hydrogen from the nail increased very perceptibly, which circumstance induced me to leave the zinc in the mercury. On looking again at the iron nail I found it amalgamated and partly sunk into the mercury.

To amalgamate iron with zinc amalgam, mercury should be placed in a vessel and covered with dilute sulphuric or hydrochloric acid. If, now, a piece of iron is agitated in contact with the mercury and the acid, no combination will take place; but if pieces of zinc are placed in the mercury, in a few minutes iron placed in the above conditions will become coated with mercury. If after a while the power of the mercury seems to decline, more zinc must be added. The zinc is only attacked when iron, or some other metal more electro-negative than zinc, is brought in contact with the zinc amalgam and the acid, so that the expense in zinc is very slight.

The coat of mercury left on iron by the various agencies I have mentioned is not a superficial layer, for the mercury sinks into the metal, modifying its physical and chemical properties. In the case of pure soft iron it is difficult to notice any decrease of tenacity after amalgamation. With hard-tempered steel, however, the increased brittleness is very marked. In the case both of iron and steel a fresh fracture shows that mercury had penetrated deeply into the metal.

Of the chemical change operated on iron by amalgamation I can call attention to only one point which is the analogy which exists with the properties of zinc amalgam. When a piece of zinc* has been amalgamated it is not attacked by acids as readily as zinc free from mercury; but if a piece of amalgamated zinc is connected to a piece not amalgamated, the amalgamated zinc becomes the positive plate in a voltaic couple. These properties of amalgamated zinc are found, although in a less degree, in amalgamated iron. Two pieces of sheet iron, presenting exactly the same surface, were placed in diluted sulphuric acid, so that the action of the acid was exactly the same on each. One of these plates was amalgamated, the other not. After prolonging the action for over two hours, it was found that the amalgamated plate had lost two-thirds as much in weight as the other.

If, however, two pieces or iron†—one amalgamated and the other not—are connected by a metallic wire, the amalgamated plate is attacked, and the other plate plays the part of a negative.

In iron amalgam, made in the way I have described, the quantity of mercury in combination is very small. A piece of sheet iron, presenting on both sides a total surface of three square inches, was amalgamated and left to soak in mercury for over an hour. The mercury was then wiped off very thoroughly, and the piece of sheet-iron weighed. The increase over the original was 13 centigrammes, which showed an absorption of mercury equal to a little over four centigrammes per square inch. The increase of weight in this thin sheet of iron was only $3\frac{1}{2}$ per cent. Still in this sheet the fracture was silvery, and globules of mercury stood on the rough edge of the fracture.

For the sake of comparison I treated a piece of sheet zinc, of the same dimensions, in the same manner, leaving it, however, only a few minutes in contact with mercury. After rubbing off the excess of mercury, and weighing, I was surprised to find a loss instead of a gain in weight. This was doubtless due to a certain quantity of zinc being dissolved by the mercury.

I must now, to fulfil the programme offered by the title of this paper, speak to you of the amalgamation of some other metals, by which are meant some of those whose point of fusion is very high, and which have always shown themselves exceedingly adverse to combining with mercury. Those that I have tried are platinum, palladium, aluminium, nickel, and cobalt. Except in the case of aluminium there seems nothing of peculiar interest to notice about their amalgams, after what has been said of iron amalgam. These metals all take mercury very readily by the processes which are effective in the case of iron. Aluminium deserves mention on account of its eccentric behaviour: it seems to take mercury in the same manner as the other metals, but shortly after being taken out and dried it becomes very hot, the mercury seems to boil, and the aluminium remains covered with a chalky crust. On brushing this off, the metal is found beneath without a sign of amalgamation.

In conclusion, I will point out that two inquiries suggest themselves in connection with these amalgams. One relates to the determining cause of these combinations, and the other is whether these amalgams—particularly amalgam of iron—can be applied to useful purposes. To both these questions the answer is, that I have nothing satisfactory to offer, although great many things suggest themselves as plausible. I am sure you will readily excuse me from presenting theories that are merely plausible, as to the cause of these phenomena, and feel equally certain that I need offer no apology to this enlightened auditory for calling their attention to these combinations of mercury with iron and other metals, because they have not yet become of practical utility, although it may be befitting to offer an apology for the manner in which the task has been performed.

* This observation relates to impure zinc. Amalgamation makes impure zinc behave towards acids like pure zinc.

† This is more easily noticed with steel than with pure soft iron.

THE INDUSTRIES OF TRIPOLI (IN SYRIA).

Tripoli is essentially an agricultural district. Its orchards and gardens are very valuable; they are abundantly watered, and yield profusely almost every kind of fruit which is known in Syria. Owing to the delicacy of these fruits and the lack of rapid means of communication with other markets, they are to be had in the season for the merest trifle. Of these gardens, the orangeries form a principal portion, and the fruit which they yield enjoys a just celebrity in the country. Vice-Consul Hordern states that for some years the export of oranges and lemons to Odessa and Constantinople has been acquiring an increasing importance, and proprietors of gardens have found it advantageous to give attention to the cultivation of this fruit to the neglect of the mulberry, which has not been satisfactory of late years. Not to speak of the result to the merchant, this trade is a valuable resource to the town as giving employment to large numbers of persons for gathering, packing, box-making, &c. The fruit is packed in boxes of from 250 to 300 each, and costs per box from 28 to 35 pias. During the season 1874–5 there were 28,600 boxes exported, and their value to the town is estimated at from £50,000 to £60,000, which amount must be understood to represent the revenue of all the fruit orchards and gardens of Tripoli.

The extensive olive groves yield an abundant employment for numbers of women and boys from all parts of the neighbouring mountains. The gathering takes place in November and December. Each labourer receives for a day's work a small measure of olives. The fruit which has fallen from the trees, either from over-ripeness or shaken off by the wind, is first gathered; afterwards the trees are beaten. In seasons when heavy rains come on before the time of ingathering, large quantities of olives are washed away and are carried by the streams to sea, whence they are again washed up on to the shore. At these times numbers of poor people may be seen gleaning all along the seaboard, and many eke out a scanty livelihood thereby. The last harvest which was very abundant, was estimated at 1,820,000

okes, equivalent to 496,300 gallons. The value of olive oil has considerably depreciated since the introduction, some twelve years ago, of petroleum. Previous to that time olive oil was almost universally employed for lighting; it is now entirely superseded for this purpose by the more brilliant and less expensive mineral oil, which has found its way into every village in Syria. About two-thirds of the quantity produced is used in the manufacture of soap, for which Tripoli has a reputation; the quantity manufactured annually is about 6,000,000 okes. It is exported to Egypt, Barbary, and various parts of Syria.

There is very little grain exported, the produce being nearly all consumed in the country. Want of roads to communicate freely with the interior, thereby equalising prices, opposes the great obstacle to this being a corn-growing country for export. During the winter months communication with the grain-growing districts is frequently cut off. Merchants speculate upon this, and it is not an unusual thing in the winter to see grain sold at famine prices at Tripoli, whilst abundance is lying in the interior. The quantity of silkworms produced at the last harvest is estimated at 250,000 to 300,000 okes, and these are exclusively exported to Marseilles. There are two small silk-spinning factories in this district where yarn is spun for the Lyons market. Silk is also spun on the primitive native principle. About 9,000 okes of yarn are produced in this way, 5,000 of which are exported to Egypt, and 4,000 used in the looms of the country in the manufacture of girdles, kefich, &c. The quantity of tobacco cultivated last year in the Lebanon and the districts of Akkar and Safita (Government of Tripoli), was 266,000 okes, representing a value of 3,200,000 pias. The quantities grown in Akkar and Safita are inferior to those produced in the Lebanon and are very little esteemed by the native consumer, whose taste has been formed by the fine aromatic discription of Gebeil and the Coura. It is exported to Egypt, and under the *régie*, is sold locally in sealed packets to the common people. Sponge diving forms the principal resource of the inhabitants of the port of Tripoli, and for six months in the year, from about the middle of April, nearly all the male population from sixteen years of age to fifty are engaged in it. The fisheries extend from Bartroun to Latakia. The sale of sponges is effected in lots composed of three descriptions, viz., fine white quality, red or bath sponge, common, used for household purposes, and the practised eye of the merchant is enabled to estimate the value of a lot very accurately. In considering the resources of Tripoli, shipbuilding should not be overlooked. This is the principal port on the coast of Syria for this branch of industry, and sailing craft of all dimensions, from the fisherman's and sponge-diver's boats to vessels of 250 tons are launched annually. The shipbuilders of Tripoli bear the palm over all others in Syria, and its mariners have the reputation of being the most expert.

Tripoli is also a market for the produce of the agricultural districts of Hamah and Homs, the amount of which may be stated at 35,000 to 40,000 quarters of wheat and about 7,000 quarters of barley, besides Indian corn, representing a total value of £60,000 to £70,000. The industries of Hamah and Homs deserve notice. These towns, the centres of a considerable trade with the neighbouring Bedouin Arabs and the surrounding agricultural districts, possess about 2,000 looms, employing upwards of 4,500 weavers. The products are cotton and silk fabrics of various descriptions, kefichs, and other articles of oriental costume, in every variety of quality and design, to meet the requirements of all classes, from the Arab shepherd to the sheikh and emir. The towelling of silk and cotton mixed is a speciality of these looms, and is highly esteemed throughout the country; they are to be seen in all the baths and barbers' shops from Constantinople to Cairo. Hamah and Homs have a population, jointly, of about 90,000 inhabitants, of whom about 20,000 are Christians. The climate is salubrious, and it is speaking within the mark to say that these towns are second to none in Syria for prosperity.

THE PROPOSED SUBMERSION OF NORTH AFRICA BY THE MEDITERRANEAN SEA.

After a brief notice of the traffic in foreign merchandise that passes through the Tunisian port of Susa, for distribution by means of caravans amongst the towns and villages of the interior, Vice-Consul Dupuis remarks more fully upon the projected inland North African sea. The project of submerging the region of Djerid by means of a canal is based upon a fact clearly recorded, viz., the presence of water, in in the form of lakes, in the line of the great depressions, and upon the presumption that these lakes were themselves but the residue of some vaster body of water or inland sea, which disappeared at a still earlier date from the surface, owing, it is conjectured, to the formation of an isthmus, which cut it off from the Mediterranean with which it was connected.

The recent surveys, though they reject the idea of any connection with the Mediterranean having existed—a hasty conclusion based upon mere inferiority of level to that of the sea—would seem to endorse the fact of all the region having been under water. Indeed, had there existed a connection, it is presumable that more than a mere incidental reference would have come down to us regarding so large an arm of the sea, as in that case it would have been indenting the land, and therefore available for the purposes of war or commerce by the ancients. The results obtained prove that the sands are of but secondary importance on the isthmus, which is chiefly composed of alternate strata of grey quartz and ferruginous freestone, which rise at an angle of sixty degrees, and lie over another stratum of chalk. This excludes all notion, therefore, of any choking up of an early passage for the waters. No reference is made to waters in the depressions by Arab writers, probably on account of their insignificance at the date of their conquest, yet all unite in describing this country as having been very woody, but state that the wood was all cut down to facilitate the subjection of the tribes, who, for upwards of a century after, fought desperately for their independence, as well as during their own internecine wars which followed. According to them the country was well supplied with streams and abundance of water, a statement itself in harmony with the notion of a degree of atmospheric humidity conducive to luxuriant vegetation, and presupposing the cause which alone could bring it about.

Whole regions, therefore, now condemned to sterility, with, save perhaps an oasis here and there, were formerly rich in pastures, and interspersed with towns. The desert, which has gradually extended in regions lying between Tripoli and Egypt until it has reached the sea, covering districts once fertile, and burying Egyptian ruins, has, beyond doubt, similarly encroached on the Tunisian southern frontier between it and Tripoli. The diminished heights and lowering of the Atlas range, let in the sands carried by every southerly wind, notably by the periodical south and south-east winds, to which the more elevated and uniform heights of the mountain system oppose a formidable barrier in more favoured Barbary States westward. In Morocco, especially, these same winds are so tempered in their passage across the intervening heights as hardly to be recognised as the same which here dry up and parch the land in summer. It may therefore be be presumed that the disappearance of the waters in question is due to the encroachment of the desert, caused by the action of these winds during a long succession of centuries, aided by absorption and by co-operation occasioned by the presence of the vast scorching desert to which their own southern aspect left them fully exposed. To these causes may also be added the substances

brought down by streams, which, by all accounts, were many; these, by narrowing the margins and spreading the waters, helped the work of desiccation. which was accelerated, moreover, by a decrease in the pluvial supplies consequent on the disappearance of mediæval forest. There can be no doubt about the drying up of many of the streams here, as elsewhere in Barbary, being due to the clearing away of forest. whether in the plains or in the highlands, by the Arabs on their conquest and after. The consequence is that the periodical rains, which at an earlier date fertilised the country, were replaced by heavier but rarer falls, the waters of which rush down the slopes and disappear in the sands, or mix with the noxious waters of the lagoons ere they penetrate and salinate the soil to any depth. The action of these passing waters is seen in a wasting away of earth and exposure of naked rock in all the "Hamayed," or elevated lands, hill sides, or ravines.

When it is considered that the regency of Tunis is a lake country, and that recent discoveries have brought to light similar vast sheets of water in Africa, the existence of an inland sea may not seem such a startling idea.

GENERAL NOTES.

Patent-right in Japan.—The Association of English patent-holders for the enactment of international Patent-laws lays special stress, in its prospectus, on the injury to English interests arising from the want of patent protection in Japan, and points out that not only has the intelligence of Japanese workmen, together with lower wages and cheap material, closed the Japanese empire against a number of English inventors, but there is also imminent danger that Japanese imitations will supplant inventions which have cost the authors heavy sacrifice of time and money, in neighbouring China and other Eastern countries. The English press in Japan warmly support the complaints of their fellow-countrymen, and urge that, even for the sake of Japanese interests stipulations should be made as to patent protection in the treaties between England and Japan.

British Association.—The following are the officers of the forty-sixth annual meeting of the British Association, which will commence at Glasgow, on Wednesday, September 6, 1876:—President-Designate—Prof. Thomas Andrews, M.D., LL.D., F.R.S., Hon. F.R.S.E., in the place of Sir Robert Christison, Bart., M.D., D.C.L., F.R.S.E., who has resigned the Presidency in consequence of ill health. Vice-Presidents elect—His Grace the Duke of Argyll, K.T., F.R.S., &c., the Lord Provost of Glasgow, Sir William Stirling Maxwell, Bart., M.A., M.P., Prof. Sir William Thomson, D.C.L., F.R.S., &c., Prof. Allen Thomson, M.D., LL.D., F.R.S., &c., Prof. A. C. Ramsay, LL.D., F.R.S., &c. General Secretaries—Capt. Douglas Galton, C.B., D.C.L., F.R.S., &c., Dr. Michael Foster, F.R.S. Assistant General Secretary—George Griffith, M.A., F.C.S. General Treasurer—Prof. A. W. Williamson, Ph.D., F.R.S. Local Secretaries—Dr. W. G. Blackie, F.R.G.S., James Grahame, J. D. Marwick. Local Treasurers—Dr. Fergus, A. S. M'Clelland. The Sections are the following:—Section A: Mathematical and Physical Science. President—Prof. Sir W. Thomson, D.C.L., F.R.S. Section B: Chemical Science. President—W. H. Perkin, F.R.S. Section C: Geology. President—Prof. J. Young, M.D. Section D: Biology. President—A. Russell Wallace, F.L.S. Department of Anthropology, A. Russell Wallace, F.L.S. (President), will preside. Department of Zoology and Botany, Prof. A. Newton, F.R.S. (Vice-President), will preside. Department of Anatomy and Physiology, Dr. J. G. M'Kendrick (Vice-President), will preside. Section E: Geography. President—Capt. Evans, C.B., F.R.S. Section F: Economic Science and Statistics. President—Sir George Campbell, K.C.S.I., M.P., D.C.L. Section G: Mechanical Science. President—C. W. Merrifield, F.R.S. The First General Meeting will be held on Wednesday, Sept. 6, at 8 p.m., when Sir John Hawkshaw, C.E., F.R.S., will resign the chair, and Prof. Andrews, F.R.S., President Designate, will assume the Presidency, and deliver an Address. On Thursday evening, Sept. 7, at 8 p.m., there will be a *soirée*; on Friday evening, Sept. 8, at 8.30 p.m., a Discourse; on Monday evening, Sept. 11, at 8.30 p.m., a Discourse by Prof. Sir C. Wyville Thomson, F.R.S.; on Tuesday evening, Sept. 12, at 8 p.m., a *soirée*; on Wednesday, Sept. 13, the Concluding General Meeting will be held at 2.30 p.m.

Street Directories.—The Street Lamp Committee of the Manchester City Council, at a recent meeting, unanimously authorised the erection in Market-street, by way of experiment, of eight of Messrs. Pearse, Lever, and Co's "Public Street Directories." These directories are a novelty in their way. The directory consists of a frame, containing either four, six, or eight name-plates, which can be adjusted to the existing street-lamps. Four directories will be placed at equal distances on each side of the street. At the top will be printed the name of the street; and below, the words "Public Street Directory of——." The name-plates are constructed to slide in the frames, so that they can at any time be corrected without trouble. They will contain:—1. The names of the various firms trading in the street in which they are erected, with the numbers, arranged alphabetically. 2. The names of the various streets and courts leading from the street, with the numbers nearest from which they abut, arranged alphabetically. 3. Information as to the nearest postal and telegraph offices, railway, fire, and police-stations, doctors, &c. Each of the directories will accommodate from 300 to 400 names.

Nickel Ore in New Caledonia.—M. Garnier, who has made deep study of the geology of New Caledonia, has sent a short paper to the *Académie des Sciences* on the nickel ores which he met with in great abundance in that country, and which are already being actively worked. These ores in no way resemble those from which nickel has hitherto been extracted, being silicates of nickel and magnesia, while the others are arsenio-sulphurets. They are found in serpentine rocks, which are very abundant in various parts of the island, associated with diorites, amphibolites, &c. Sometimes they appear on the various rocks as a beautiful green coating, sometimes they penetrate the rock and give them a more or less intense colour, sometimes they form therein threads which may assume the importance and regularity of veins, and sometimes again they occur in kidneys or in pockets. As might have been expected, the nickel is associated with iron, chrome and cobalt, these metals, especially the two former, being very abundant; their stratification is analogous to that of nickel, except where cobalt is met with. The latter metal is associated with manganese forming pure masses of greater or less extent in the midst of friable arenaceous rocks, composed of felspathic and magnesian detritus. Two patents have been taken out for the working of this ore, which has received the name of Garnierite after its discoverer. One, by M. Garnier himself, proposes a method by the dry way, almost identical with that employed to extract the iron from its ores, while the other, by M.M. Christofle and Bouilhet, who propose a method by the wet process.

NOTICES.

SUBSCRIPTIONS.

The Midsummer subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

HEALTH AND SEWAGE OF TOWNS.

The Report of the proceedings at the Conference on the Health and Sewage of Towns, held by the Society on May 9th, 10th, and 11th, has been published, and can be had on application at the Society's House. Price 2s. 6d.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

The fifth lecture of the second course of Cantor Lectures for the past Session, on "Iron and Steel Manufacture," by Mr. W. Mattieu Williams, was delivered on Monday evening, February 14th, as follows:—

Lecture V.

Before entering upon the proper subject of this lecture, I must say a few words on the subject of "lamination," "blistering," and other diseases, to which large masses of iron, built up by the welding together of many puddled balls, are subject.

In the first place, it should be understood that uniformity of composition is not attainable in the iron produced by puddling. This is the case not only when the iron of one heat is compared with that of another heat, but it applies to the different balls of the same heat. I have several times taken samples of each ball in one heat, and examined them in reference to their carbon, and in all cases have found that the first ball contains more carbon than the second, and the second more than the third. I have found as much as one-fourth per cent. in the first, and only a trace in the last; thus the first ball was what is now called mild steel, while the last was soft iron.

This difference is easily explained. It is owing to the oxidation, which, in spite of all the puddler's precautions, occurs to the spongy iron after it is balled up, and while waiting its turn at the hammer. The longer this interval, the greater of course is the oxidation. So long as there is some amount of carbon the iron is protected by it, but when this is all burnt out, the iron itself begins to suffer burning or oxidation. Most puddled balls are thus more or less burnt on their surface while on their way to the hammer, but the shingling mixes the inside and outside together, and thereby delivers the oxygen of the outside oxide to the inner carbon, which effects reduction, as shown by the evolution of blazing carbonic oxide, commonly seen during the shingling or squeezing.

The welding together of the pasty balls, which is done under the steam hammer when large work is required, does something towards admixture of the iron and effecting an approximation to uniformity of composition. By rolling the puddled bar thus formed, cutting it up, piling and re-rolling, a further admixture of heterogeneous material and a further approach to homogeneity is effected, simultaneously with the squeezing out of residual cinder.

In this case the shearings of which the piles are composed must be united together by welding. If this welding is perfect the iron is unquestionably improved by a certain amount of re-heating, piling, and re-rolling, but it sometimes happens that the welding fails, and thus the finished result, a boiler plate for example, is composed in some parts of separable laminæ—is "laminated."

This lamination very rarely occurs in common iron, but it is a source of considerable trouble from its frequent occurrence in the best iron. Suspecting the cause of this, I carefully examined the scale of the bars from which the common iron was rolled, and that of the best, and found traces of silica in the common, but only pure iron and oxide of iron in the best. This explained the difference. When a blacksmith makes a weld in a common open fire, he throws sand on the surfaces to be joined, the object being to "flux" the scale, that is, to convert the oxide into fusible silicate. This being done, he brings the fluxed surfaces together, and by hammering, forces out the liquid silicate, and thus brings clean surfaces of pure iron together, which at a proper heat unite perfectly. If he had a film of oxide between the surfaces it would prevent welding.

Following up this principle, I obtained from the Potteries some "slip," or finely-ground flint used for glazing earthenware, mixed this with sufficient water to form a sort of paint or whitewash, and with a whitewasher's brush painted it over the surface of the piles on both sides of each layer. I treated several piles of the finest quality of iron in this manner. They were rolled into boiler plates, none of which showed any signs of lamination. I believe that by this means lamination may be effectually prevented. My experiments upon twenty or thirty plates were, however, not quite conclusive, inasmuch as it is quite possible that these particular plates might not have laminated even without the whitewashing. To prove its efficacy it should be practically used on a large scale. I tried other piles, with sand between, but this, as I expected, was too coarse, and introduced too much silica. The slip is a very fine, almost impalpable powder, well fitted for this purpose, it is cheap, and very easily obtained and applied.

"Blistering" is not so easily explained or cured. A plate of excellent quality may be worked and rolled to its last stage, when suddenly, just as it is finished, a bubble or blister rises upon its surface, and it has either to be condemned altogether, or cut up into smaller plates, the blistered part being set aside to form portion of a pile for other plates. When a blister rises in the early stages of rolling it may sometimes be pricked, the gas let out, and the wound healed by subsequent rolling, but this is rarely the case. Many theories of the cause of blistering have been suggested, but the subject is still a puzzle. It may possibly be caused by a small piece of coal or other carbonaceous matter, or hydrocarbon, imbedded in the iron. This, when heated, would be converted into gas if the gas were capable of expanding, but its imprisonment under resisting iron prevents this. As the plate is rolled thinner and thinner, the thickness

of the resisting cover of iron diminishes, and when its power of resistance becomes less than the elastic pressure of the gas, the blister rises. This is the best explanation I can offer at present.

Another source of mischief to malleable iron is "burning." I have examined many specimens of "burnt iron," and find that all contain small particles of oxide—apparently magnetic oxide—diffused more or less completely throughout them.

A very instructive series of experiments was made by the late Mr. Joshua Jeavons, at Sir John Brown's Works, Sheffield, about nine years ago. In making armour plates (some of which weigh as much as 30 tons) from ordinary puddled balls, weighing less than 1½ cwt. each, there is of necessity a great deal of building-up, piling, welding, and re-heating. The balls are rolled into plates; these plates are piled, forming the "moulds" of the armour-plate maker. These moulds are heated in a gigantic mill furnace, a white-hot chamber, or oven. They are then rolled into larger plates, serving as material for still larger moulds, and so on till the huge plate is compiled, and finally rolled into the required length, breadth, and thickness. The great difficulty of this is to avoid producing burnt iron. The ingenious device of the puddler which I have already described is here carried out on a grand scale. The door of the fiery chamber must be large enough to admit the mass of iron to be heated. It must be opened from time to time to watch the progress of the heating. Luting or other means of making it air-tight is quite impracticable, and yet the admission of free oxygen would be fatal. The workman's unlettered chemistry overcomes the difficulty; he places around the door, just inside it, at the places where air must enter, great lumps of coal. These are roasted and distilled by the radiant heat; the hot hydrocarbon gases thus evolved are thirsting for oxygen. The air that rushes into the crevices must pass these lumps of coal, and in doing so all its oxygen is taken up by the hydrocarbons and the glowing coal, and thus it becomes combined and converted into an element of a reducing agent, carbonic oxide, before it can reach the iron.

In spite of this, however, the plates sometimes become burnt in the course of their removal from the furnace to the rolls. They are more and more liable to this the oftener they are reheated. Why is this? My explanation is, that so long as they contain any carbon it protects them, but when this is burnt out, the iron, no longer protected, begins itself to burn, even at a red heat, if freely exposed to the air.

Mr. Jeavons tested this by rolling, piling, and re-rolling thick iron plates, using every possible precaution. He found by fracture and mechanical testing that the quality of the iron steadily improved up to the 5th, 6th or 7th rolling; then it as steadily deteriorated, each successive re-heating and re-rolling diminishing the toughness, tenacity, and elasticity of the iron, and deteriorating its silky, fibrous fracture. At last it became quite rotten, and in the fracture between the fibres a black dust was visible even to the naked eye. I find this black dust to be oxide of iron, and the permeability of iron to gases was curiously shown by the fact that these black grains were visible even in the centre of plates five or six inches in thickness.

I read a paper on this subject at the Chemical Society, and some eminent chemists disputed the existence of these particles of oxide in the burnt iron. They failed to find them. I do not question the accuracy of their analyses. They found no oxide because they sought for it in the wrong place. The iron they examined was not burnt. One analysed the end of an old rabble, assuming that, because it had been continually heated, it was burnt; but the fact is, that the conditions of heating of a rabble are just those that would prevent burning. The rabble is not exposed to oxidation, but, on the contrary, is immersed in a liquid containing carbides and silicides of iron, having considerable reducing power, as shown by their action on the oxide of the fettling. Burnt iron would be cured by using it as a rabble, and every puddler knows that his rabble remains malleable to the last, even though half-fused. He bends and forges it continually.

A French chemist heated some iron in hydrogen gas. It became brittle, like burnt iron. This could not have been oxidised, therefore he inferred that burnt iron is not so. If I had stated that oxidation is the only means by which iron can be made brittle, this experiment would have refuted so ridiculous a statement; but I say nothing of the kind, and understand perfectly well the source of the brittleness of the iron thus heated in the hydrogen gas. It is due to the occluded hydrogen, and the iron thus saturated with hydrogen is quite different from burnt iron.

I must now proceed to the manufacture of steel, but encounter a difficulty at the threshold. I am compelled to use the term "steel," but cannot easily tell you what I mean by it. The meaning of a word is determined simply by usage—by present usage; but in this case we have a word, the meaning of which is just now passing through a stage of transition. A substance which now in the Government contracts is officially designated "steel" was not called steel ten years ago, and the question, "What is steel?" has been recently discussed with much elaboration.

Formerly, steel might have been defined as a mixture or compound of iron and carbon, in which the proportion of carbon varied from about ½ per cent. to 1½ or 2 per cent., and which could be hardened, softened, or tempered. When it contained less than ½ per cent. of carbon, it was called wrought iron; when more than 1½ or 2 per cent., cast iron. Now we are producing large quantities of iron combined with only ¼ per cent. of carbon, or even less, which is officially described as steel.

There is another discrepancy, dating still further back, and of considerable practical importance, although merely a matter of definition. In most text-books Karsten's definition of steel is adopted, viz., "that it forms an intermediate link between cast iron and wrought iron," that it is "a member of a series commencing with the most impure pig iron, and ending with the softest and purest malleable iron." This oft-repeated definition has been the cause of much misery. Quite a multitude of inventors have unfortunately accepted it as applying to present-day iron, and accordingly have ruined themselves by attempting to manufacture steel by mixing wrought and common cast iron together, or by burning out by various means the excess of carbon of ordinary pig iron, and thus producing the intermediate product supposed to be

steel. The specifications in the Patent-office supply a miserable record of the ruinous failures thus engendered by a mere definition. I shall explain this more fully as we proceed.

The methods of making steel are very numerous, but may be reduced to four classes—

1. Steel made directly from the iron ore.
2. Steel made by adding carbon to pure iron.
3. Steel made by fusing pig iron with scrap iron.
4. Steel made by partial oxidation of pig iron.

The first was the primitive method of making steel. In the ancient bloomeries, where pure oxides and charcoal fires were used, most of the iron contained enough carbon to come under the modern definition of mild steel, and some of it sufficient to form hard steel. It was merely a matter of more or less blowing, and varying proportions of ore and fuel, whether iron, semi-steel, mild or hard steel was produced. The same is still the case with the primitive iron workers of India, Burmah, Borneo, Africa, China, Madagascar, &c. I have already described how this came about in the first lecture, and therefore need not further dwell upon it now.

The Catalan, or Corsican, furnace, which is still

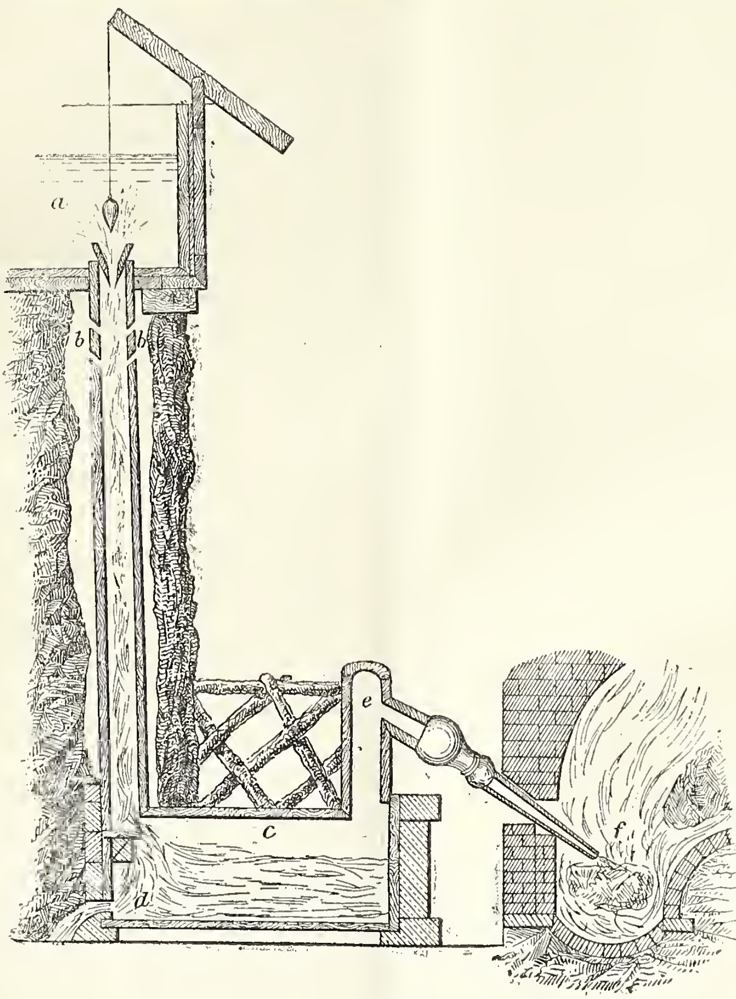

Fig. 13.

used in the south of Europe, especially in the neighbourhood of the Pyrenees, demands some further description. It is shown in the diagram, Fig. 13, where *f* is the hearth, or furnace, in which the ore is reduced. The bottom of this is made of a sandstone capable of standing a great heat, and is lined with a coating of charcoal dust. A pile of ore—usually rich hæmatite—is placed on the hearth, and heaped up over the curved wall opposite the twyer; and this portion is arranged to lie parallel to this curved wall. The hearth is then filled up with charcoal, and covered over with "*greillade*," *i.e.*, charcoal dust and small ore moistened and matted together. A gentle blast is applied at first, and when the flame bursts through the coating of *greillade* more is laid over it to check or damp the combustion, and prevent the heap of ore piled over the curve from falling

in too soon. This is continued for about two hours, then the blast is turned on fully, and the cinder tapped out. The ore that was piled on the curved wall is then pushed down gradually as the lower portion is reduced, and this is continued until the whole is reduced and a mass of spongy iron formed. The bloom thus obtained is then drawn out, hammered, and rolled with very primitive machinery. Some skilful management is necessary in order to flux away the silica; this is done at the expense of the iron oxide of the ore.

Here, then, we have a miniature blast furnace, wherein the operation is stopped at the reducing zone, and the spongy iron is taken out before the absorption of impurities and subsequent fusion occurs. Steel, or hard steely iron, is usually and most easily produced. In order to obtain soft iron a greater inclination is given to the twyer, and the blast is increased. A charge of 8 or 9 cwt. of ore, containing 45 per cent. of iron, yields about 33 per cent. of iron; and about three tons of charcoal are used for every ton of finished iron produced. If this process were used in England, with charcoal at 50s. per ton, the cost of fuel alone would be £7 10s. per ton of iron, besides very high charges for labour.

The American or Canadian bloomery is similar. It is used in Vermont, Quebec, &c., but with a hot blast and a consumption of about $1\frac{3}{4}$ of charcoal to 1 of finished iron.

The blowing apparatus of the Catalan bloomery is a very interesting contrivance. It is called the "trompe." It is available in mountainous countries where streams of water, pouring from high levels, are abundant. An upper tank *a* (Fig. 13) is erected on a ledge of rock, or other convenient place, with one end overhanging, as shown in the diagram, where this end is supported by a tree trunk. Connected with a large hole in the bottom is a wooden tube with oblique openings in its side at *b b*. This tube connects with the top of a lower tank *c*, which has an outflow opening at *d*, and which at its upper part communicates with the twyer (made of copper) at *e*. This tank is otherwise closed and air-tight. At *a* in the upper tank is a plug that can be raised and lowered by a lever to regulate the flow of water into the descending wooden tube.

When the water is allowed to flow down this tube, its velocity is of course accelerated as it descends. This acceleration divides the column of water, and the spaces between must therefore become more or less vacuous. In consequence of this, air rushes in at *b b*, and is dragged down by the descending water, and cannot return on account of the resistance offered by the fallen and broken water, which enters the lower tank by an opening suddenly contracted by the ledge shown above *d*. Thus there is a continual inflow of air as well as water to the lower tank, and a consequent pressure of air which produces a blast through the twyer. The pressure is regulated by the quantity of water allowed to fall through from the upper tank, and may be increased until it is so great as to overcome the falling water and drive itself back again up the tube. When the inflow and outflow of water at the lower tank are equal, the blast remains steady; when the inflow is in excess its pressure increases, when less it diminishes. One defect of this arrangement, otherwise admirable, is that the air of the blast is supersaturated with water, and even carries some spray. The ascending chamber at *e* allows much of the spray to settle down before entering the twyer.

Seeing that these primitive ironmasters have thus made steel directly from the ore, it is not at all surprising that modern attempts should be made to imitate them, and to work on a larger scale. I will give a few typical examples. In 1781, Lucas obtained a patent for making cast steel directly by melting hæmatite in pots, with charcoal, bone dust horn, &c.

In 1800, David Mushet made what he called "homogeneous metal," by melting ore with scrap and charcoal in crucibles. This was a semi-steel, very similar to that now so largely produced by the Bessemer and Siemens-Martin processes. In 1836, a curiously ingenious man, John Isaac Hawkins, the inventor of ever-pointed pencils, iridium-nibbed pens, manifold writers, &c., patented a similar method to that of Mushet.

In 1837, Clay patented a method of mixing small fragments of hæmatite with small coal or coke, and heating them together in ◠ retorts, similar to those used for gas making. Chenot, in 1854, made "metallic sponges" by reducing ore in similar retorts by means of carbonic oxide, and then separating the metal from the pulverised sponge by means of a magnetic sorting machine. This was afterwards heated with fatty matter to make steel, and melted in crucibles.

The process of Blair, of Pittsburg, is one of the most recent and ambitious attempts at direct steel making. I have lately seen it at work near Burslem, where firebrick cylinders, $4\frac{1}{2}$ ft. internal diameter and about 50 ft. in height, are built together in nests of six, and surrounded with an external tower of brick-work. At the upper part of each cylinder is a cast iron "thimble" or cylindrical cup, the outside diameter of which is 10 inches less than the internal diameter of the brick tube. Thus, when it is placed in the middle of the tube, there is an annulus of 5 inches all round it. This thimble extends downwards about 6 or 7 feet into the brick-tube. Fuel is placed inside the thimble, making its sides red hot, and the outsides of the brick tubes are heated by means of gas fuel at their upper half. The tube is charged with ore mixed with charcoal, peat, coke, or anthracite, which, by means of an arrangement similar to the cup and cone already described, is made to pass into the annulus surrounding the thimble. The thin layer of material is thus heated from both sides without contact with the fuel, the heat having only to travel $2\frac{1}{2}$ inches on each side to penetrate the whole of the charge. The maximum temperature is attained at about the bottom of the thimble, where the charge falls into the whole thickness of the brick tube, and descends gradually. All being heated before it gets there, the heat is easily maintained throughout this thick mass until reduction is completed. This occurs about half-way down the cylinder, all the gas heat being applied to the upper half. The spongy iron now gradually descends the cooler half of the cylinder, and by the time it has reached the bottom is sufficiently cooled to be protected from the rapid oxidation to which heated sponge is liable. The cooling is aided by a water jacket surrounding the lower part of the cylinder. The cooled sponge is drawn from the

bottom by a contrivance which discharges small quantities at short intervals.

At Burslem, the reducing agent was peat, and the sponge was broken into small fragments (it crumbles easily) mixed with charcoal, and pressed in moulds of the shape of the interior of the crucibles in which it was melted to form steel. This, however, was an expensive operation, only used in the experimental works. It was proposed to dissolve the sponge in a bath of melted pig iron, when a suitable furnace could be erected. This ingenious and promising process was, however, when I saw it in operation (January 12th) sadly crippled for want of the necessary capital for carrying it out fairly.

Mr. Larkin's process, recently described in a paper read here before the Society, is another interesting effort in the same direction. He uses crushed magnetic oxide of iron or iron sand, such as that from Taranaki, and by means of a magnetic sorting machine separates the ferruginous from the earthy particles. The grains of oxide are then mixed with charcoal, or charcoal and resin, moulded and pressed into the form of bricks that may be easily handled. These are charged into a ◘ retort by means of trays, which run from end to end, the retort opening at each end. The retorts are set and heated like gas retorts, and in them the oxide is reduced and falls to powder. This powder is discharged into a closed iron box, while the retorts are filled with reducing gas.

The box, now containing a powder of reduced iron mixed with impurities, also powdered, is cooled, and its contents withdrawn. These are again sifted by the magnetic sorting machine, and thus nearly pure iron dust is separated. This dust is now mixed with the quantity of carbon required for its conversion into steel, is again moulded into bricks, which are melted in crucibles, or better, in a Siemens regenerative furnace.

This furnace, which has now become so important an adjunct to the manufacture of steel, is supplied with gas fuel produced in a large chamber, capable of holding several tons of small coal or slack. Air in limited quantities is admitted to this, and the combustion so regulated that the carbonic acid produced, at the bars where the air is admitted, is converted into inflammable carbonic oxide in its passage through the heap of heated fuel above, while the upper portion of the fuel that has not yet reached the bars is distilled down to coke, yielding its combustible hydrocarbons, which are thus mixed with the ascending carbonic oxide. This mixture of gases is carried by means of flues to the furnace bed or other places where the heat is required, and there meets a regulated supply of air already heated in the regenerative chambers (which I have not time to describe) by the waste heat from the combustion that produces the fuel gas in the generator. Thus no heat is lost, and the final combustion of these gases takes place by means of heated air just where the heat is required, and all the fuel, including the solid carbon of the coal, is converted into gas. Besides these advantages, the original fuel itself may be of the cheapest kind—coal slack, peat, or any combustible refuse. The chief drawback to the use of "the regenerative furnace" as it is called, is the costliness of its original construction.

Puddling furnaces, steel melting furnaces, and special devices for the production of iron are now heated by this furnace, and the intensity of heat obtainable is limited by the fusion of the wall of the furnace, rather than the possibilities of the combustion of the gases.

This is also the case with Mr. Crampton's dust fuel. Both he and Dr. Siemens demand a new firebrick in order to do the utmost of which their sources of heat are capable.

Dr. Siemens has recently applied this source of heat to a process for the direct manufacture of iron and steel.

He mounts a cylindrical iron melting pot or crucible, about 9 feet long and 7 feet 6 inches in diameter, on friction rollers connected with machinery, by which it can be made to rotate slowly or quickly as desired. Unlike an ordinary crucible or melting pot, it is heated from the inside by means of the gases of the regenerative furnace.

The ore to be smelted is broken into small fragments, and to it is added a proper quantity of flux. The charge of about one ton of ore is put into the fully heated cylinder, which by slow rotation brings it successively to all parts of the heated lining, while it is also being heated by the flame of gaseous fuel filling the chamber. When the whole charge has thus attained a bright red heat, 5 cwt. of small pieces of coal are added, and the velocity of rotation increased. The coal reduces the ore, and the flux combines with its silica. Carbonic oxide is produced in the course of this reduction, and its combustion is found to be sufficient to maintain the heat. Therefore, during this stage of the process, only heated air is admitted in sufficient quantity for the combustion of the carbonic oxide thus cooled within. When the reduction is completed the fluid cinder is tapped off, and a quick speed is given to the rotator in order to ball up the granules of iron. The balls thus formed are taken out and treated in the same manner as the balls from the puddling furnace, if malleable iron is to be made.

A mild steel is made by stopping the action somewhat sooner; or a liquid steel by adding spiegeleisen (which I shall describe presently), and rapidly raising the heat by an abundant supply of gases from the regenerator. This fused steel is tapped out and run into ingot moulds. Instead of adding the spiegeleisen into the rotator containing the reduced iron, the balls may be conveyed into another rotator containing the spiegeleisen already fused, and thus several charges of iron may be combined, and 5 or 6 tons of homogeneous fluid steel produced. Dr. Siemens prefers this.

At a meeting of the Chemical Society, where this process was fully described by Dr. Siemens, he stated that a ton of iron can be thus produced with the consumption of only 14 cwt. of coal, or a ton of cast steel with 12 cwt. of coal, *i.e.*, about one-fourth of the quantity ordinarily used.

The principal difficulty in carrying out this system appears to be the maintenance of the lining of the rotator. *Bauxite*, a mineral found at Baux in France, and composed chiefly of alumina, has been used by mixing it with clay, and thus forming bricks. These are far more durable than the best ordinary fire brick, but a new fire brick is still demanded.

I may now pass from these processes of the 1st

class, or direct methods of producing steel, to the 2nd class, upon which we still depend for nearly all our best steel, that which is hard enough, and at the same time tough enough, to be made into tools with keen edges, or sharp teeth. This is what I may call the Sheffield method—the indirect or roundabout process—of first taking away all the carbon from the pig iron, and then putting about half of it back again in the "cementing" furnace. The reasons for this apparently clumsy proceeding will be explained in the next lecture.

For making the best steel the best iron is imperatively demanded, and for this purpose Swedish charcoal iron is generally used.

The cementing furnace is a cupola or dome-like structure, externally resembling a glass house, and forming a characteristic feature of the gloomy landscape of Sheffield. The lower part (with the upper or conical chimney cut off) is shown in the diagram, Fig. 14, where *f* is the ash-pit of the fireplace, the bars of which are shown endwise, just above the letter; *c c* are two "chests," or converting pots, shown in section. These are made

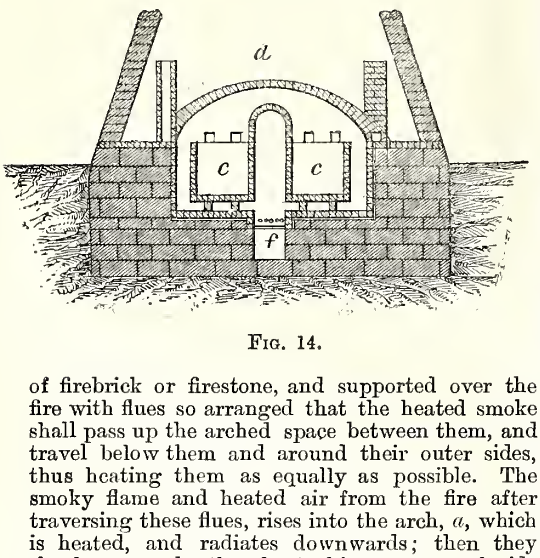

Fig. 14.

of firebrick or firestone, and supported over the fire with flues so arranged that the heated smoke shall pass up the arched space between them, and travel below them and around their outer sides, thus heating them as equally as possible. The smoky flame and heated air from the fire after traversing these flues, rises into the arch, *a*, which is heated, and radiates downwards; then they slowly escape by the short chimneys on each side of the arch into the great cavity of the conical dome. The main object of all this is to steadily heat the chests with a slow-burning, semi-smothered fire, that shall yield reducing rather than oxidising products of combustion. If there were a strong draught, the combustion would be too vivid for this, and there would be great waste of fuel by the carrying away of the heated gases too rapidly, and before they had done their work.

The chests, which are 10 to 15 ft. long, $2\frac{1}{2}$ to 3 ft. deep, and about the same width, are charged with 12 to 18 tons of bars, corresponding in length to that of the chests, and usually 3 in. wide and $\frac{3}{4}$ in. thick. The charging is conducted by first spreading on the bottom of each chest a layer of coarsely ground charcoal—that from hard wood preferred—about two inches thick, then a layer of bars with $\frac{1}{2}$ to $\frac{3}{4}$ in. space between. Over these, and into the interspaces, a layer of charcoal is sifted until about 1 inch deep above the bars. Then another layer of bars and charcoal, so on up to about 6 in. of the top. Then old cement powder (*i.e.*, the charcoal already used) and grinders' waste, or "wheels waif," is moistened, and plastered over this, and the whole covered with damp sand or clay to exclude the air. The man-hole is now stopped, but some long trial bars are left protruding from the "tasting" holes.

The furnace is maintained at a glowing red or yellow heat for eight or ten days, and the trial or tasting bars are occasionally withdrawn for inspection. The progress of the cementation is ascertained by the blisters on these, and by fracture. When the carbon has sufficiently penetrated to the centre of the bars, the furnace is allowed to cool slowly. This occupies about another week.

The bars, when removed from the furnace, have their surfaces covered more or less completely with blisters, and the steel thus formed at this stage is called "blistered steel." Chemical examination shows that the iron has combined with carbon, that the quantity of combined carbon is greatest at the surface, but some of it has penetrated to the middle of the bars. The workman determines the penetration of the carbon by the grain or fracture, for the bar-iron during the cementation process loses its fibrous structure, and acquires a very fine granular or minutely crystalline structure, which is revealed by the fracture.

That the carbon should actually penetrate these solid bars of iron in this manner is a very remarkable fact. The experiments of the late Dr. Graham, demonstrating the permeability of iron and other metals, especially when heated, to certain gases, assist in explaining the phenomena of cementation, especially as it is found that a certain quantity of hydrocarbon, or cyanogen, or other carbon compounds which become gaseous at a red heat, materially assists the cementation. The use of cyanides in steel-making—(one of the profound secrets of the trade, well known to all concerned)—supports this explanation.

The usual explanation is that the surface of the bar first obtains, by direct contact with the charcoal, a large dose of carbon; that this superficial film then passes on a portion of its carbon to a film within, and simultaneously regains what it gave up, from the superficial carbon, as at first. Then the second film transfers some of its carbon a stage deep, and reabsorbs a compensating amount from the outside film, and so on deeper and deeper, the carbon travelling by a sort of convection until the centre is reached.

However this may be, the outside of the bar being harder and containing more carbon than the interior, and the bars being unequally charged with carbon, both as compared with each other and in different portions of their length, it becomes necessary, in order to obtain uniformity of composition, to mix these varying portions together. The most obvious method of doing this is to cut the bars into small pieces, mix them well together, and melt them. This is done in the manufacture of the best quality of British steel, the "cast steel," or "pot steel," of Sheffield. It is, however, a costly process, in consequence of the high temperature required and the consumption of fuel and destruction of crucibles. As only small quantities are melted at one time, the labour charges are also high upon every ton of steel thus melted.

So great is the destruction of crucibles, that in and around Sheffield garden walls and other structures are commonly built of old pots instead of bricks.

This process of melting is applied to the hardest or most highly carburetted steel for two reasons. First, that such steel should combine hardness and toughness in the highest degree, and consequently must be homogeneous; and secondly, because it is more practicable with hard steel containing the most carbon, as this is the most fusible.

Although this is the best means of rendering steel homogeneous, it is not the only one available. A cheaper method is practised very extensively in the manufacture of softer second class steel. The cemented bars of blister steel are cut into short lengths, then packed together in bundles or "faggots;" these are raised to a welding heat, then hammered out with a tilt hammer (Fig. 15)

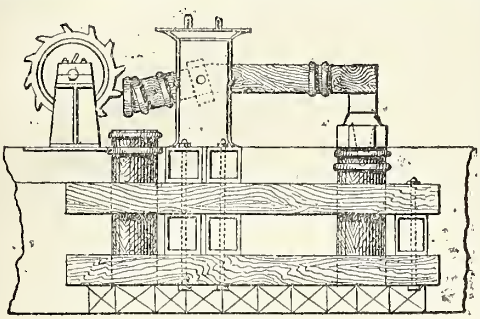

FIG. 15.

striking 300 to 400 blows per minute, so rapidly that the heat of the faggot is maintained by the percussion. This bundle, thus welded into one piece, is rolled into bars, sheared, re-faggoted, and re-tilted. Steel thus treated is called "shear steel," "single shear," "double shear," &c., according to the repetition of the process.

MISCELLANEOUS.

HEALTH AND SEWAGE OF TOWNS.

The *Lancet* again recurs to this subject, and in the number for August 5th writes as follows:—

The Vestry of Kensington have declared "that the statement made by Sir Henry Cole to the Metropolitan Board of Works, that typhoid fever is chronic in South Kensington, has no foundation in fact, for no death from that cause has occurred in South Kensington during the present year, and the medical officer of health of the parish is unacquainted with any cases of illness from the same disease." We believe Sir Henry Cole coupled scarlet fever with typhoid fever, but the Kensington Vestry are silent on that point, and doubtless with reason. Most persons who have had any lengthened acquaintance with Kensington will admit that Sir Henry Cole's statement, though, perhaps, somewhat strongly put, is not altogether without foundation. The present medical officer has worked manfully in improving the condition of his district, and has succeeded in effecting many great improvements, but the very points that have baffled him are those that are baffling health officers everywhere, and over which the sanitary authorities have practically no control. It was to strengthen the hands of the local boards that the Society of Arts waited on the Metropolitan Board of Works with their memorial in reference to improved supervision of house-drainage, and we venture to say the sympathies of every person interested in sanitary matters go with the memorialists. We regret, therefore, to see the Kensington Vestry practically placing themselves in opposition to a scheme at once reasonable and necessary, by raising what must be considered as a mere quibble. Surely the vicar, the Rev. W. D. Maclagan, who presided at the Vestry meeting in question, must know of many houses occupied by his poorer parishioners in which the improvement of the house-drainage is urgently demanded. For our part we fully endorse Sir Henry Cole's statement with respect to the defective drainage of some of the best houses in Kensington, and we have received frequent complaints as to the unhealthy conditions produced by it. We recommend the Kensington vestry to co-operate with Sir Henry Cole and the Society of Arts in procuring additional legislative powers, by which the present sanitary imperfections can alone be remedied.

SUPPLY OF WATER TO THE METROPOLIS.

It has often been said that the chalk about the metropolis has a supply of pure water sufficient to last for 200 years without addition. For years fine water has been obtained at Caterham and at Tring, and lately a most successful result has been obtained at Bushey by the Colne-valley Waterworks. The following account of the opening of them has been taken from the *Times*:—

Numerous projects, advanced from time to time, for supplying a portion of London with pure water, have, hitherto, always met with great opposition from various sources. So long ago as 1641 there was a proposition to supply St. Giles-in-the-Fields with water from Rickmansworth. One great objection, however, to water for domestic purposes as derived from the chalk is its hardness, and this quality has hitherto formed one of the barriers to the utilisation of the water at Watford. Advantage has, however, at length been taken of this supply by the Colne-valley Water Company, who have established works at Bushey, which were publicly opened on Thursday. The difficulty of the hardness has been admirably overcome by the adoption of the late Dr. Clark's process for softening water, by which means the only objectionable feature present in the water is now removed before distribution to the consumers. The works occupy a site of land about five acres in extent, and the buildings comprise an engine-house 68 ft. long by 38 ft. wide, a boiler-house 50 ft. long and of the same width, a coal vault about half that area, a lime tank-house 63 ft. long by 33 ft. wide, and a slaking room 30 ft. in diameter. Besides the buildings there are three large open reservoirs in the grounds, as well as a settling pond, and other adjuncts of waterworks. The well from which the water is raised is immediately under the engine-house, and the water is drawn from the chalk at a depth of 235 ft. from the surface. The bottom of the well proper is 95 ft. below the engine-room floor, and from the bottom of the well descends a bore 140 ft. deep, and 11 in. in diameter. The lower portion of the well is 10 ft. in diameter, the upper part being about 17 ft. square, and containing the pumps.

The pumps are driven by a pair of horizontal condensing engines of 60-horse power each, steam being supplied from three Cornish boilers, each 21 ft. long, and 5 ft. 6 in. diameter, with 2 ft. 9 in. flues. The pumps by which the water is raised from the well are double acting plunger pumps, each 12 in. diameter, and having a 2 ft. 6 in. stroke. There are two of these pumps, one to each engine, and they with the engines are in duplicate in case of a break down. Each pump will raise 300,000

gallons of water per 12 hours. The water having been raised to the surface by one of the pumps, flows by gravitation to the reservoirs in the grounds. There are three of these reservoirs, each capable of holding 640,000 gallons of water. It is in these reservoirs that the softening process is carried out, the reservoirs being used alternately. Dr. Clark's process consists simply in mixing a certain proportion of lime water with the hard water, which has the effect of completely softening it. The lime for this purpose is first slaked in the circular room previously referred to, and is passed thence into the adjoining lime tanks, where it is mixed with water to the consistence of cream. There are two lime tanks, each capable of containing 74,000 gallons of the mixture. This mixture of lime and water, aftr settling, flows by gravitation to the reservoirs, and there, on being admitted, acts upon the contained water. After remaining for about five hours in the reservoirs, during which time the chalk held in solution is precipitated by the lime,* the softened water flows back by gravitation to the engine-house, where it is pumped by a set of three throw pumps to a covered reservoir on Bushey-heath. The pumps are 10 in. in diameter and 2 ft. 6 in. stroke, and are driven by the same engines which drive the pumps for raising the water from the well, and, like them, they are in duplicate. The covered reservoir on Bushey-heath has a capacity of about 2,000,000 gallons, and is situated at an elevation of 518 ft. above Ordnance datum, so that the water can be supplied to the highest land between Watford and London by gravitation. The districts to be served comprise Bushey, Aldenham, Elstree, Pinner, Harrow-Weald, Stanmore, Edgware, a portion of Hendon, and Kingsbury. The mains from the pumping station to the Bushey reservoir are 20 in. in diameter. From the latter place the water is carried by an 18-inch distributing main, with branches of various sizes down to 3 in. diameter. In the districts supplied a number of Bateman and Moore's ball hydrants are to be fixed, so that a plentiful supply of water will always be ready at hand.

The water, as pumped from its source, has $18\frac{1}{2}$ deg. of hardness, but on leaving the works it possesses only 3 deg. which places it well within the limits of soft water. In the course of time the precipitated lime becomes deposited in the reservoirs in which the softening process is carried out. This deposit is cleared out occasionally, and is run into an adjoining pit, where it is collected and afterwards sold for manure. The works were constructed from the designs of Mr. J. F. Bateman, C.E., the engineer to the company, at a cost of about £80,000, Messrs. Lucas and Aird being the contractors for the general works, and Messrs. J. Watt and Co. for the engines and machinery. The engine house and adjacent buildings are red brick structures of neat design, a house of similar character for the manager being in course of construction. Besides having the machinery in duplicate, the plant has been laid out so that the pumping machinery can at any time be doubled, thus enabling the company to double their productive capacity at a small cost should circumstances favour an extension.

With regard to the Society's endeavour to promote the practical study of Domestic Economy, it may be worth while to recal a remark made by Dr. Dawes (Dean of Hereford), who said he attributed most of the success which had attended his education exertions to the fact of his having made the knowledge communicated to bear on the practical duties of life.

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* This description is of course rather popular than accurate. The soluble bicarbonates, to which the hardness is due, are decomposed into insoluble carbonates. The temporary hardness is thus got rid of, the permanent hardness, due to sulphate of calcium, remaining the same. The method, however, is so well known as hardly to require this explanation.

REPORT ON THE PROGRESS AND CONDITION OF THE ROYAL GARDENS AT KEW, DURING THE YEAR 1875.

Dr. Hooker's report on the result of the year's work at Kew, though bearing date January the 1st, has only just appeared. These well-known gardens, though a popular place of resort during the summer months, are much more valuable to the public, indirectly, for the solid work quietly done there than as a place of pleasure and recreation, nevertheless, immense numbers of people visit the gardens during the year. The total number, as given in the report, from January 1 to December 31, 1875, was 678,002 against 699,426 in 1874. This diminution may, perhaps, be accounted for in various ways, one of which is, that every year, the simple pleasure-seekers are taken farther away from London by the attraction of cheap railway fares. The strength, or true value of the gardens, however, is not to be found in these great numbers, but in the amount of work got through by the staff. Thus, for instance, in referring to the revival of the office of assistant-director, Dr. Hooker says it has been rendered obligatory by the great increase in the collections of all kinds whether living, dried, or economic, by the expansion of the official correspondence, more especially with the Admiralty, Colonial, and Indian Offices, the local Governments of our foreign and colonial possessions, and by the more numerous scientific persons, travellers, and others who visit Kew for information. There are few Government establishments indeed where so much work is got through at such little expense to the country, work not only of a truly scientific character, but also of a nature beneficial, either directly or indirectly, to our Indian or Colonial possessions as well as to the world at large. The successful acclimatisation of useful plants in countries of wide geographical range, notably the Cinchonas in India, are illustrations in point, and year after year plants of economic or medicinal value are, either by seeds or cuttings, distributed freely from Kew. A few abstracts on what has been done during the year in this system of distribution will show the value of Kew as a national botanical establishment, and the kind of work effected about which the general public know little or nothing. The Liberian coffee, which besides being of a more robust habit and producing larger seeds than the ordinary coffee (*Coffea arabica*) will, it is hoped, be proof against the attacks of fungi which has of late years so fearfully devastated the coffee plantations in Ceylon. This Liberian coffee, now known to botanists as *Coffea liberica*, has been distributed to all the coffee growing countries, colonial or foreign, with which Kew is in correspondence, the most important recipients being Bahamas, Barbadoes, Bermuda, Dominica, Jamaica, Montserrat, Ceylon, Bangalore, Calcutta, Madras, Java, Mauritius, Natal, New Grenada, and Rio de Janeiro, in all of which places, with the exception of Grenada, the plants have been successful.

Dr. Hooker says, "In my last report I stated that an extensive correspondence had been carried on between this establishment and various coffee growing countries with respect to the diseases and insect ravages to which the coffee is subject. At my request, Dr. Thwaites, the Director of the Botanic Gardens, Peradeniya, Ceylon, drew up a series of questions, which have been addressed to the various coffee-growing colonies. A large body of replies have been received, and the information contained in them is now in course of examination, and will be reported upon to the Colonial-office." The thorough investigation of this subject will prove a matter of the greatest interest, both scientifically and commercially. The cultivation of tobacco in the Straits Settlements has been advanced by furnishing the Governor with a supply of seeds of the best kinds of American, West Indian, and Turkish. The subject of the production of different kinds of caoutchouc in India, which has recently occupied the

notice of the Society of Arts, continues to engage the attention of the India-office and of Kew. One fact in connection with it, which seems to require very careful consideration, has been pointed out by Mr. Mann, in his report on the caoutchouc plantations in Assam. It is found that, although the *Ficus elastica*, the indigenous rubber-plant of India, will grow with undiminished rapidity and luxuriance in situations remote from the hills, it fails to yield caoutchouc. Mr. Mann concludes that no greater mistake could be made than to start plantations of this plant in any part of Bengal. It appears, therefore, judging from this case, that conditions which may ensure the successful growth of caoutchouc-yielding trees may not be sufficient to determine their producing caoutchouc. The most valuable rubber plant, that of Para (*Hevea brasiliensis*), has already been introduced into India, and is capable of easy propagation by cuttings; so far as the plant itself is concerned there seems no reason why it should not only be successfully introduced but quite acclimatised in India. The introduction of the Central American rubber plant (*Castilloa elastica*) has already been referred to in the *Journal*, forming as it did part of the subject of Mr. Clements Markham's paper read before the Society during the past session.

The pods of the *Prosopis pubescens*, under the name of the Mesquit or Screwbean, are largely used in Arizona for feeding cattle. It grows in the dryest places where extreme drought prevails, and it is thought that it would probably prove useful as a cattle food in South Africa and Australia. A gum also exudes abundantly from the stems of these plants, which is used in Texas and Arizona for medicinal and technical purposes, similar to gum Arabic.

Finally, in this diffusion of useful plants, a large consignment of young cork oaks have been despatched from Kew to India for the Punjab.

SECONDARY EDUCATION.

The statistics of this important branch of National Education are well known abroad, but have never been collected in this country. A movement at last has been made by Lord Aberdare, late Lord President of the Council. On the 4th he asked the Duke of Richmond, the present Lord President, whether he had the means of making a return of the number of schools in England and Wales in which instruction was given to children above 13 years of age, and if he had not, whether he would take any measure to supply such deficiency. There had been exhaustive inquiry into the Universities, public schools, and elementary schools, followed by legislative action, but there had been no inquiry into the state of the schools—such as the endowed schools throughout the country—which occupied a position between the elementary and higher class schools, and he believed that on inquiry it would be found that large districts were insufficiently supplied with the means of obtaining such education. He knew it would be impossible for the noble Duke, however well disposed, to furnish the same amount of information on this subject which would be supplied through the medium of a Royal Commission. At the same time valuable information might be obtained through the large body of Inspectors and Sub Inspectors who were employed by the Department, and the country might in this way get to know the number of these schools, the number of children attending them, and the class of education given there.

The Duke of Richmond and Gordon said that if the noble Lord confined his question to the number of elementary schools under inspection there would be no difficulty in furnishing the information. Indeed, he could give it at once. The number of elementary schools under inspection was 15,921, and there were in them 92,215 children who were above 13 years of age, making 3·36 per cent. of the scholars on the register of the aided schools. If, however, the reference was not merely to schools under inspection, but to schools of all classes, he had not the means of obtaining the information sought for, and doubted whether the expenditure of time, labour, and money necessary to procure such information would justify the Government in attempting to procure it. If, too, an inquiry was instituted, it was doubtful whether the return would be even approximately accurate, for the inspectors were not likely to be able to obtain these particulars. Even now it was difficult to get the work done in the Department, for this work increased day by day with the increase in the number of elementary schools and of the scholars attending there; and the work was likely to become greater if the Bill now before the other House were passed. Moreover, the information asked for would be necessarily imperfect, because there must be a number of schools into the condition of which no one would have a right to inquire, and as to which the persons conducting them might be unwilling to give information. Under all the circumstance, he must answer the second part of the noble Lord's question in the negative.

The subject of obtaining the information will be considered by the Council.

NEW GALVANIC BATTERY.

M. Leclanché has just constructed a new galvanic battery, which the *Annales Industrielles* thinks likely to render great service both in manufactures and in scientific research.

The original oxide of manganese battery by the same inventor consists of a porous jar filled with *pyrolusite*, in which is contained the carbon forming the positive pole. This jar is immersed in a solution of sal ammoniac in contact with zinc. M. Leclanché has, however, introduced several improvements into this battery. He has superseded the porous jar by conglomerating the oxide of manganese, mixed in nearly equal parts with carbon, but with the addition of a small quantity (5 per cent.) of resin for the purpose of giving consistency to the mass. These three substances, properly pulverised and intimately mixed, are conglomerated under a considerable pressure, and at a temperature of about 100° Cent. (212° Fahr.) into a solid cylinder, which serves at the same time as a porous diaphragm and a positive electrode. But here a difficulty occurred. Under the influence of the current, an almost insoluble oxychlorate of zinc was formed, which was deposited in a crystalline form in the pores of the electrode, and considerably diminished its conductibility, so that the internal resistance of the battery increased very rapidly, occasioning considerable inconvenience, especially when used for telegraphic purposes.

M. Leclanché has now got rid of the difficulty by inserting in the centre of the carbon and manganese electrode, while being moulded, a small cylinder of bisulphate of soda. This acid salt prevents the formation of the oxychlorate of zinc; and the battery preserves its regularity for more than a year without the necessity for renewing the water of the saline solution. It offers a much slighter resistance than other batteries, and gives out a considerable quantity of electricity. A single element of small size, presented by M. Du Moncel to the Académie, immediately caused a platinum wire connecting its two poles to become red hot.

Mrs. Griesbach has presented to the Lord President of the Council, for the proposed scientific museum, a valuable collection of a acoustical apparatus, invented and made by her late husband, John Henry Griesbach. This apparatus is now exhibited in the Loan Collection of Scientific Apparatus.

THE CITY OF BRUSSELS.

[NOTES BY A CORRESPONDENT.]

Brussels, when the writer visited it for the first time forty-two years ago, contained about 80,000 inhabitants; it now, with the suburbs, which are practically Brussels, numbers 400,000. Though from time to time, at intervals, he has paid visits to this thriving capital, the enormous progress made in the last few years is still most striking. In addition to the extension of the city into the suburbs, numerous crowded and unhealthy quarters, with narrow, crooked, and ill-drained streets, have been entirely swept away, and are replaced by superior buildings, broad streets, and well-planted avenues. An excellent and commodious system of street tramways adds greatly to the convenience of getting about, and these are largely made use of by all classes. The carriages are light, and so made as to run readily round sharp curves. Some are drawn by two horses, and some by only one; some are open at the sides, with rows of seats *char-à banc* fashion, and an awning to shade from sun or rain, and some have side curtains; while others are entirely closed, having a division, by means of a sliding door, to separate first and second-class travellers, the fare varying according to class or position of seat. It is evident that the traction must be far less heavy than that on the London trams, for the small Flemish horses employed trot away with their burden at a good pace, and are in excellent condition; in fact, they will bear no unequal comparison in that respect with those employed in our private carriages. Within the last few weeks steam has been pressed into the service, and a steam-drawn tram-car has been and is in actual daily use on the Bois de Cambre line. A small engine of compact character, burning coke and making neither noise nor smoke, the invention of M. Duroy, precedes and drags an ordinary car with ease and facility. It is under perfect control, stops readily, and runs at one part of the line over a gradient of 1 in 33 without any difficulty and without alarming the horses met with on its journey. The engineer stated that so far as their experience had gone, it was considered that the cost of the steam system was 20 per cent. less than that of horses. Former visitors will recollect the filthy tortuous stream of the river Senne, running through the city, dark and foul from all sorts of abominations collected in its course from the narrow ill-conditioned streets which abounded in that direction. This has been entirely abolished, the course of the river has been diverted into a more or less straight channel, covered over entirely from one end to the other, with a large intercepting main sewer on each side. These works are on a grand scale, and do credit not only to the engineering skill with which they are designed and constructed, but to the broad and comprehensive views taken by those entrusted with the administration of the city. New streets, new houses, and a broad handsome boulevard, well planted with an avenue of trees, now take the place of the expropriated quarter. The sewage at present is not utilised, but simply taken into the Senne below the town. It is, however, decided to employ it on a farm as the best means of dealing with it, and the delay in adopting this course has hitherto arisen from the very heavy demands made by proprietors for compensation. The clearance round the cathedral is very striking, as that noble pile can now be seen to advantage. Since the writer visited Brussels a few years since a grand and commodious Conservatoire of Music has been built, superseding the old and inadequate structure then used for the purpose. The new building is a handsome massive structure, and consists of two wings and a centre, forming three sides of a square. It contains, besides the necessary offices, twenty lofty class-rooms, large and small, a library, and a theatre and concert-room combined, adapted for holding about 1,500 persons in capacious stalls and boxes. An organ for teaching purposes, of three rows of keys and thirty stops, is placed in one of the lower rooms. A large organ for the use of the concert-room is in the course of construction. A residence for the Director is about to be built adjoining the main building. All Belgians are entitled to the privileges of instruction in the Conservatoire, for a nominal fee of 5 francs. Foreigners pay 200 francs, about £8. Not far from this building is the new Palais de Justice, an enormous structure, which it is intended shall be finished in 1880, marking the era of the 50 years' existence of Belgium as an independent kingdom. Without entering into the exact dimensions of this building and our own law courts, the Brussels Palais de Justice will, when complete, compare with them favourably, both in point of size and solidity. The Bourse, too, an entirely new building, is worthy of the city, and the arrangements for the convenience of the merchants and bankers attending to transact their business there are very complete in character. It is in electric communication with every leading commercial town of note. The Bureau des Postes is also noteworthy. There is in operation a very simple and convenient system of public clocks, placed at the corner of some of the principal streets in electric communication with the Observatory, by means of which correct time is displayed. This, however, is not new; but it is worthy of consideration whether some such system could not be adopted in our own metropolis. All these buildings and constructions, except the trams, which are in the hands of two companies, are erected, and the administration connected with them maintained, at the public cost, and bear remarkable testimony to the wealth and thrift of this nation; for, in spite of these large expenditures for public works, it does not appear that the taxation, imperial or local, is by any means heavy.

GENERAL NOTES.

Endless Rails.—On 11th July a trial was made by M. Clément Ader with his "endless rails," at the Parc des Buttes Chaumont, Paris, with very satisfactory results. Three small carriages made up into a train circulate on a line of way formed by articulated rails, which are raised after the passage of the carriages, and are laid down again in front of them. The train, propelled by steam or horses, may, at the will of the guard or driver, take any direction, and may even run over treacherous or sandy ground. The Administration des Forets, which has taken the initiative in these experiments, proposes to repeat them on a large scale on the sandy soil of the department of Les Landes.

NOTICES.

SUBSCRIPTIONS.

The Midsummer subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

HEALTH AND SEWAGE OF TOWNS.

The Report of the proceedings at the Conference on the Health and Sewage of Towns, held by the Society on May 9th, 10th, and 11th, has been published, and can be had on application at the Society's House. Price 2s. 6d.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,239. Vol. XXIV.

FRIDAY, AUGUST 18, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

HEALTH AND SEWAGE OF TOWNS.

The following letter has been received from the Metropolitan Board of Works, in reply to the memorial recently presented to the Board by the Society*:—

Metropolitan Board of Works,
Spring-gardens, 14th August, 1876.

Sir,—The Board have had under consideration the memorial presented on the 21st ultimo, from the Council of the Society for the Encouragement of Arts, Manufactures, and Commerce, on the subject of house-drains and their connection with sewers.

I am directed, in reply, to draw the attention of the Council to the provisions of the Metropolis Local Management Acts of 1855 and 1862, relating to this question, by which extensive powers are conferred upon the Vestries and District Boards of the Metropolis, to compel owners of house property to provide for drainage. Under Section 69 of the Act of 1855, the Vestries are to repair and maintain all the district sewers, and they are to cause all gully-holes, &c., to be trapped, and (by Section 72) to be cleansed and emptied. Section 73 of the same Act provides that if any house built before or after 1855 be not properly drained by a communication with some sewer, and if a sewer of sufficient size be within a hundred feet of any part of the house, the Vestry may order the owner to make proper covered drains, with a proper fall, and to provide proper surfaces to convey water and wash into the sewer, and sinks, properly syphoned and trapped, to prevent stenches. The Vestry may cause the works to be inspected while in progress, and make orders for proper alterations, and so as to secure the complete and perfect working of such works, and in case of neglect of the owner, the Vestry are empowered to carry out the same. Section 74 provides for combined drainage; and Section 75 requires houses to be erected on the condition of drains being satisfactorily constructed. Under Section 76, the Vestry are to have notice of such works; and by Section 81 heavy penalties are placed on parties erecting houses without proper water supply, and other apparatus and traps. Section 82 provides that Vestries may direct their surveyor to inspect drains, closets, privies, cesspools, water-supply apparatus, at all reasonable hours in the day time, and may cause works to be done; and the three next sections make fuller provision. The Vestries have also large powers under the Nuisance Removal Acts, and under 25 and 26 Vic., cap. 102, Sec. 67, they may also require water to be laid on.

It will thus be seen that an examination of all the statistics relating to this subject points to the conclusion that the Vestries and District Boards have ample powers as regards the matters complained of by the memorialists, but I am to state that, should they be able to demonstrate to the Board that there is a deficiency of such powers, the Board apprehend that no difficulty would be made by Parliament in granting all needful amendments.—I am, Sir, your obedient servant,

J. Wakefield, *Clerk of the Board.*

P. Le Neve Foster, Esq., Secretary,
Society of Arts, John-street, Adelphi.

* See *Journal* for July 28, p. 859.

The letter will be considered by the Executive Committee on "Health and Sewage of Towns," at their next meeting.

CANTOR LECTURES.

The last lecture of the second course of Cantor Lectures for the past Session, on "Iron and Steel Manufacture," by Mr. W. Mattieu Williams, was delivered on Monday evening, February 21st, as follows:—

Lecture VI.

In the last lecture I described the round-about Sheffield method of making steel, by first taking the carbon away from the pig iron in the puddling furnace, and then restoring about half of it in the cementing furnace. If this were all that is done, and if good steel really were, as commonly described, "an intermediate link between ordinary cast iron and wrought iron," a "number of a series commencing with the most impure pig iron and ending with the softest and purest malleable cast iron," or if "all intermediate products which cannot be classed with cast iron on the one hand, or with wrought iron on the other may be called steel," then the Sheffield process would indeed be disgracefully clumsy; but these descriptions of steel, though repeated again and again in even our best text-books (I quote the above from "Phillips's Metallurgy") are, as I have already stated, fallacious and mischievous, for British pig iron is a medley of impurity, and good steel of high market value is not an intermediate substance between this and wrought iron, but is simply a compound of iron and carbon. Perfect steel would be that in which nothing else existed but pure iron and pure carbon; and although this may not be attainable, the excellence of any given sample of steel is proportionate to its approximation to this standard.

It is my duty, however, to tell you that I make this broad statement on my own authority, and therefore you must accept it at its proper value, several eminent chemists having expressed very different and conflicting opinions on this subject. These I will discuss presently.

Accepting the descriptions of steel as a compound intermediate between pig and wrought iron, or as pig iron deprived of about half of its carbon, a great number of inventors have naturally sought to supersede the Sheffield process, by simply mixing pig and wrought iron together, stopping the refinery of pig iron half way, or, as in Heaton's process already described, using some artificial oxidising agent. All these have failed when ordinary English pig iron has been used, for the simple reason that the sulphur and phosphorus of the pig have remained in the steel thus easily produced, and in some cases much of the silicon also. Steel has been thus made over and over again, and sanguine inventors have displayed their samples and testimonials, have proved the un-

questionable hardness of this cheaply made steel, and have had its tenacity tested with grand results. It has borne a tensile strain of 50 to 60 tons to the square inch, more than double that of the best iron, and considerably more than Sheffield steel. Companies have been formed, shares eagerly taken up, works erected, all upon faith in the text-books descriptions of steel, and consequently the obvious common-sense simplification of the round-about Sheffield process confirmed by the practical testimony of these prospectus samples. Upon placing the steel in the market, however, it has been rejected, and the scheme has collapsed, only to be replaced by a repetition of the same idea similarly patented, similarly shown to be valuable, and ultimately proved to be worthless.

The reasons for all this will be better understood presently. In the meantime I must describe some cases in which these short and cheap methods, classed as Nos. 3 and 4 in the last lecture, have been actually successful. In none of these, however, has ordinary English pig iron been used.

As an example of the method of mixing cast and wrought iron, I may cite the process first worked with practical success by Martin, of Sireul, near Paris, with the aid of the Siemens regenerative furnace and the use of special pigs nearly free from phosphorus.

The furnace used for this is like the working chamber of a puddling furnace, but flat on the bottom, which gradually inclines towards the tap-hole. The bed is made of ground quartz rendered solid by heat and pressure.

The charge consists of 35 cwt. to 4 or 5 tons of a mixture of these special pigs with scrap iron and spiegeleisen (a charcoal iron containing much carbon and manganese with very little sulphur or phosphorus). The proportion of pig iron to scrap is about one to ten, an important feature of this process, as the impurities of the pig are thereby so largely diluted.

The pig iron is first melted to form a liquid bath, the furnace being intensely heated by the gases from the regenerative furnace. The scrap iron (crop ends of rails, old rails, &c.) is now added, care being taken not to cool down and solidify the bath. This object is attained by first raising the scrap pieces to a white heat, by exposure to the gas flame on the bridges, and then casting them, in small quantities at a time, into the bath. Ladle samples are taken out occasionally and tested. When these indicate a proper degree of hardness the whole is tapped into ingot moulds.

By thus using a very large proportion of wrought iron, *i.e.*, iron from which the other impurities are already removed, and a pig of superior quality made especially from red hæmatite, very good samples of mild steel are made, some of which I have on the table. (These specimens were manufactured by the Landore Siemens Company, and kindly lent by Messrs. Campbell and Morris.)

This process is especially valuable as a means of using up scrap iron, Bessemer scrap, and other cheap material.

The Uchatius process, patented in 1855, although a failure in England, has been worked successfully in Sweden.

Pig iron is melted in a cupola furnace, then run in a thin stream into water, and agitated on its way by a dash-wheel. By this means the iron is granulated. The granules are mixed with roasted peroxide of iron and some oxide of manganese, a little fire-clay being added as a flux. This mixture is melted in crucibles. The peroxide is reduced, giving up its oxygen to the silicon, and to some of the carbon of the pig. The silica thus formed combines with the flux and oxide of manganese, and floats to the top, while the remaining unoxidised carbon of the pig supplies the steel with the necessary quantity of carbon.

I need scarcely add, after what I have already stated, that the failure of this process here and its success in Sweden, is not due to the difference of climate, or of skill in the workmen, but is simply one of a multitude of evidences of the incompatibility of phosphorus and sulphur with good steel. It would succeed here if Swedish charcoal pig were used, but with our common pigs it produces worthless steel.

The most interesting and important of all the oxidising processes is that now so well known as the "Bessemer" process. It is a curious example of a great success achieved in spite of failure. Mr. Bessemer started upon the idea that the puddling process is merely one of oxidation; that by simply blowing air through melted pig he could do all that the puddler does; and more than this, that he might stop half-way, or at any other stage, and thus produce steel of any degree of hardness. He overcame all the mechanical difficulties of carrying out this idea; did blow the air fairly and bodily through the melted pig; did oxidise successfully, so far as silicon and carbon are concerned; but there he stopped. The sulphur and phosphorus stubbornly remained, and his iron was worthless. He struggled with this dfficulty for some time, under discouragements that would have baffled most men. A great deal of public attention was directed to his invention, and he was especially assailed by a class of men who are about the most ignorant and insolent of any in existence. I mean those who "pooh-pooh" and sneer at every innovation, every aspiration for human advancement, every project of every inventor, and then, when any of these fail, they assert their own superior wisdom by the vulgar and detestable shout of "There, didn't I say how it would be." Seeing that at least three such projects out of every four are failures, any insolent fellow, however ignorant, may be right three times out of four, provided he is so utterly incapable of discrimination as to denounce at random every suggested innovation.

This preliminary failure of the Bessemer process, when properly studied, is very instructive and important. It clearly pointed to a fallacy, which was not merely Mr. Bessemer's, but which he held in common with all the most eminent metallurgists of the time. This fallacy once cleared out of the way, the course to be adopted was obvious enough. If the sulphur and phosphorus of ordinary pigs are not removeable by mere oxidation, can any extraordinary pigs be found or made that are sufficiently free from them to be available for this blowing process? An answer to this question was found by the ironmasters of the Cleator hæmatite district. They made, and are still making from red hæmatite ore a superior class of iron—iron commercially known as "Bessemer pigs."

The following is a statement of the average re-

sults of my own analyses of thirteen brands of Bessemer pigs in actual use at the Atlas Works, Sheffield. It may be instructively compared with the analysis of a common Cleveland pig and with the average of thirty high-class ordinary pigs that I gave in the third lecture. All these analyses being made and stated in similar manner, are strictly comparable.

Average Composition of 13 *Brands of Pig-iron, made and used expressly for Bessemer purposes.*

Combined carbon	0·47	Total carbon, 3·19
Graphitic ,,	2·72	
Silicon	2·84	
Phosphorus	0·08	
Sulphur	0·14	
Manganese	0·90	
Iron by difference	92·85	
	100·00	

Comparing this with the other analyses, it will be seen that the Bessemer pigs (the average given is of all the pigs actually used during a period of 2½ years, and those of the mill forge the same) contain more carbon and more silicon than ordinary pig iron, little more than half the quantity of sulphur, and less than one-fourth of the quantity of phosphorus—this by comparison with a long average of high-class and high-priced pigs used for making the superior quality of armour plates, &c., for which the Atlas Works were celebrated. If we compare with common, low-priced Cleveland pig of the analyses No. 2, we find silicon and carbon still in excess, sulphur as before, about one-half, and only one-sixteenth of the quantity of phosphorus. These differences are very significant; the pigs have not been selected on any theoretical grounds, but have fallen into their places by a process resembling natural selection, which here, as in the animal and vegetable world, has determined the survival of the fittest.

By using such pigs as these, Mr. Bessemer overcame the defects of his first specimens, the cracking under the hammer, and obtained fair samples of mild steel; but then another difficulty started up. He found it practically impossible to regulate the quantity of carbon left behind, and therefore could obtain no reliable steadiness of results.

This difficulty was effectually overcome by an invention of Mr. Robert Mushet, which he secured by a patent dated Sept. 22nd, 1856, but which he eventually lost by failing to renew, as the law demands, at the end of the first three years. I am told that the instructions and remittance which he sent to his patent agent arrived but one day too late. This valuable invention thus fell into the lap of Mr. Bessemer free of cost; but I believe I am not committing any breach of confidence in stating that Mr. Bessemer has honourably acknowledged his obligations to Mr. Mushet's ingenuity, by an offering in the shape of a very acceptable annuity. This, however, I only have on hearsay, but cannot refrain from mentioning it as a set-off against the treatment which Mr. Cort and others received from the wealthy ironmasters who fattened upon their inventions.

This invention of Mr. Mushet overcame the difficulty of irregular composition, and some other collateral difficulties presently to be explained, by fusing cast iron very rich in carbon and exceptionally free from phosphorus, and pouring it into the melted iron from which all or nearly all of the carbon had been burnt out by the blowing. The composition of the carburetted iron being known, that of the resulting mixture could easily be determined by the quantity added.

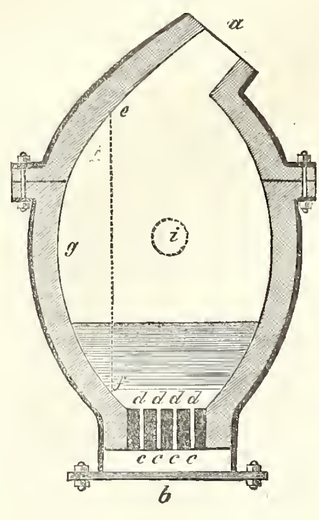
The highly carburetted iron selected by Mr. Mushet for this purpose, and still used, is that known as "spiegeleisen," or mirror iron, from the brilliancy of its crystalline fracture. It is the whitest of white iron, and, besides containing an unusually large proportion of combined carbon, is especially rich in manganese, its value for this purpose being thereby much increased. It was originally made from spathic iron ore, sparry carbonate of iron found in Sweden, Styria, &c., and was imported, but is now produced in this country.

The following is the average composition of four brands which were in use during about two-and-a-half years at the Atlas Works, and which I analysed at different periods, *i.e.*, by samples taken from different deliveries:—

Combined carbon....	4·20	total carbon 4·62
Graphitic ,, ...	0·42	
Silicon	0·93	
Phosphorus	0·06	
Sulphur............	0·17	
Manganese	6·63	
Iron by difference ..	87·59	
	100·00	

The present mode of carrying out the Bessemer processes is, first, to melt the pig iron in a cupola, which communicates, by means of a trough, with the converter. This converter, shown in section by the diagram, Fig. 16, is an iron vessel lined

Fig. 16.



with fire-clay or "ganister," and has a flat circular bottom, which is made removeable, as it requires frequent renewal.

This bottom is fitted with fire-clay cylinders shown as *c d*, *c d*, *c d*, *c d*, and each cylinder is perforated from end to end with several holes of half to three-quarters of an inch diameter. The bottom is thus riddled with sixty, seventy, or a hundred or more

of such holes, according to the size of the converter. These communicate, by means of an air chamber, *c c c c*, with a powerful blowing machine. This converter is mounted on an axis, *i*, upon which it may be turned by suitable machinery.

When about to be charged, the lining is made red-hot, by burning coal inside, and the converter is bodily turned over until the line, *ef*, is horizontal. The trough from the melting furnace is then adjusted to the mouth, *a*, and the melted pig iron is run in, and lies in the belly of the converter below the line, *e f*.

When so charged the blast is turned on, after which the converter is turned over to the position of the diagram, and the melted metal of course stands on the bottom over the hundred holes. It does not, however, run down these holes, as the pressure of the blast is more than sufficient to support it, by driving the melted metal upwards faster than gravitation can carry it downwards. If the blast was checked for a moment the fused iron would run through those openings, solidify below, and do serious mischief.

The "blow" has now commenced; the hundred streams of air are tearing through the pool of melted metal, and a huge flame roars furiously from the mouth of the converter. With this flame magnificent cascades of brilliant coruscating sparks are belched forth at irregular intervals, and the dazzling spray as it dashes against the flame-shaft rebounds with redoubled splendour, each glowing globule bursting with brilliant scintilations.

These globules may be collected on the floor below, and, when examined with the microscope, are found to be minature bombs or hollow spherules that have burst, and are either shattered into fragments or merely perforated by the explosion.

The blast still roars on monotonously, and the flame steadily increases in size and brilliancy, attaining its maximum at the end of about ten minutes. This continues, with but little variation, for five or ten minutes longer. During this period its splendour is painful to the eye, and yet so fascinating that few who see it for the first time can resist it and turn their dazzled eyes away. The spark eruptions continue their spasmodic outbursts, but their appearance has curiously changed; they no longer appear to be red-hot, nor yellow-hot, nor white-hot, but curiously purple. This is probably an optical illusion, due to the dazzling impression of the flame, which is sufficiently strong to make all ordinary gas-lights appear red and smoky, and even to modify the appearance of sunlight.

Presently the flame contracts, the converter turns over deliberately, and the uninitiated spectator is startled by a new display, for in the course of this turning, the blast, instead of rising through the whole depth of metal, cuts obliquely through the superficial layer of floating cinder, and dashes it forth in a splendid eruption of sparks, which the rotation of the converter spreads out into a fan-shaped cascade of fiery hail, extending from end to end of the building.

Another trough is now swung round to the mouth of the converter, and from this the charge of spiegeleisen is poured. A violent ebullition commences immediately it mixes with the melted metal that has been blown, and a great waving flame of burning carbonic oxide silently pours out of the mouth of the converter. Whence comes this carbonic oxide, and why this agitation? I have endeavoured to reply to these questions, by analysing samples of the iron taken from the converter at the end of the blowing, and before the addition of the spiegeleisen. They were not free from combined carbon, but contained from one-tenth to one-quarter per cent., and also contained a considerable quantity of entangled particles of oxide of iron. It was burnt iron. While the quantity of carbon was considerable, the iron was protected from burning, even in spite of the intense activity of the blast; but, as this diminishes, its power of protection is lost, and oxidation of the iron itself commences.

The action of the spiegeleisen on this burnt iron is easily understood; the particles of oxide are reduced by the redundant carbon of the spiegel, and thus the carbonic oxide flame is produced, and hence the furious ebullition, as the evolution of carbonic oxide is proceeding throughout the whole mass of melted metal.

The Bessemer metal is now made, and is cast into ingots of the size that may be required, by first pouring it from the converter into a "ladle'," a lined pot capable of holding the entire charge, usually five or six tons—sometimes double this quantity. The ladle stands on one end of an oblong platform, which until lately swung round over a semi-circular line of ingot moulds, and by means of a moveable plug in its bottom was made to fill ingot after ingot in turn as it came over them. Now, however, the usual practice is to connect all the ingots with each other from below, and thus, by pouring into one, all are filled from below. This not only saves some waste of metal, due to occasional leakage of the plug while passing from one ingot to the next, but it improves the quality of the metal, by clearing it of entangled air bubbles and of adhering cinder.

The following are the changes which take place during the blow. The evidence of these changes was obtained mainly by making a series of analyses of the contents of the converter at different stages. Those who desire to examine this evidence will find it stated in a paper which I communicated to *Nature*, March 9th, 1871, page 374. Other and independent analyses of the same kind have been made with almost identical results; the discrepancies are not greater than may be fairly explained as due to the variation of circumstances and the limits of error to which such investigations are liable.

First, the silicon and manganese are oxidised, and simultaneously the graphitic carbon is converted into combined carbon. (No. 1 grey pigs were used in all the blows that I examined.) Fusible cinder is formed by the silicic acid and oxide of manganese. As the quantity of uncombined silicon diminishes, the oxidation of the carbon commences, and goes on increasing, reaching its maximum when the flame is the brightest. It thus appears that the silicon, and possibly the manganese, by their greater affinity for oxygen, protect the carbon from oxidation while they exist in considerable quantity. In like manner the carbon, until it is reduced to about a quarter per cent. protects the iron from rapid oxidation. A certain amount of oxidation does, however, take place,

even in the earlier stages, as shown by the cinder and the sparks; but, unfortunately, sulphur and phosphorus remain practically unmoved. (This applies to the quantities existing in fair samples of pig iron. Very large proportions of either would probably be reduced by oxidation of the excess.) All this oxidation is, of course, attended with a corresponding evolution of heat, the amount of which may be estimated by considering the following figures.

With a charge of six tons of pig containing the average proportion of carbon, silicon, and manganese, the absolute weight of effective fuel they form amounts to about 8 cwt. This quantity is burned in the course of about twenty minutes, within the small space occupied by the melted metal in the converter. Such being the case, we need not be surprised at the effectual fusion of the mild steel, and even the nearly pure iron.

The importance of Mr. Mushet's invention, and the action of the spiegeleisen, will now be understood. Suppose, for illustration sake, we have a sample of spiegel containing 5 per cent. of carbon, a charge of 5 tons of pig, estimated to be reduced to $4\frac{1}{2}$ tons of blown metal, and we require steel for rail or tyres containing $\frac{1}{2}$ per cent. of carbon. By adding half-a-ton of the spiegel, this is attained, supposing none of the carbon is lost, or that the small residue of carbon in the blown iron is sufficient (which is usually the case) to compensate for the carbon consumed in reducing the granules of oxide before mentioned.

The proportion of carbon in the resulting steel may thus be regulated with some approach to accuracy, though occasional discrepancies of practical magnitude sometimes occur. These are checked in all well-regulated Bessemer works by casting a small testing ingot from every blow, numbering this, and sending it to the laboratory, where, by a very simple and effective method of analysis, devised by Professor Eggertz, the per-centage of carbon is tested. I have not time to describe this process, but may say that with practice it may be so expeditiously conducted that my assistant at Sheffield ordinarily made thirty, frequently as many as forty, carbon determinations, and sent in three copies of reports upon them between 8.30 a.m. and 2.30 p.m., getting his dinner in the meantime. The practical value of this is so great that, judging from my own experience, I doubt whether the Bessemer process would have attained to one-half its present extension without it.

The spiegeleisen appears to do something more than merely supply the carbon in due proportion. It somehow improves the quality of the steel, and there is every reason to believe that this improvement is due to the manganese of the spiegel, but how it acts is still an obscure problem. It may be by washing out the residual silicon with which it so readily combines. The steel is rendered "cleaner" by the aid of the manganese.

At one time it was supposed that the best steel contains an alloy of manganese, as the Sheffield maker of pot steel adds oxide of manganese to his blister steel when he melts it; but analysis has proved that the best finished steel contains no manganese. The steel-maker tells us that the oxide of manganese which he adds "throws up a cinder," *i.e.*, a silicate, which floats on the surface of the melted steel.

I have tried a good many experiments on the action of manganese upon iron and steel, and am still in the dark respecting it. I have used it by adding oxide of manganese to the fettling of puddling furnaces, and have improved certain kinds of iron thereby, especially the steely iron, or "puddled steel," as it is called, which is made by damping the fires, and balling up rather prematurely, but I have not found the manganese itself

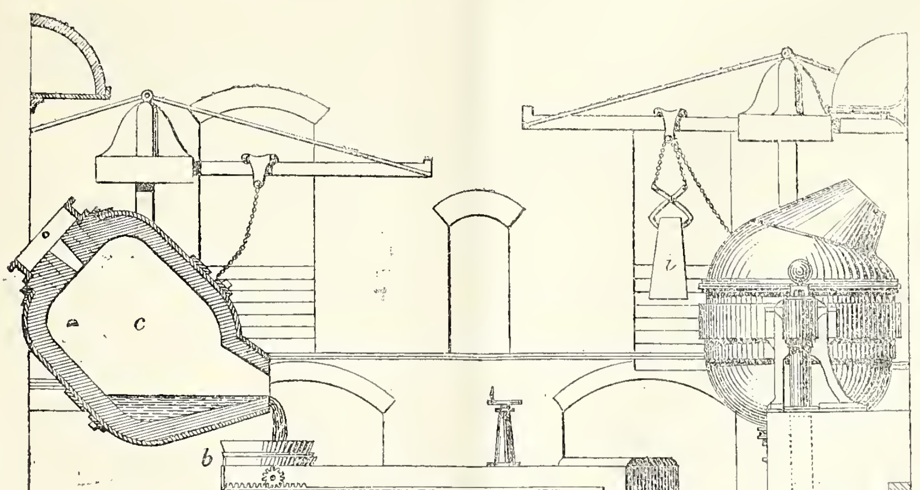


Fig. 17.

in the finished iron thus improved. It existed in small quantities in the puddled bar, but disappeared in the course of working. This leads me to suspect that it operates by giving increased fluidity to the cinder, and thereby rendering it more easily separable, thus producing a cleaner iron or steel.

The general arrangements of a Bessemer house are shown in the diagram, Fig. 17, where one of the converters, *c*, is in section, and turned over to pour into the ladle, *b*; the other converter (they are usually worked in pairs) is shown upright. The ladle is set on a platform, turning on an axis according to the old arrangement, where it was swung round over the mouths of the moulds, *m m*, some of which are shown, but their semi-circular arrangement is not well displayed. The moulds, which are open at the bottom, spread out downward, and the ingot is correspondingly thicker at the lower part. The object of this is that the moulds may be lifted off the ingot, which rests on a sand bottom of the floor. The crane and tongs for lifting the moulds and ingots are shown in the background; that on the right hand side is carrying an ingot, *i*, by means of the self-acting tongs, which are hanging from a bracket that runs on wheels along the arm of the crane. The cranes, the converters, the ladle, &c., are all moved by hydraulic machinery.

The cost of Bessemer steel is about one-fourth of that of the Sheffield pot steel, which it resembles in the important quality of homogeneity. It is nevertheless unfit for the chief purpose to which the Sheffield cast steel is applied, that of the manufacture of edge tools and good cutlery. Ordinary Bessemer steel will not bear more than about three-fourths per cent. of carbon; with a larger quantity it cracks or crumbles under the hammer. I have studied this subject with much care, aided by my friend the late Mr. George Brown, who was the first to carry out successfully, on a commercial scale, the manufacture of Bessemer steel. By analysing the samples of pig delivered at different times, and comparing the quality of steel produced from them, I found that the more phosphorus the pig contained the less carbon the steel would bear. In one case the steel was rotten with only a half per cent. of carbon, and the pig was returned. In another case, with an exceptionally fine "Cleator" pig, containing but a trace of phosphorus, and with superior spiegel, Mr. Brown succeeded in making tool steel of very fine quality, and containing nearly 1½ per cent. of carbon.

The most extensive application of Bessemer steel is to the manufacture of rails and tires for railway carriage wheels. These should contain about one-tenth per cent. more of carbon than the rails upon which they run. If the tires are softer than the rails, or even of the same hardness, they rapidly become grooved. If made too hard, they are dangerously brittle. Ploughshares, and what in Birmingham are called "steel toys," *i.e.*, hatchets, hammers, pincers, &c., a multitude of rough, coarse tools, and much bad cutlery, are now made from Bessemer steel, and besides these, it is occasionally used for boiler plates and for structural purposes, such as steel bridges, roofs, &c.

The advantages it offers for the latter purposes are, its homogeneity and its greater tenacity as compared with iron. The latter quality enables the architectural engineer or the boiler-maker to obtain the required resistance to a given strain with an expenditure of about two-thirds the quantity of metal, thus combining lightness with stability, a most important desideratum.

Steel boilers and steel structures are, however, liable to a very serious objection. I have already stated that the quality of Bessemer steel is very materially affected by the quantity of phosphorus in the pig from which it is made. The phosphorus confers hardness like carbon (my own experiments indicate that a given per-centage of phosphorus hardens about equally to three times as much carbon); all hardness is accompanied with brittleness, but phosphorus hardness with far more than carbon hardness. If, therefore, in the construction of a steel bridge, or steel roof, only one tie-rod, girder, or other important element of construction, were accidentally made from the metal of a bad blow, containing too much carbon, or from bad pig, the whole fabric would be endangered, as nothing is stronger than its weakest part. The same applies to boilers, where one brittle plate might give vent to a very serious explosion.

On this account the utmost caution is necessary in the use of Bessemer steel for such purposes, and skilful scientific testing is demanded. This, I suspect, is the reason why the Government is able to use far more of this material, and the corresponding homogeneous soft steel made by the Siemens-Martin process, than private firms can venture to use, the Government having, in connection with their dockyards, a staff of able scientific officials for testing all such material.

I must now pass to the subject of tool steel, *i.e.*, the composition and properties of the material of which edge-tools are made. I have already stated that the best steel should contain only iron and carbon, and that the more free the steel from any any other ingredient the better its quality; and also that, in making this statement, I am at variance with some high authorities.

I will now quote a few of these, as many as time permits, and state in outline my reasons for contradicting these conclusions.

Mr. Brande maintained that phosphorus improves the quality of steel. As lately as 1869 Dr. Miller, in a report on the Heaton process, stated that 0·298 per cent. of phosphorus in steel iron "is obviously not such as to injure the quality;" and Dr. Paul, in a paper read at the Chemical Society at about the same time, stated that 0·24 per cent. of phosphorus would be quite a harmless quantity. Some continental chemists have even asserted that a half per cent. of phosphorus improves the quality of steel.

Those who desire to study the contradictory statements of learned chemists—especially continental chemists—on this subject, may read the article "Steel" in the fifth volume of Gmelin's "Handbook of Chemistry," where they will find that "according to Clouet, steel contains on an average 3·1 of carbon; according to Vauquelin, 0·71." A number of other authorities are quoted, who only agree on one point, viz., that of equally contradicting each other.

On page 214 of same volume (Cavendish Society's

edition) we are told that "Schafhautl remarks that cast iron, bar iron, and steel almost always contain more or less arsenic and phosphorus, which often greatly improve their quality. Thus the celebrated Dannemora iron and English Low Moor iron owe their good qualities to the presence of arsenic, and a particular kind of Russian iron (marked C C N D) from Demidorff's works at Nischnetagilisk is indebted for its peculiar qualities to the phosphorus it contains." In the same paragraph we are told, on the authority of Karsten, that "the largest proportion of phosphorus, as it occurs in the iron from limonite, amounts 5·6 per cent. (This is probably a misprint for 0·56.)

Some chemists have stated that silicon improves steel, others that nitrogen is essential to its existence. Faraday was supposed to have greatly improved the quality of steel by introducing minute quantities of silver, platinum, and other metals. "Silver steel" was made accordingly, but has been long since abandoned, not only on account of its cost, but simply because practical use proved that the improvement attributed to these alloys was a delusion.

I yield to no one in proper respect for science and the great discoverers and teachers of science, but I, nevertheless, maintain that a very great mistake is made when mere book-learning or laboratory experience, or both combined, is supposed to confer authority on such subjects as the quality of steel. Actual workshop experience, or special and practical workshop study, can alone confer this qualification.

Passing over the gross errors expressed in statements concerning the 5·6 or 0·56 per cent. of phosphorus in iron made from limonite, and the grotesque idea that Dannemora and Low Moor iron owe their good qualities to the presence of arsenic, the other and oft-repeated fallacies respecting the beneficial influence of phosphorus and silicon on steel, are not beyond the reach of reasonable explanation.

Most people who are not practical workmen take it for granted that hardness is the primary quality of good steel. This is a great mistake. Both phosphorus and silicon do unquestionably increase the hardness of steel, and there are some special exceptional purposes, to which steel is occasionally applied, that would be better served by the use of a special steel thus exceptionally hardened.

I will take two examples to illustrate this. Brande founds his statement concerning the advantage of phosphorus in steel upon having learned that, unless it contains phosphorus, it cannot be depended upon for the manufacture of dies in coining. I have no practical knowledge of this particular use of steel, but can easily understand that a die faced with steel, exceptionally hardened by the presence of phosphorus, would emboss a larger number of coins without losing its sharpness than would a die similarly made of softer steel. I say "faced," because a die made throughout of hard phosphorus steel would probably be shattered by the blows of the press, and even the phosphorused facing would be liable to this.

Recently, a metallurgical chemist of very extensive experience and unquestionable ability, a man on whose analyses of iron, or anything pertaining thereto, I should place the utmost reliance, Mr. Riley, showed at the Chemical Society a tool made of steel containing a very large per-centage of silicon, and argued because this tool did its work well, that silicon is rather beneficial than injurious to steel.

But what was this tool? It was a very heavily made roughing chisel for turning iron. The bevil of its cutting edge was nearly a right angle. This tool had been used for turning cast iron, had kept its edge well, therefore, says Mr. Riley, it is made of good tool steel. Another tool made by Mr. Riley with this silicon steel, as he stated lately in this room, was a "jumper," *i.e.*, the heavy bar with rude bevil used for boring rocks by jumping it up and down, and turning it round in the hole it has already formed in the stone.

These instances are very instructive, and I quote them because they illustrate so clearly the common fallacy I am so anxious to refute, that of judging the quality of steel by mere hardness.

In the cases of the die-face, the heavily made roughing tool, and the jumper, extreme hardness was a primary requisite, and Mr. Brande and Mr. Riley were quite right so far as they went; but I have no hesitation in predicting that, if a keen edged tool, such as a carpenter's chisel or plane iron, or a wood saw of usual cut, or a penknife, razor, or needle, fish-hook, or any other delicate tool or implement were made from the phosphorus or silicon steel, its worthlessness for such purposes would be demonstrated at once. The plane iron would "notch" directly it encountered its first knot in a deal board; the saw would "rip;" the penknife would snap off close to the handle, if used with any considerable force; the razor would not take an edge, it would run into teeth upon the hone; the needles would break, and so on with all other tools that are commonly made from the best steel.

But the best test of all would be to make a few tons of such silicon or phosphorus steel, and offer them for sale to experienced practical cutlers or tool makers, say for temptation sake, at 25 per cent. under the price of their usual material. This, after all, affords the most reliable evidence, and this has been applied again and again by the multitude of projectors who have made very hard steel by partially decarburising common pig iron, and have been partially or totally ruined by the impossibility of finding a market for it. It is a commercial fact that the market value of steel is proportionate to its freedom from all ingredients except iron and carbon. Common white pigs and spiegeleisen are harder than the best tool steel.

The workman would not test the steel by making jumpers or roughing chisels, or by sending it to Mr. Kirkaldy to ascertain the tensile strain, as Dr. Miller did in order to prove the quality of the Heaton steel containing 0·298 per cent. of phosphorus; but he would make a small piece red or white hot, and try to forge it out to a fine point, and see whether it would bear the necessary hammering without splitting. He would harden and temper it, and test its brittleness when cold by hammering a fragment upon an anvil or in a crushing mortar, and would learn thereby whether it crumbled to powder or embedded itself in the face of the hammer or anvil; by these and similar tests he would ascertain whether it could bear a vibratory shock such as working steel is subject

to, and which bad steel cannot endure, especially when it has a fine edge. All his tests would be with fine edges or fine points, and none with the clumsy lumps that have deluded the laboratory chemists, who should never forget that when a fine gentleman, who can afford a "tip," comes into a workshop, a mill forge, or other factory, to test something of his own, the amiable workman seldom disappoints him, but shrewdly guesses his wishes, and gratifies them accordingly. Hence, probably, the peculiar applications by which these brittle steels were tested.

I have had much vexatious experience of this kind, especially with puddlers, who will make good iron out of anything, provided the investigator is generous in the matter of beer. I have, in fact, been driven to the conclusion that beer is the only compound that invariably succeeds in improving the quality of iron or steel. It is very difficult to make sound experiments on this account. If the experimenter is "stingy" all goes wrong, if generous all succeeds, even though changing the material is necessary for the purpose.

I had a controversy on the subject of phosphorus in steel in the *Chemical News*, February 19th, 1869, and there pointed out the fallacy of testing the quality of steel by mere tensile strain. This was heterodox at that date, but I am gratified to find that it is so no longer. In some recent Government specifications, instead of high tenacity, one of the fundamental requirements for the "angle bulb or bar steel" is that "the whole of the steel shall stand a tensile strain of 26 tons to the square inch, and not to exceed 30 tons to the square inch." The supposed excellence of the steel-iron of Dr. Miller, containing the 0·298 per cent. of phosphorus, was based upon its having resisted a tensile strain of nearly double that specified as the present Government limit of rejection. This is a curious revolution of authoritative opinion on a purely practical subject.

Tool steel comes quite within the old definition of steel, *i.e.*, a compound of iron and carbon, containing not less than ½ per cent. of carbon, or more than 1½ to 2 per cent; or, more practically stated, that shall contain sufficient carbon to be susceptible of hardening and tempering, and not so much as to prevent it from welding. Such steel, practically free from anything else, will take a fine, acute edge, that will bear a heavy shock without either turning or breaking, and will be neither red-short nor cold-short.

This property of hardening and tempering is the characteristic and most important property of true steel. It is the speciality of the hardness conferred by carbon that it may be modified through a long range of gradations, and thus the material may be made to cut, forge, or otherwise work itself; a property the usefulness of which can scarcely be exaggerated.

Steel is hardened by making it red-hot, and suddenly cooling it. A cherry-red is the usual temperature, but this is modified according to the quality of the steel. The best steel is the least heated in hardening.

The methods of heating are various. Simply, in a coal fire; in a flame, as the blowpipe flame; pinching in red-hot tongs; packing in an iron box with charcoal, and slowly raising to red heat; immersion in red-hot melted lead; and other devices are used. In most cases, the object is to obtain a regular, equal temperature throughout, and the steel is accordingly "soaked," or left for some time exposed to the source of heat.

This, however, is not always the case, as some tools—such as broaches—are hardened only superficially, by immersing them for a very short time in a red-hot lead bath, and then rapidly quenching. The object of this is to obtain a soft core, and thereby increase the toughness of the body of the tool. Simple as it may appear, much skill and judgment is necessary in effectively heating, especially when the tools are of large size.

The cooling, or quenching, requires still more skilful management, as the contraction that would take place in slow cooling is checked in proportion to its suddenness, and the consequent hardening of the steel. Thus, if a long tool of any kind were cooled by dipping it sidewise into water, it would be curved by the unequal rate of cooling of the opposite sides. Thus broaches, files, and all such tools should be plunged perpendicularly. If the tool is unequally thick, the thick part should be dipped first, or cooled by some other device than dipping, as the equal immersion of the whole would cause the thin portion to be cooled throughout sooner than the thick part. Splitting, cracking, or bending might result from this, besides inequality of hardness.

Many small and thin tools are cooled by pinching with cold tongs, or between flat plates of metal, thus keeping them straight by mechanical force, as well as by equal cooling. Small drills and similar tools are frequently hardened by simple heating with a blow-pipe flame and plunging the point of the tool into the tallow of the candle used as the source of heat. Melted tallow, oils of various kinds, mercury, brine, acids, soapsuds, and mysterious messes are also used for quenching. In this, as in most things, there is much quackery, especially concerning secret hardening fluids.

Cast steel hardens with more equality and less distortion than shear steel, on account of its greater homogeneity. The unequal expansion due to unequal hardening is sometimes ingeniously used as a means of modifying the shape of steel articles. This inequality may be obtained by covering with clay the portion required to be the softest.

Steel thus hardened by simply heating and suddenly cooling, is too hard and brittle for most purposes. It, therefore, requires "tempering" or "letting down," which is effected by re-heating in different degrees, according to the amount of softening demanded, which varies with the purpose for which the steel is to be used.

Such tools as files, roughing tools for cast iron, jumpers, &c., are seldom tempered at all at their working parts, but are tempered or annealed in other parts to prevent breaking. Thus files are tempered at or near the "tang."

The higher the heat of the re-heating, the softer the temper. The workman has discovered an easy means of measuring the heat he applies for this purpose. Without reading Newton's "Optics," he avails himself of the beautiful property of colouration due to the films which Newton investigated and expounded. These films are due to the incipient oxidation, and vary in colour with the heat producing them.

Another method of regulating the temperature

is to smear the tool with tallow, and watch the effect of the heat upon it; and another is to immerse the tool in a bath of metal or alloy that fuses at the heat required. An alloy of lead and tin may be used tbus. Tbe following is a scale of tempers :—

	Colour.	Temperature.	Alloy.	Effect on Tallow.
1	Pale straw	420° F.	7 lead 4 tin	Vapourises.
2	Straw	450°	8 ,, 4 ,,	Smokes.
3	Straw yellow ..	480°	8½ ,, 4 ,,	More smoke.
4	Nut brown ..	500°	14 ,, 4 ,,	Dense smoke.
5	Purple	530°	19 ,, 4 ,,	Black smoke.
6	Bright blue ...	580°	48 ,, 4 ,,	Flashes if light is applied.
7	Deep blue	590°	50 ,, 2 ,,	Continuous burning.
8	Blackish blue..	640°	All lead or boiling linseed oil.	All burns away.

The first degree is the temper required for tools used in eutting iron, excepting the most obtuse chisels, which are commonly left hard; and for lancets and some other surgical instruments.

2 and 3, for drills, turning tools for brass, and most of the tools used by watchmakers, mathematical instrument makers, &c.

3, for penknives, razors, and tools of this class.

4, for scissors, stonemason's chisels, and the strongest of carpenters' and other tools for cutting hard wood.

5, for clasp knives, domestic knives, ordinary carpenters' and other tools for cutting soft wood.

6, for swords, cutlasses, bayonets, axes, &c.

7, watch springs, needles, fine saws, and other tools, &c., in which elasticity is required. This is called "spring temper."

8, common wood-saws and other tools roughly used for soft material. This is the lowest temper in use.

Tempering in oil is generally reputed as conferring toughness.

For many purposes steel requires to be made as soft as possible. This is the case with mild steel boiler plates, engravers' plates, &c. To attain this softness tbe steel is annealed by heating to redness and cooling very slowly. Various devices are employed, and insure the slow and steady cooling demanded. The most common and simple is to bury the steel in ashes. This is commonly done by the tool maker in order to soften bar steel, &c., before working it.

More elaborate and complete annealing is effected by packing the steel in iron boxes between layers of lime, tben heating and cooling very slowly. Special annealing ovens are also used, wherein large masses of steel, such as plates, &c., are heated slowly and left for several days to cool.

I made some curious experiments, some few years ago, on a method of annealing, that appears rather paradoxical. It is that which is adopted by the manufacturers of pianoforte strings. The steel is made red-hot, and then dipped in boiling water. The water around the steel appears to assume what is called the spheroidal state, and thus the steel remains red hot under water for some time. The result is a certain degree of softening, accompanied with great toughness. I found that hard cast steel thus treated would stand all kinds of bending tests better than when annealed by the ordinary methods of slow cooling. This appears to depend on the retention of high tenacity, with a certain degree of softness.

Case-hardening is an interesting and useful process. By it the surface of malleable iron may be rendered as hard as the hardest steel. It is in fact a process of superficial cementation or conversion into steel. The iron may be made to acquire sucb a steely surface by simply heating it in a bed of charcoal; but it is more effectually done by covering it with bone dust, horn shavings, hoof parings, or leather cuttings. These animal substances give up their carbon more readily tban mere charcoal, probably through the agency of gaseous cyanides. The most rapid mode is to make the iron red hot, and, while it is thus heated, to dust it over with powdered ferrocyanide of potassium (yellow prussiate of potash) by means of a pepper-box arrangement.

The advantages of case-hardening are that the toughness of the soft iron is retained throughout the body of the work, while its surface is hardened to a very high degree. It is especially useful for lathe mandrils, and axles, or sbaft bearings, of various kinds.

The fundamental principle upon which all edge tools are constructed is to adapt the angle or bevil of the cutting edge to the nature of the resistance to be overcome. The specimens I have here illustrate this. This roughing tool for cast iron has a bevil of little less than a right angle, this graver for brass turning about 45°; this for ivory turning still more acute. Here are plane irons for iron, brass, and wood, with progressively-increasing acuteness of edge. The same with chisels and all other tools, until we reach the maximum of acuteness in knives, swords, and surgical instruments, used for cutting flesh. In all cases where these acute edges are exposed to violent shocks, as plane irons, &c., they are tempered accordingly. Even climate has to be considered in tempering. The axe of a Canadian woodman, used during a Canadian winter, requires to be much softer than an axe used in England for similar work.

I must now conclude, regretting that time will not permit me to go further into details on these subjects, but I hope that those who have attended the lectures will leave this room with an appetite for further information, and will understand that merely listening to a few lectures is not sufficient for the study of any subject. The proper object of such lectures is to awaken curiosity, and stimulate the desire to learn rather than to satisfy them.

I hope, however, you will have learned enough to see how important are tbe mutual relations between scientific and technical knowledge, how much the artisan needs the aid of the philosopher, and how largely the true philosopher may be instructed by the humblest workman. Both should therefore co-operate with mutual respect for each other's attainments.

The future prosperity of our country depends mainly upon this. We have excelled in fighting, excavating, coal-digging, earth work, &c.; we have turned out the best sailors and soldiers, and colliers and navvies that the world has yet seen. But this will not be sufficient hereafter. We have already touched tbe beginning of the end of our coal supplies. The richest seams are in many places quite exhausted, in others nearly gone.

The main coal of Flintshire is now nearly historical, the great ten-yard seam upon which the blackness of the "Black Country" is founded is nearly exhausted, and we are thus approaching the position of other nations that have only thin seams of coal at great depths, or otherwise difficult to obtain. Our coal will never be absolutely exhausted, but will be continually growing dearer, and all those branches of industry depending upon cheap coal must be extinguished. We shall very soon cease to make pig iron in blast furnaces, but we need not therefore be alarmed, for by combining science and art with industry and skill, we may do higher work than fighting and coal digging.

The fact that from the time of the revival of Dudley's invention till 1872 our produce of iron steadily increased, and that from 1872 until the present time it has been continuously declining, is an ominous warning that shows the direction in which we are going, and the necessity for preparing for another line of progress.

MISCELLANEOUS.

TYPHOID FEVER IN KENSINGTON.

The following letter, in reply to the assertion of the Kensington Vestry that there have been no deaths in the present year from typhoid fever, has been sent to the Vestry Clerk by Sir Henry Cole :—

"Immediately upon the receipt of the resolution of the Vestry of Kensington, dated the 26th of July, which asserted that no death had occurred from typhoid fever in South Kensington during the present year, I communicated with the General Registry Office of Births and Deaths. I found the Vestry had no authority for their statement, and learnt that in the sub-districts of Kensington town and Brompton, including South Kensington, which is a modern local name, without definite boundaries, upwards of 24 deaths from fever had been registered during the 26 weeks ending the 1st of July, 1876. Of these, sixteen were certified as 'typhoid,' and this number is independent of deaths from diphtheria and diarrhœa, often connected with sewer gases. I beg leave to refer the Vestry to the 'Annual Summary of the Causes of Death of London in 1875,' printed and published by the Registrar-General, from which the Vestry will see that the deaths in 1875 from typhoid fever were 21 in Kensington and Brompton, so that the usual average death-rate from this disease would seem to be increasing. I have thus shown that deaths have been occuring without the knowledge of the Vestry or its medical officer. My statement that typhoid fever is chronic has foundation in fact. But it cannot be gainsaid that typhoid fever may be chronic, although it may not terminate in death, and it may exist, especially among well-to-do people, although the Medical Officer of Health of the parish may be unacquainted with any cases of illness from that disease. I may also remark that the proportion in fever epidemics is usually one death in 20 cases. I will assume that the Vestry, like myself, will not mind a little trouble in this serious business, so I submit a suggestion which will enable the Vestry to improve the health and comfort of the Kensington inhabitants under their charge. I suggest that, with the view of affording to the medical officer that knowledge of the existence of typhoid fever which he does not at present possess, and until the law be improved, the Vestry should form a sanitary committee of the inhabitants of Kensington, who should report when cases of illness connected with sewer gases occur, and thus enable the Medical Officer of Health and the parish surveyor to inquire into the state of the house drains where such cases are reported. As the Vestry communicated their resolution to the Metropolitan Board of Works, I request them to have the kindness to forward a copy of this answer to it."

GENERAL NOTES.

Soda in the United States.—The soda consumed in the United States is now imported from England. During the year 1875 about 200,000 tons were used, costing 12,000,000 dollars. There is a prospect now, it is said, that the time will soon come when not only the consumption of the country can be supplied from the production of its own borders, but that enough can be mined to supply the world. "The deposits lately discovered," says the *Omaha Herald*, "for which land patents have recently been issued, lie on the north side of the Sweetwater River, in Carbon county, Wyoming, about fifty-five miles north of the town of Rawlins, on the Union Pacific Railroad. The soda is found in a crystallised state, solid as ice. The deposit is something over 400 acres in extent, and of unknown depth, and estimated to contain enough soda to supply the world for 1,000 years. The mineral is a carbonate of soda, containing a small quantity of common salt and sulphate of common soda. Analysis has shown it to be of about the same purity as soda ash of commerce. The owners, it is said, will immediately commence to build a railroad from the deposit to connect with the Pacific road. A capital of 1,500,000 dollars is to be employed, and to fully utilise these deposits there will be employment for 2,500 persons."

Channel Passage.—The commissioners appointed by the English and French Governments respectively have submitted to the two Governments a memorandum which they recommend should be adopted as the basis of the proposed treaty between Great Britain and France with regard to the Channel Tunnel and Railway. It provides for the conclusion within five years from the 2nd August last, of an agreement between the French and English companies for the construction and working of the submarine railway, including the tunnel. An international commission of directors is to be appointed by the two Governments. The concession for the submarine railway will be for ninety-nine years from the opening, at the end of which period the undertaking will be handed over to the respective Governments. The works of exploration are to be commenced within one year from July 1, 1876, and within five years the companies are to declare whether they propose to retain or abandon the concession. After the end of thirty years the two Governments are to have the right of purchasing the undertaking. With regard to the working of the railway, it is proposed that each Government shall have the right to suspend the working of the Submarine Railway and the passage through the tunnel whenever it shall, in the interests of its own country, think necessary to do so. And each Government shall have the power to damage or destroy the works of the tunnel or submarine railway, or any part of them, in its own territory, and also to flood the tunnel with water. Works for purposes of defence, and such other works as may be required by either Government, shall be executed by each company in accordance with the laws for the time being in force in the country where the company is established. It is understood, as regards the use of the submarine railway, that equal facilities shall be afforded in the formation of trains, in the running of carriages and wagons, and in the transport of passengers, animals, and goods of every description, whatever may be the points of departure or of destination, and whatever may be the routes followed.

SUBSCRIPTIONS.

The Midsummer subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to P. Le Neve Foster, Secretary.

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BRUSSELS EXHIBITION.

(FROM A CORRESPONDENT.)

It will not, perhaps, be desirable to go so fully into the other sections of the Exhibition as was done with the British section, but still there are many points in which our own part of the exhibition is behindhand, and which are much better illustrated by the contributions of foreign countries. The two classes in which we are least fully represented are Classes I. and IV., which deal respectively with methods of saving life from fire, and means of assistance in war. The reasons of this state of things are not far to seek. As regards fire-engines, it was found that it was impossible to spare any of those actually in use in London, while some of the principal makers who were asked to contribute were either unable or unwilling to do so. As for Class IV., it is obvious that the recent wars on the Continent have been the cause of the great improvements made in the appliances for helping the wounded, and it is among Continental nations that the movement in this direction has principally been felt. As regards educational appliances, too, we are outstripped by several other countries. The contributions of our London School Board hardly come up to the more elaborate appliances shown in the German and Russian sections.

The most important exhibit in the Austrian section may certainly be said to be the ambulance train sent by the "Chevaliers de Malte," to which allusion was made in the account of the British section.

This train is composed of seven carriages. Along the middle of each carriage runs a gangway, and as there is a platform connecting each carriage with the one before and behind it, there is thus a passage running from end to end of the train. All the carriages and platforms are well lighted at night, and there is electrical communication between the different parts of the train. They are entirely lighted and ventilated from the top, with the object of shutting out the cold draughts of wind, which can scarcely be avoided with side windows. The springs can be adjusted to the number of the patients. The first carriage is devoted to the commandant of the train, the sous-commandant, and two surgeons. The space on each side of the gangway is divided, so that there are four small cabins, one for each of the four occupants. Each cabin is fitted with a seat, which also forms a bed, a flap table, and as many conveniences as can be crowded into the very small space available. The second carriage contains two officers' cabins and a number of cupboards for stores and provisions. The third is fitted up as a kitchen. The fourth is arranged for a refectory or dining-room, with tables and benches along the sides. The rest of the train consists of three ambulance carriages, each capable of carrying ten wounded men. The litters in which the men are brought to the train are lifted up and placed in a sort of rack, so that the litter when placed on the rack forms the bed. There are six men on one side and four on the other, the litters being placed in two horizontal lines, one above the other, like the berths of a ship. In practice the train would consist of 15 waggons, there being seven more ambulance waggons, so that there would be ten of these, each carrying ten men.

The Knights of Malta have ordered ten of these luxurious trains, which will provide immediate accommodation for 1,000 wounded soldiers. Arrangements have been made with the railway companies to supply, in the event of war, 500 more waggons, which the railway companies themselves undertake to alter by shutting up the side lights, putting the lights overhead, &c., within a fortnight. The railway companies having thus provided the rolling stock, it would be supplied by the Order with the *personnel* and materials. Besides these railway ambulance trains, the Order possesses 42 road ambulances, for conveyance of the wounded to the trains or from them. These are all constructed upon the system of Baron Mundey, who is chief physician of the Order.

Another exhibit in the same class is that made by the "Teutonic Order," which shows one of its light ambulance waggons for six wounded seated and two lying down, or for ten wounded lying down. There is also one of the larger waggons—a four-horse kitchen; two ambulances upon Baron Mundey's system; a surgeon's carriage, with instruments, medicine, &c., for a field hospital of 200 beds; and a waggon for a field hospital. Most of these waggons have been constructed by Jacob Lohner at Vienna, but the kitchen on wheels was made at Paris, in 1870, by Kellner.

The other parts of the Austrian section compare rather unfavourably with most of the other countries. There are some examples of lighthouse arrangements, including a fine model of the Grado floating light. Some fog signals and horns, a gun for throwing a line, by which communication can be set up between the shore and a wreck, are among the noticeable objects shown. A travelling apparatus for burning the dead bodies of those killed in war is also remarkable.

The most important exhibits in the space allotted to Germany relate to saving life from fire, and to education. There are a number of fire-engines and other appliances, showing considerable variety. A very noticeable exhibit is that by M. Krupp, of Essen, the well-known iron-master. The men of the works are formed into a fire brigade, and are all drilled, so that, on an alarm of fire, every man goes at once to his post. There is a constant supply of water all over the works and buildings, with hydrants to which hose can be attached. The fire brigade is also well supplied with engines, hose, ladders, and all the usual appliances necessary for dealing with fires. Besides the apparatus commonly used in this country, there are several descriptions of fire escapes, by means of which a fireman can either let himself down from the upper storeys of a house, or can lower a person in safety to the ground. There are also masks and respirators, to enable the wearer to breathe and work in dense smoke. All these different appliances are shown, and their application is also exemplified by a large model of a house, with small figures representing the firemen at work. Here one man runs out the hose, while another attaches it to the hydrant; two more are engaged in lowering one of the inmates of the house from a window; another is letting himself down; others are bringing up the fire-engine. and so on. The whole model is an excellent example of what may be done to prevent danger from fire by means of careful organisation and proper resources.

In the class containing school appliances, the educational departments of the Cultus-ministerium of the kingdoms of Prussia and Wurtemburg illustrate their school systems, by plans, desks, and publications, very fully. There is also a very elaborate model of a swimming-school, shown by the Prussian ministry. A number of municipalities show models and plans for schools, hospitals, systems of sewage, and water-supply, &c.

There are very complete plans of the water-supply and drainage of Berlin; in addition, there are the

plans of the Charité and Augusta Hospitals. Bremen sends the plans and photographs of its new school and mortuary. Dantzic exhibits a magnificent plan of its sewers and water-works. Elberfeld sends a project for supplying that town with Rhine water. Heilbronn sends plans for an aqueduct. Heidelberg shows its water-supply and other hygienic improvements that it has in hand. Stuttgart sends plans of water-works, twenty schools, a cemetery, urinals, and a hospital. Wurtemberg has a similar exhibition.

Among private exhibitors, Messrs. Siemens and Halske, the electrical engineers of Berlin, show numerous appliances for working railways under the "block system," also their dynamo-electric machine with accessories. It should be noted that in the German section also, as in the Austrian, there is a large collection of ambulance waggons and cars, and various medical and sanitary appliances, to help wounded men in time of war, these being contributed by the ministry of war and the railways, as well as by several of the special associations for succouring the wounded.

One of the most conspicuous objects in the Belgian department is the model of the apparatus used in the collieries of M. Warocqué to raise and lower the workmen. This is called a Warocquère, after the name of the proprietor, who is one of the largest coal owners in the kingdom. M. Warocqué is the President of the Exhibition, and during the week of the opening he invited the members of the various foreign committees to visit his works, and inspect the arrangements he has made for the comfort and welfare of the workpeople, a subject to which he has devoted much thought and care.

Another important exhibit is a direct-acting blowing-engine, constructed by the Société Anonyme des Ateliers de la Meuse, under the direction of M. A. Stévart. It has two cylinders of 6 ft. diameter, and is intended for the ventilation of coal mines.

The recent improvements in the city of Brussels are illustrated by the plans and models of the works on the Senne. This river, which formerly flowed as practically an open sewer through the lower town of Brussels, has now been entirely covered, and its course is marked by a wide boulevard. Unfortunately for the appearance of the new road, the shallow layer of soil over the arch covering the stream is not sufficient for the growth of trees, so that this can never equal in beauty the older boulevards surrounding the town, with their fine avenues at the sides of the road. There are also models of other public works finished or in progress in Belgium.

Among the private firms exhibiting, the Vieille Montagne Zinc Company holds a conspicuous place. They exhibit various applications of zinc, such as its application to the sheathing of iron ships, for which purpose it is recommended, from its being electro-positive to iron, so that the iron is protected and the zinc slowly oxidised. It must, however, be remembered that in practice these excellent theoretical results do not appear to have been attained. Another yet more novel use of it is to prevent incrustation in boilers, though here again further trial seems necessary before such an application can be admitted as of any value; there are so many infallible—yet useless—remedies for boiler incrustation. However, a perfect cure is said to be effected by the simple introduction of an ingot of zinc within the boiler. It is stated that this quite prevents incrustation, the zinc itself being entirely dissolved. The result is attributed to a thermo-electrical action set up in the boiler between the zinc and the iron boiler-plate. The discovery of this effect of zinc resulted from the accidental placing of a piece of zinc in one of the boilers of an Atlantic steamer, running from Havre to the United States. The workman who had left the zinc in the boiler went to look for it when the vessel returned from a voyage, and was surprised to find the zinc vanished but the boiler quite clean. A specimen of zinc that has been for some time in a steam-boiler is shown by the company. It appears spongy and friable, and has lost a great part of its original weight.

In the educational department is a curious specimen of a complete *crêche*, with all its appliances for the comfortable reception of its tiny inmates. The whole thing is shown—cots, washing-stands, and all, just as it exists in actual use.

An arrangement of electrical apparatus is exhibited by Rau, intended for use in case of accidents on railways. At intervals along the line posts are set up containing the signalling apparatus, which is locked up, and can only be got at by means of a key to be carried by the guard of every train. On opening the case with this key, a number of keys are seen, by the application of each of which a special message is sent. The apparatus, therefore, requires no knowledge of telegraphy; the person telegraphing simply inserts the particular key in the hole, and on turning it the required message is sent. The invention is of course applicable to other purposes than railways, but its utility is somewhat questionable, and it appears rather cumbrous and complicated. Other electrical apparatus is shown by the same exhibitor.

Some arrangements for enabling a guard to walk safely along by the side of the train are also shown in this section. One of these consists of a long bar, extending along the side of each carriage, with flexible couplings between. Over this a sliding-hook fits, carrying a belt worn by the guard. Another is simply a platform with a hand-rail outside. This seems to add considerably to the width of the carriage.

Some of the most important exhibits in the French section are the plans and models lent by the City of Paris. These have already been shown in London, as they figured in the French Annexe at the International Exhibition at South Kensington in 1874. They include drawings and models of a great number of the public buildings of Paris, the schools, churches, &c.; those of the schools are in great detail, as are also some of the sewers, which show not only the construction of the sewers themselves, but the apparatus used in cleansing them, &c. It is well known that the larger channels are navigated by boats, and a model of the special boat employed, which serves to sweep away deposits, as it is carried along by the current, is one of the objects shown. The Gennevilliers sewage farm, which has been the subject of so much discussion both here and in France, is illustrated by maps, as are several other public works in or near Paris.

Close to the municipal collection is a singular looking model of a vessel intended for passenger and goods traffic, and invented by M. Bazin, whose "*extracteurs*" are now well known. The idea is to replace the ordinary surface friction between the water and the sides of the vessel by rolling friction. To this end the lines of the vessel are as fine as possible in the submerged portion, and the necessary floating power is supplied by large hollow wheels or discs, either at the sides or in the centre of the hull. Rotary motion is given to these, and, though it is not supposed they actually help the propulsion—which is effected by a screw—it is stated that they very greatly diminish the resistance of the water, and thereby increase the speed of the ship. Whatever may be the merits of the invention, it appears to be founded on a novel idea, though it must stand the trial of a long series of experiments before it can even be worth much consideration. It certainly does not recommend itself at first sight. M. Bazin also shows models illustrating the action of his hydraulic "*extracteur*," for dredging operations, and a collection of curious objects brought up by his machines. The most remarkable thing about these is the size and weight of the objects brought up in the sort of suction-tube employed.

Though a large space is occupied by the French section, there is less of interest in it than in many of the others. The collection is very miscellaneous, and the

advertising element is rather conspicuous. Many of the things shown have no connection whatever with the real purpose of the exhibition, and many more are totally devoid of interest.

The Russian section was liberally aided by the Government, and the result is obvious in the character of the exhibits. Most of them are contributed by institutions and associations, Government and others the number of private exhibitors being comparatively small. Some of the educational appliances are specially noticeable, especially those for giving instruction in the laws of health, food, ventilation, &c. Among the objects shown may be noted some maps of St. Petersburg and Moscow, by Dr. Hubner, showing the prevalence of various diseases and their localisation during a certain number of years; a combined sledge and boat for use on ice; a method of raising sunken ships by inflated bags, &c. There are also a great number of plans and models of hospitals, public baths, and various engineering works. As might be expected in a country where the winter cold is so intense as it is in Russia, and where also fuel is costly, the science of warming and ventilation is far better understood than in England. This fact is strongly evidenced by the plans shown in this section for domestic architecture, and the appliances for warming houses and cottages. Some of the heating apparatus by which, from a stove in the basement, warm and pure air can be admitted as required to any part of the house, might offer models for imitation to many of our manufacturers.

The Italian exhibits are not numerous, but are rather interesting, as many of them deal with a subject hardly noticed in other sections, that of cremation. There are models of several furnaces for this purpose, while one inventor shows the results of his process, in the shape of a bottle containing the remains of a human body after incineration. Holland has rather a small collection, the chief exhibits being some fire-engines from Amsterdam, a city which has a most complete and elaborate organisation for dealing with conflagrations, including an extensive system of electrical communication. A lifeboat is also shown by the Dutch Société de Sauvetage, a much smaller one than that of the Lifeboat Institution, in the British section. The principal objects shown by Sweden and Norway are connected with lighthouse apparatus. The Danish collection is small, and includes a small lifeboat. There are also in this, as well as in the last-named section, some educational appliances. Switzerland seems to be the smallest contributor of any; most of the exhibits are of a medical or surgical nature.

A PHYSICAL SCIENCE MUSEUM.

(From *Nature.*)

Many of our readers will, no doubt, entertain the belief that the proposal to establish a Museum of Pure and Applied Science, to include what is known as the Patent Museum, recently laid before the Duke of Richmond and Gordon by the President of the Royal Society and other distinguished men of science, has been a thing of sudden growth. Some justification for such a belief may seem to be derived from the Loan Collection of Scientific Apparatus now being exhibited at South Kensington, and many of those who have witnessed its success would like to see it developed into a permanent institution. No doubt this collection has helped to bring into practical shape the desire which, for years, many men of science in this country have possessed of seeing this country possessed of an institution similar to the Paris Conservatoire des Arts et Métiers, which desire has at last taken the form of the all but unanimous memorial on the subject which was recently presented to the Lord-President of the Council, and which we published in a recent number. But the truth is that this memorial is strictly in accordance with an official recommendation made to the Earl of Granville, then Lord-President of the Council, as far back as the year 1865. At that time the Secretary of the Science and Art Department and Director of the South Kensington Museum, Mr. (now Sir) Henry Cole, along with the late Capt. Fowke, were instructed by the Lord-President to proceed to Paris, and report upon the relations between the Conservatoire des Arts et Métiers and the French patent system.

The results of this official visit to Paris were given in a report by Mr. Cole and Capt. Fowke to the Lord-President, which will be found in the "Twelfth Report of the Science and Art Department" (1865), and was laid before Parliament. As few of our readers can have access to this report, and as those with whom the decision as to the memorial will rest, cannot be expected to know all that has been previously said and done in this matter, and as, moreover, the subject is one of prime importance to the country and to science, we believe we shall be doing good service by exhuming from this old Blue-book the special report to which we refer:—

Report on the Conservatoire des Arts et Metiers and Brevets d'Invention.

To the Lord-President of the Council.

South Kensington Museum, January, 1865.

My Lord,—In obedience to your Lordship's instructions that we should proceed to Paris and examine into the relations which exist between the Conservatoire des Arts et Métiers and system of French patents, we have prepared, and have now the honour of submitting, the following report:—

1. The Conservatoire of late years, under the able direction of General Morin and M. Tresca, has become one of the most popular institutions in Paris.

2. This establishment, first created in 1788, has passed through many phases of constitution and management. At the present time it has three predominant features: (*a*), the public exhibition of machinery, manufactures, and models of an industrial and scientific nature; (*b*), a scientific library opened gratuitously to all; and (*c*), courses of gratuitous lectures given during the autumn and winter, in the evening, by the most eminent professors in France. These lectures are attended by several hundred persons. A prospectus of the courses for the present session is appended.

3. Besides these three features, the Conservatoire is the repository for the *Brevets d'Inventions* and the models deposited with them, which have exceeded the age of 15 years from the first issue of them. This connection of the institution with extinct *Brevets d'Invention* is a subordinate feature to its chief operations.

4. The Conservatoire consists of a series of ancient and modern buildings. The ancient, belonging to the Abbey of St. Martin des Champs, date from A.D. 1060, and are highly interesting to the archæologist. They have been well adapted to the purposes of the establishment, especially the old refectory, now converted into the library.

5. The principal façade is now opened to the new Boulevard de Sevastopol, fronting a large square. Additional parts of the old monastic buildings of the Convent of St. Martin are being restored and brought into use, whilst new buildings are being constructed to afford additional space. The ground already occupied by the establishment is 5·178 acres (or 20,956 mètres carrés), and this is being extended to 6·558 acres, or 26,540 mètres *carrés de terrain.* The buildings themselves occupy at present 8,383 mètres carrés, or 10,026·346 square yards, which will be enlarged to 16,744·565 square yards.

6. The laying out of the ground and the divisions into which the collection is arranged are shown by the accompanying plan.

7. The divisions are—machinery in motion, hydraulics in motion, agricultural implements, locomotives, horology, building models, &c.

8. These plans show the position of the two chambers,

the lower of which contains the specifications of *Brevets d'Invention*, whilst the upper contains the models. These chambers are on the opposite side of the court to the library, and have no connection with it. These rooms are about 60 feet long by 20 feet wide. The contents are very miscellaneous, and covered with dust, such as old hats, and woven fabrics, traps, tin ware, surgical appliances, and broken wooden models. It is not surprising that they are not considered of sufficient value or public interest to be kept with the general collection. They are never consulted. M. Tresca, the sous-directeur, has kindly answered some questions which we put to him. He shows that they do not influence the extent of the general collection of machinery, &c., and their value to it is explained to be nothing.

9. On Thursdays and Sundays the galleries are open free, and are crowded. On other days, reserved for students, the principle of admitting the public by a moderate charge, as at South Kensington, has been adopted, and visitors pay one franc each.

10. Four separate authorities throughout France are concerned in the issues and searches of *Brevets d'Invention*.

a. The Ministry of Finance.
b. The Ministry of Agriculture and Commerce.
c. The Prefecture of the Department.
d. The Conservatoire.

The necessary instructions, &c., for obtaining a brevet are given in a paper appended (page 282). It will be observed that the instructions make no mention of models as any part of a *Brevet d'Invention*, and, as M. Tresca shows, they are of no value whatever.

11. In Paris all *Brevets d'Invention* are kept and registered. Those under 15 years of age are preserved in the Rue de Varrenne, on the south side of the Seine; those above that age in the Conservatoire des Arts et Métiers on the north side, about two miles apart.

12. The steps necessary to be taken in Paris for obtaining a *Brevets d'Invention* are as follows:—The applicant for a patent must first apply to No. 24, Rue de Mont Thabor. This is a subordinate bureau of the Ministère des Finances, not very readily found or publicly indicated. He passes through a gateway between the Café des Finances and a stable for *remises*. He ascends to the second stage up narrow stairs, dark and odorous. Here is the bureau for the first stage of proceeding. He pays five francs, and obtains the necessary forms to be filled up; fills them up and pays 100 francs.

13. These forms being filled up, he takes them with the receipt to the Hôtel de Ville, and there he deposits his specification.

14. This specification is sent to a third bureau, which is on the opposite side of the Seine, No. 78, Rue de Varenne, the Ministère de l'Agriculture et du Commerce, and is also up two pairs of narrow, dark stairs. Here the specifications are kept during 15 years, whilst the patent lasts; after that period they are transferred, with any models accidently accompanying them, to the Conservatoire des Arts et Métiers. The room for searches is about 60 feet long and 16 feet wide. The specifications are arranged in carton boxes on shelves. It is rather crowded. Anyone enters and searches in the printed catalogues, and calls for the *brevet*, without let or hindrance; but he is not permitted to make notes even in pencil. Copies must be ordered of the office at a given tariff, and if a copy of a drawing is required, he must bring his own draughtsman.

15. The catalogue of the specifications is printed, and may be bought at V. Bouchard Huzard, Rue d'Eperon, No. 5.

16. It has been already pointed out that the law does not require that any models should be made, but some are sent. The officers kindly showed us what they possessed. We were conducted up back stairs into a little room about 10 feet wide by 20 feet long. The floor was covered with models unarranged, and very dusty. On a shelf were some models in tin, also very dusty. A model of a shoe was here, a candlestick there, &c. The officer said that they were very rarely looked at, and the accuracy of the statement was fully borne out by the condition of the room. He said that all the models in this small chamber were the products of some 20 years.

17. These facts show that the Conservatoire des Arts et Métiers did not arise and is not at all dependent on any connection with models accidentally delivered with the *Brevets d'Invention*, which are not recognised by the French law. The Conservatoire is a great educational institution, teaching the general public through its exhibitions, and a special public through its lectures. It seems to us to afford an example which our own country might imitate with advantage, generally as to scope and also in many of its details.—We have, &c.

(Signed) Henry Cole,
Francis Fowke, Capt. R.E.

A map accompanies this report, which shows the buildings then occupied by the Conservatoire and those which it was proposed to build in addition. If the Commissioners of the 1851 Exhibition, to whose laudable scheme we recently referred, have not already consulted this map and the report, we think they might do so with great advantage. There are many points in common between the scheme which they are considering and the plan which was then being carried out by the French Government, and which resulted in an institution that has been in working order for years, with, it is universally acknowledged, the best results to science and to France.

In the same Appendix M. Tresca furnishes answers to a number of questions with reference to the actual use made of the models of patents in the Patent Museum of Paris. The information thus afforded we would recommend to the notice of the Treasury Commission, which has for some time been cogitating as to what course to pursue with regard to our own Patent Museum. The analogy between the two cases is very complete, and it suggests that the best solution lies in a course similar to that which has been followed in France. From M. Tresca's answers we learn that in the Catalogue of Patents there were 7,300 entries of models, only 10 of which are accompanied by specifications. While 1,400 specifications had been consulted during 1864, not a single model had been examined or asked for, thus showing that the models were a practically useless part of the Patent Museum. M. Tresca states that the place of a model can be supplied by a drawing, leading to more complete, exact, and certain results, and thus avoiding useless expense. Their loss, therefore, would really be a gain to the Conservatoire; they cause, M. Tresca states, embarrassment by their compulsory preservation, the objects rarely representing the final idea of the inventor. They for the most part get destroyed by time without having been consulted by any one. Might not a somewhat similar report be made of our own collection of "Patents?"

The same Blue-book contains some valuable information with regard to the lectures which were then given in the Paris Conservatoire, which is worth consulting. Later and more complete information in this department may, however, be found in the appendix to the Report of the Duke of Devonshire's Commission. From what we have said, it will be seen that the idea of a Government Science Museum is by no means of recent growth, but that, on the contrary, it has taken many years to come to a practical issue; and that, moreover, we have a ready-made example, which has stood the test of years, and is now doing work of the highest practical value, in the Paris Conservatoire des Arts et Métiers.

The following letter on the same subject appears in this week's *Nature*:—

The fact that the Science and Art Department have had before them, for at least ten years, the proposal

to establish a Science Museum, is shown conclusively enough in *Nature* for last week. May I be allowed to draw attention to a still earlier suggestion of the same character? As far back as 1859, two years after the establishment of the Patent-office Museum, the Commissioners of Patents laid a report before Parliament, in which the following passage occurs:—"It is intended to make the Patent-office Museum an historical and educational institution, for the benefit and instruction of the skilled workmen employed in the various factories in the kingdom, a class which largely contributes to the surplus fund of the Patent-office, in fees paid upon patents granted for their valuable inventions. Exact models of machinery in subjects and series of subjects, showing the progressive steps of improvement in the machines for each branch of manufacture, are to be exhibited; for example, it is intended to show in series of exact models each important invention and improvement in steam propellers [steamboat propulsion], from the first engine that drove a boat of two tons burden to the gigantic machinery of the present day, propelling the first-rate ship of war or of commerce. The original small experimental engine that drove the boat of two tons burden, above referred to, is now in the museum, and is numbered one in the series of models of propellers."

Unhappily, this brilliant project rested unfulfilled. "No. 1" of the series of models of steamboat propellers had but few followers, while other branches of mechanical science did not get so far as to have even a "No. 1." The conception was excellent, the execution lamentably deficient. Thus the collection which was to have expanded into a Museum of Mechanical and Industrial Science degenerated into an old lumber-room, and instead of expanding over the ground originally allotted to it, contracted into its present dimensions.

Into the causes of this failure there is no need to enter. The thing has failed, and there is an end of it. Luckily there is a chance of something better now, and it is to be hoped that we shall soon have the collection belonging to the Patent-office divided into two parts, one part to be sent to the Science Museum and the other to the nearest dust heap. So long as it belongs to the Patent-office the aggregation of rubbish must continue. The Commisioners exercise no power of selection, and any foolish invention, so only that it is the subject of a patent, has the right of *entrée*. Naturally, it is not the important inventions which make their appearance at South Kensington. As part of a Patent-office, a museum is practically worthless. It is hardly possible to imagine an invention which, at least to an expert, cannot be as clearly explained by descriptions and drawings as by a model. For purposes of experiment and instruction models are obviously invaluable. By no other means, for instance, can *motion* be rendered intelligible to a class of students or a popular audience. When the object, however, is simply to define what an inventor has discovered or constructed, so that it can be understood by an expert, a drawing and a description are nearly always much better—always as good—as any model. The only reason why the Patent-office should have charge of such a museum is that the officials of the office are in constant communication with the particular class likely to contribute to the Museum. Patent cases are fruitful in models, constructed not for the engineers, but to enable engineers to explain, to those who have no special mechanical knowledge, the action of the different apparatus before them. Many such models are of no public interest, but many are well worth preservation, and it was thought that from these and like sources the Patent office Museum would soon grow rich. The event has hardly justified the hope, but that is no reason why, under better management, the promises held out fifteen years ago should not now be realised. With all its deficiencies, the Patent-office Museum has done one good service. It has preserved some quite invaluable examples of early mechanical science which would otherwise have been scattered to the four winds—most of them to the west wind and the States. These are ready to form the best possible foundation for the mechanical section of the Science Museum, a section which, in a great manufacturing country like this, ought certainly not to be the least important of all.

TRADE AND MANUFACTURE IN THE UNITED STATES.

The following letter appeared in the *Times* of the 14th inst.:—

Sir,—The marked decline in the British export trade, as shown in the recent Returns of the Board of Trade—a decline especially noticeable in the exports to the United States, induces me to offer a few remarks upon the development of manufacturing industry in that country, which I had a favourable opportunity of observing during my recent visit to the Centennial Exhibition at Philadelphia, as one of the Judges in the Group for Railway Appliances.

I last visited the United States in 1856. The progress made in the interval of 20 years is very marked. The stimulus afforded by the demands and expenditure on account of the war, assisted by the protective system which has been adopted, have developed and nursed every variety of manufacture, from iron rails to Parisian fancy articles. The advocates of the protective policy say it should be called nationalism, not Protection. Without discussing the wisdom of the Protective policy, or how far it has been instrumental in aggravating the present stagnation of trade, it is certain that it has led to the erection of a large number of factories and of numerous iron and steel works, and to a rapid development of manufacturing industry, as evidenced by the great increase in late years of the amount of coal raised. Thus, while the total amount of coal raised in the United States in 1870 was about 32,000,000 tons, as compared with 113,000,000 raised in Great Britain, the coal raised in the United States in 1874 was 50,000,000 tons, as compared with 125,000,000 raised in Great Britain. Of the coal thus raised in 1874 only about 500,000 tons was exported from the United States, of which about 400,000 tons was exported to the Dominion of Canada. The coal-fields of the United States cover an area of 196,000 miles, the coal is, in most cases, easily accessible; iron ore is abundant, both near the coal-fields and elsewhere.

The rate of wages for unskilled labour varied in the works which I visited from 90 cents a day to 1·20 dollars, equivalent, at the present rate of exchange, in our money from 3s. 6d. to 4s. 7d. The wages of carpenters, joiners, blacksmiths, and fitters varied from as low as 1·50 dollars to 2·75 dollars—*i.e.*, in our money, from 5s. 6d. to 10s. 6d. The day is at least ten hours long; these higher prices are moreover counterbalanced by the use of machinery, guided by unskilled labour to an extent much exceeding that generally in use in this country. Notwithstanding the stagnation of trade I observed several new works in course of erection. Although there is not so large an amount of new railway in construction as was the case in 1872 and 1873, many lines are substituting steel for iron rails. The rails now used in the United States are almost all being manufactured in that country, and it is not probable that England will be called upon much longer to supply rails for the United States. The development which the manufacturers of the United States have obtained, and the energy with which they work, make it manifest that not only can we no longer expect to obtain a market for our manufactured goods in the United States, but that we must be prepared to find the manufacturers of that country competing with us in every market to which we and they

have access for all our principal manufactures, such as iron, cotton goods, &c. It is most important that England should thoroughly appreciate its true position in this matter. The Centennial affords an excellent opportunity for seeing the process of American industry, and for meeting the leading manufacturers, as well as the most prominent men of all classes in the United States. I would, therefore, strongly urge all Englishmen who can afford the time, especially those interested in the political aspects of this question, to visit Philadelphia.—I am, &c., Douglas Galton.

August 12.

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(Subsidised by Parliament.)

The results, giving important information for public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. Number of visitors for the months of June and July, 1876. When they are counted by sight the letter "S" is used, when by turnstile the letter "M":—

Institutions.	Amounts voted in 1876.	Number of Visitors in June.	Number of Visitors in July.	How counted.	Remarks.
	£				
1. British Museum	108,947	50,757	58,594	S	Return refused. (1)
2. National Gallery, Charing-cross	6,898	*None.*	*None.*	S	The Gallery is now closed for alterations (2)
3. Kew Gardens and Museum ..	22,622	152,312	113,590	S	Open on Sundays and week days. (3)
4. South Kensington Museum ..	39,058	153,873	135,180	M	Total for year, 839,212. Open daily all the year and in the evening, except Sundays (4)
5. Bethnal-green Museum	7,200	45,590	34,693	M	Total for year, 522,098. Open daily all the year and in the evening, except Sundays. (5)
6. National Portrait Gallery, South Kensington	2,000	..	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines and Mining Record Office, Geological Museum, Jermyn-street..	8,947	2,359	2,423	M	Open daily, except Sundays and Fridays, and in the evenings of Mondays and Saturdays. (7)
8. Patent Office Museum, South Kensington	..	25,141	20,866	M	Open daily, except Sundays. (8)
9. Edinburgh National Gallery..	2,100	10,690	18,745	M	(9)
10. Edinburgh Museum of Antiquities	..	9,855	20,232	M	(10)
11. Edinburgh Museum of Science and Art	10,320	22,737	37,769	M	(11)
12. Edinburgh Botanic Gardens ..	1,750	15,462	14,567	M	(12)
13. Dublin Museum of Natural History	1,742	7,577	7,463	M	Open daily, and in the evening. (13)
14. Glasnevin Botanical Gardens and Museum	2,224	28,281	23,877	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland ..	2,339	8,829	8,246	M	(15)
16. Museum of Royal Irish Academy, Dublin	300	..	..	M	(16)
17. Zoological Gardens, Dublin ..	500	13,193	..	M	Open daily, including Sundays. (17)
18. Tower of London	1,590	33,847	34,708	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall	38,051	38,521	35,476	S	Open daily, including Sundays. (19)
20. Royal Naval Museum, Greenwich	1,055	7,502	8,574	S	Open daily, except Fridays & Saturdays. (20)
21. India Museum, South Kensington	..	33,595	88,633	M	Paid for by Indian Government. (21)
22. Hampton Court Palace	7,475	..	..	M	Open on Sundays, and on week days except Fridays. (22)

(1) Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays. The numbers are those for the corresponding months of last year, as given in the Parliamentary return.

(2) Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays.

(4) (5) Open morning and evening till 10, on Mondays, Tuesdays, and Saturdays. Students' days—Wednesday, Thursday, and Friday, 6d. entrance.

(4) Visitors in May, 101,635.

(5) Visitors in May, 37,501.

(7) (8) Open till 10 in evenings of Monday, Tuesday, and Saturday.

(8) (10) (12) (15) (16) (20) No information as to opening.

(11) Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days, Monday, Tuesday, and Thursday; admission 6d.; other days, admission free.

(21) Open on Mondays, Tuesdays, Fridays, and Saturdays, 1d. admission; on Wednesday and Thursday, 6d. admission.

FEVER AT SOUTH KENSINGTON.

The following two extracts are taken from the *Lancet*. The first is an article in the last number, the second is a letter which appeared the previous week :—

It having been hinted that the statements which we made, in support of Sir Henry Cole's allegation, that fever was chronic in some parts of South Kensington, were not founded on fact, we beg now to show that our conclusions were perfectly justified. South Kensington is included in the Brompton registration sub-district, the population of which in 1871 was enumerated at 28,000, and for the present year it is estimated at 37,000; the increase of the population is therefore 9,000 in five years. The deaths from diseases of the zymotic class in 1874 amounted to 57; in 1875 they increased to 87; and for the first seven months of this year, on the authority of the medical officer of health, they are 55, which, continued at the same rate, will give 94 deaths for the twelve months. Now if we estimate the population in 1874 at 31,000, then the death-rate from zymotic disease stands at 1·8 per 1,000; and taking the population in 1875 at 34,000, then the death-rate from zymotic disease would be 2·4; whilst in 1876 the death-rate from the same cause would be 2·5. But will the death-rate for the second half of this year continue at the same ratio as for the first half? Judging from the experience of the two preceding years, we hardly think that it will. In 1874 the deaths from zymotic diseases in the first half amounted to 21; those in the second half to 36. Again, in 1875 the deaths in the first half were 34, those in the second half 53; therefore an increase of the present rate may not unnaturally be looked for in the second half of this year, in which case the rate per 1,000 will also be increased. Even without such natural increase the rate for the present year is in excess of that for 1874 and 1875. It appears, therefore, that the zymotic death-rate of the South Kensington district is steadily increasing, and this increase is in advance of the estimated increase in the population. Surely this fact should engage the serious attention of the Kensington Vestry. Again, a death-rate from zymotic diseases of more than 2·0 per 1,000 is absurdly high for such a suburb as South Kensington, containing, as it does, such a large proportion of mansions and wealthy inhabitants, and the causes of which should certainly be inquired into. Lastly, the Vestry has declared that no deaths this year have occurred from typhoid fever in South Kensington (one death has been registered), but they have not informed us that in 1874 thirteen deaths were registered as fever, and last year nine from the same cause. Now, what do these figures represent? Dr. Murchison gives the mortality per cent. among all the typhoid cases admitted into the London Fever Hospital during twenty-three years as 17·2, or 1 death in every 5·79 cases. This average is undoubtedly extremely high, for Dr. Murchison states that at the London Fever Hospital "every patient admitted with enteric fever and dying in the hospital has been registered as a death from enteric fever, although death may be due to some sequel months after recovery from the primary attack; that many abortive cases, all of which recovered, have been registered as 'febricula,' and not as enteric fever; whilst a large proportion of the slighter cases were never brought to the hospital at all." But granting this high rate of mortality to have existed in South Kensington, then in 1874 there would have been seventy-five, and in 1875 fifty-two cases of fever in the district. But if the rate of mortality did not reach this outside limit, as there is no reason to suppose it did, then the number of cases would be proportionately increased. Still the fact that in a fashionable and wealthy London suburb, at the lowest estimate, from fifty to seventy cases of typhoid fever have occurred in two successive years is most alarming, and completely justifies the remarks made by Sir Henry Cole and the comments we have made.

Sir,—In an article on house drains in your journal of July 29th, you call attention to a hiatus in sanitary legislation, which renders a very large portion of the sanitary work of an urban health authority mere waste paper, and the implied security a delusion and a snare.

You suggest, "that, in addition to the proposal (of the Society of Arts) to submit the plans of house drains and connections to the local authority, power should be given to the authorities to appoint an inspector to see that all such sanitary work was properly carried out."

In confirmation of the opinion expressed, and in illustration of the pressing want you have pointed out, may I relate a sanitary exposure which has recently come before my notice?

A lady took on lease a newly-built semi-detached house in Leeds, rent £80. The house had been inspected by a land surveyor, had been found to be dry, and had been passed as satisfactory. In a few weeks the cellar and kitchen walls became wet, and the houses was pervaded by a smell of drains, and in four months seven out of a family of nine were ill with febrile attacks, high temperature, sore-throat, swollen cervical glands, and enlarged tonsils. The two maid servants were each laid up twice in a short period.

The illness suggested defective drains, and, under the pressure of the medical attendant, the following defects were discovered, much to the annoyance of the landlord :—

Defect No. 1. The main drain, nine-inch tube, was laid immediately against the outer wall of the house, and twelve inches above the level of the kitchen floor.

Defect No. 2. These drain-pipes had no fall, the joints were not made good, and the sewage freely escaped into the ground, saturating the kitchen wall and the soil under the kitchen floor.

Defect No. 3. The branch drains for sinks and water-closets were built into the wall, and the lead delivery pipes were simply turned into these drain-pipes, without any attempt whatever at connexion having been made. In two instances an inch and a half pipe was turned into a six-inch pipe, thereby allowing ample space for the untrapped sewer gas to escape into the house.

Defect No. 4. The overflow-pipe from a cistern, and the waste-pipe from a lavatory, were connected to an untrapped, unventilated soil-pipe, and through these untrapped pipes the sewer gas was literally blowing into the house.

Every one of these sanitary defects is in direct violation of the building bye-laws of Leeds. The plans of every new building or of any alteration of an old building have to comply with the bye-laws, and are passed after careful inspection by the surveying authority. And what next? Dishonest speculators, dishonest builders, dishonest contractors may scamp every sanitary requirement, as no effective machinery is provided to secure that these requirements ever reach any stage beyond the paper on which they are drawn. Houses are built, and let, and sold for what the speculators can get out of them, and in nine cases out of ten the sanitary flaws are not discovered until they have worked their natural results in the illness, or perhaps the death, of the unfortunate tenants. Scamped drain work is one of the most dangerous, one of the most common, and one of the most difficult to detect of the sanitary flaws of new buildings, and is rarely found out except by the illness it produces. We must not rest content until it shall be compulsory on every sanitary authority to provide that the laying of every drain shall be watched from beginning to end by a competent inspector, who has the independence, the courage, and the honesty to compel, in every case, sound, reliable workmanship.—I am, Sir, yours faithfully,

T. Pridgin Teale.

Leeds, August 3rd, 1876.

This year the value, as declared, of boots and shoes imported had increased from £127,005 in 1875 to £203,777. It was only £85,573 in the same period of 1874.

SIEMENS-MARTIN STEEL.

After the reference made by Mr. Mattieu Williams, in his last lecture on "The Iron and Steel Manufacture,"* to this process for making steel, some further account of it, as carried out by the Landore Siemens-Steel Company, and also of the works themselves, where were produced the remarkable samples of "mild" or "semi" steel exhibited by the lecturer, will perhaps not be inopportune.

The works were started about seven years ago for the manufacture of steel under the patents of Dr. Siemens, who is chairman of the company, and have since been considerably extended by the addition of the "new works," so that the present area of ground occupied is now nearly 100 acres. The old and new works are together capable of an average production of no less than 1,500 tons of steel a week, and give employment to over 1,000 men.

The works are situate about three miles to the north of Swansea in Glamorganshire, and, being intersected by the river Tawé, and in close proximity to the Midland and Great Western Railways, are in a favourable position for receiving supplies of the raw material, and also of getting rid of the finished products. Coal is raised in the neighbourhood from the company's own collieries, and the limestone flux comes from the Mumbles, only a few miles off, being brought up the river in barges; but the hard blast ores of South Wales contain too high a per-centage of phosphorus and other impurities for steel-making, which requires the purest of iron ore. To meet this want, the company purchased a mine of their own, near Bilbao, but have, unfortunately, not been able to obtain a ton of ore from it during the the late civil war; they have, therefore, had recourse to the famous red hæmatite ores of Whitehaven and Furness, and, to a certain extent, the no less celebrated Mokta ore from Algeria.

The nature of the ground favours the arrangement of the blast furnace plant which is situated at the old works. A double row of a hundred coke ovens, on a level with the charging floor of the blast furnaces, presents considerable features of interest. They are charged by trucks running on rails over the top, and are drawn by the chains attached to the cradles, previously inserted at the bottom of each oven, being connected to an endless chain passing over a pulley at one end and worked by an engine at the other. Penrose and Richard's method of making coke by grinding together suitable proportions of anthracite, bituminous coal, and pitch fromgas works, has been tried with great success, a saving of 30 per cent. having been effected, while at the same time a good hard coke is produced.

Two furnaces of large dimensions have been built under a bank, in such a position that ore and coal can be run in trucks direct on to the top of one furnace, while a lift of only a few feet is required to make up for the difference in height of the other; both furnaces are close-topped, and are fitted with patent hydraulic brakes for lowering the charge. Both ordinary pig iron and spiegeleisen are made in these furnaces as may be required; but a smaller furnace is also occasionally used for producing a spiegeleisen somewhat richer in manganese.

When the works were established, it was intended to run the metal direct from the blast furnace into the melting furnaces, and the relative positions of the blast furnaces and melting-house were arranged with this object; but it has never been carried out, and the charge for the blast furnace is run into the ordinary "sows and pigs" in front of the furnaces.

When cold, the pigs are conveyed in trucks to the Siemens regenerative melting furnaces, of which there are sixteen at the new works alone, capable of turning out over 1,000 tons of steel ingots a week. This production is brought up to more than 1,500 tons a week by the eight furnaces at the old works, including two of large dimensions, equal to a charge of over twelve tons. In these furnaces, instead of the molten metal being tapped, as usual, into a ladle, from which each ingot-mould is filled in succession, the moulds are arranged in a circular frame, which revolves, bringing each one in turn under the ladle, so as to be filled by the charge running continuously from the furnace through the ladle and into the mould. By this arrangement a charge of nearly 14 tons of steel has already been run at a time, to form the ingot from which was rolled the first steel armour-plate that has ever been made. This was only by way of experiment; but on the slab, which was 3 inches thick, being planed at the edges to a size of 8 ft. by 3 ft. 6 in., and also through the middle, to see if it was homogeneous, the result was considered so satisfactory that more armour-plates are to be rolled.

The furnaces themselves, both at the old and new works, are built entirely of silica bricks made on the spot from rock obtained in the neighbourhood; but the Siemens' regenerative chambers are composed of Stourbridge bricks. The gas for heating the furnaces is generated in blocks of Siemens gas producers, and led in pipes and culverts under the floors to the furnaces, the current being reversed by the valve about every half hour. The furnace bottom consists of good silica sand obtained from the same rock as that which yields the bricks. The charge for each furnace is properly apportioned by weight, and consists, as a rule, of 6 tons of good pig-iron containing no phosphorus, and not more than 0·05 per cent. of sulphur, 25 cwt. of pure steel or iron scrap, and from 30 to 35 cwt. of Algerian ore for decarburising. The pig iron and scrap are first charged cold into the furnace, and, when melted, the ore is added from time to time in small quantities, until the carbon has become sufficiently reduced. The spiegeleisen is then added, sometimes cold, but more frequently after having been previously raised to a red heat in an ordinary melting furnace. As the spiegeleisen is added for the purpose of restoring the proper amount of carbon to the metal, its proportion depends upon the quality of steel required, whether hard or soft; but the per-centage can be regulated exactly, even to the second place of decimals. To ascertain the proportion of carbon contained in the charge, samples are taken out from time to time towards the close of the operation, quenched in water, and broken, when the fracture gives the necessary information to an experienced manager.

The ingots, after being re-heated, are hammered into blooms under the steam-hammer, and then either rolled off at once into plates, bars, rails, &c., or again re-heated before rolling. All the furnaces, however, are on the Siemens regenerative principle, no raw coal being used in the working of the metal. Rails and tyres are chiefly produced at the new works, where there is much to interest the visitor. After the rail—which may be 65 feet long, to be afterwards cut into two—has passed through the rolls for the last time, it is received on rollers made to revolve by steam, and by them brought up to a circular saw, which advances to the rail and cuts off the "crop" end, at the same time automatically putting out a hand, as it were, to hold the rail fast while being sawn. The rollers then take the rail on to a distance corresponding to its required length, the rail is sawn off, and finally the remaining crop end. It is, however, found impossible to saw the rails off while hot to the exact length required, on account of the varying temperature, and consequently unequal contraction of the bar; they are, therefore, generally sawn off a little too long, and afterwards reduced to the standard length by a machine which takes a paring off the ends, at the rate of one-eighth of an inch a minute, leaving a square well-finished end. The operations of straightening the rails and punching the holes for the fish-bolts and fang-bolts, are accomplished by powerful

* See the last number of the *Journal*, p. 895.

presses. In punching the fish-bolt holes, gauges are used for stopping the rail under the punch at the right place; but in the case of the fang-bolt holes, the workman has no other guide than his eye in stopping the rail under the punch, which makes twenty holes in a minute.

In the manufacture of railway tyres, a circular bloom is first made, and a piece punched out under the steam hammer, thus leaving a slab of annular form, which then has an incipient flange formed upon it under a "beaking" hammer. After another "heat" in the furnace, the tyre is finished in a tyre-mill, worked by hydraulic power, the only one of the kind at present in use in the United Kingdom.

The bar-mill, at the new works, is capable of turning out over 100 tons of bars a week, chiefly used up in the adjoining wire-mill, which is equal to a production of 90 tons of wire a week. This wire is of every degree of hardness, from the "special soft," for telegraph purposes, to pianoforte wire of great hardness and high tensile strength.

The "special" plates for the Admiralty, now being used in the construction of Her Majesty's despatch vessels *Iris* and *Mercury* at Pembroke Dockyard, are rolled at the old works. They are brought out of the furnace for final rolling at almost a wolding heat, and during the last passes between the rolls, birch twigs are thrown upon them, to generate carbonic acid gas and to remove the scale, while during the last pass of all the plates are washed with water by birch brooms. The consequence is that a remarkably fine surface is given to the plates, and the usual operation of scaling before painting is thus rendered unneceseary. The vessels above named are being built entirely of Siemens metal, with the sole exception of the rivets; but some severe tests, with a favourable result, have been applied to the metal by the authorities at Pembroke, with a view to employ it also for rivets. These tests were described in a paper read in April last before the Society of Naval Architects, by Mr. J. Riley, the manager of the Landore Works, and have elicited from the Admiralty the opinion that this metal "works sound and well, and that rivets can be made of the steel with the same facility as of iron." Each separate plate is annealed in a large furnace recently erected to a design by Dr. Siemens, a test strip, 10 inches by 2 inches, being invariably sheared off each plate. These strips may be planed to 1½ in. wide, but such confidence is felt in the toughness of the metal that the strips, merely rough-sheared, are heated to cherry redness, quenched in cold water, and then beat double until the radius of the curve equals the thickness of the plate—a test they must stand without cracking. Other test pieces, 8 in. × 1½ in. × ½ in., with suitable ends, are inserted in the shackles of a direct-acting lever testing machine, arranged so that the weight of a cwt. at one end gives a tensile strain of a ton at the other. The strips are then pulled apart by continued increments of load, the government specification providing that the tensile strength shall not be less than 26 tons, nor more than 30 tons.

In the testing house is a large collection of pieces of steel of various shapes, subjected to all kinds of torture, bending up, twisting, and even tying into knots in a cold state, to show the remarkable tenacity and uniformity of composition of this metal of the future, which is at present, for the want of a better title, distinguished by the name of "mild" or "semi" steel.

The tonnage movement of the principal Italian ports appears to have largely increased during the last 15 years. It amounted at Ancona last year to 751,689 tons, against 372,749 tons in 1861; at Brindisi to 771,096 tons, against 38,938 tons in 1861; at Genoa, to 3,109,800 tons, against 1,436,764 tons in 1861; at Leghorn, to 2,375,169 tons, against 1,673,219 tons in 1861; and at Naples, to 2,923,922 tons, against 1,603,875 tons in 1861.

AGRICULTURE OF LABUAN.

The agriculture of Labuan is of the rudest possible description, and is confined to the growth of *padi* and a little sugar cane. Of the 21,000 acres of cultivable land supposed to be available, only about 1,500 are such as could be used in the regular cultivation of *padi*. These consist of black soil, the product of the decayed foliage of the fine forests which formerly covered the island. This has been carried by the heavy rains into the valleys, leaving the hills quite denuded of vegetable mould. This soil lies fallow between the months of March and August, when the grass and weeds upon it are cut down and burnt. The *padi* plants are then dibbled into the mud with the point of a stick or a chopping knife, no ploughing or stirring of the soil having taken place, and being once weeded during their growth, no other care is bestowed upon them till the harvest is ripe in January and February. The other parts of the island are very much cut up by numerous watercourses with steep sides. The hills thus formed consist for the most part of poor soils of a yellow or reddish colour, sandy or clayey loam, now covered with ferns and grass, but which until 1868 supported a noble forest. Some small herds of buffaloes and cattle are grazed upon the land, and are in sufficient numbers to supply beef of very good quality to the inhabitants.

In geological structure the Island of Labuan must be referred to a recent tertiary period. The shells which are found in the sandstones and clays appear to differ in no respect from those now living in the neighbouring seas. The blue clays above the coal are crowded with perfect impressions in coal of the foliage of the trees from which the beds of the mineral beneath have been formed, and there are easily recognised amongst them the leaves of trees of the same kind as those which so recently covered the surface. *Dipterocarpi* are the most common order in the fossil as in the recent vegetation, and large masses of the resin exuded by trees of this class are frequently found in the veins of coal. Impressions of palms and ferns are rare, but these are not common in the recent flora, except in certain suitable spots favourable to their growth. The only shell which has been found in very close proximity to the coal is a bivalve, such as is now found in muddy estuaries.

CULTIVATION OF OPIUM IN PERSIA.

Opium is cultivated principally in Yezd and Ispahan, and partly in the districts of Khorasan, Kerman, Fars, and Shushter. The opium grown in Yezd is considered to be better than that in Ispahan and elsewhere, owing to the climate and soil of that place being better adapted for the growth of the drug. But the district of Yezd, notwithstanding the existence of a large cultivable area, is not capable of any considerable extension of the cultivation of opium, owing to the insufficiency of the means, both natural and artificial, of irrigation. Ispahan, however, differs from Yezd in this latter respect, as it abounds in streams and rivers, and is capable of greater extension of the cultivation of the drug. But the cultivation of cotton and cereals takes up a large part of those resources, and tends in no small degree to reduce the culture of opium.

A few years ago, the profits of the opium trade having attracted the attention of the Persians, almost all available or suitable ground in Yezd, Ispahan, and elsewhere was utilised for the cultivation of opium, to the exclusion of all cereals and other produce. It was then supposed by some that the opium cultivation would be indefinitely extended in Persia. But circumstances eventually showed that such could not be the case. The attempt of the natives to enrich themselves by cultivation and growth of a profitable article of trade, and their neglect to provide for the necessaries of life, combined with drought and other circumstances, resulted in the famine of 1871-

72. The costly experience then gained has made the Persians more careful and provident, and they are now using only a limited space for the cultivation of opium. The largest produce they had in Persia a few years ago did not exceed 2,600 cases; it has since been reduced to some 2,000 cases.

The crop comes to hand in May and June, and the great part of the opium finds its way to the shipping ports between September and January. The shipping ports are Bushiri and Bunder Abbass. The whole produce of Ispahan and Fars is brought to Bushiri. The produce of Khorasan and Kerman is taken to the Yezd market, and this together with that of Yezd itself are sent partly to Bushiri, partly to Bunder Abbass. The Persian opium, it is said, is not much liked in China, owing to its having a peculiar flavour caused by the mixture of a large quantity of oil during the process of preparation, and owing, also, to its being sometimes found adulterated. It, however, finds a somewhat better market in London, inasmuch as it contains, on an average, a large quantity of morphia.

NOTES ON BOOKS.

The Old Days of Price's Patent Candle Company.— London: Gilbert and Co., 1875.

A small book under this title has been written by Mr. G. F. Wilson, F.R.S., who from the first starting of the company and for many years afterwards was its able scientific managing director. The history of a great industrial establishment, its origin, rise, progress, and especially of one based on the application of purely scientific researches, cannot fail to awaken a keen interest among the members of a Society whose aim is the promotion of Arts, Manufactures, and Commerce. Those of a previous generation will not fail to recollect the tronble of the old mould candle, with its defective light, and its wick which ever required snuffing, Price's Patent Candle Company, and its original private firm of E. Price and Company, set on foot by the enterprise of the elder Wilson, were the first in this country to effect a reform and bring good candle light within the reach of a large class who could not previously afford it. The "composite candles" in all its varieties, now so well known that its origin is forgotten, conferred a boon on society which it is difficult for the present generation to appreciate. The discoveries and researches of Chevreul on fatty substances commence as far back as the year 1811, but these researches do not appear to have borne practical fruit even in France till many years after, and it was not until 1835 that the French process of making stearine candles from tallow, based on Chevreul's researches, was introduced into the English factory, which soon went ahead with further improvements. The happy idea of mixing the solid matter of the cocoa-nut oil, to which the previous labours of the company had been confined, with the solid part (stearic acid) of the tallow, appears to have been the idea of Mr. James Wilson, the brother of the author, and "the composite candle" was the result. The invention was never patented, and sundry other manufacturers soon took advantage of it. The labours of the company were, however, not confined to candle-making, but a variety of important products arising out of its dealings with fatty matters, and bearing largely on the well-being of other industries, were in succession placed in the hands of the public. A patent cloth oil enabled the great woollen millers to oil their cloth much cheaper than with olive oil, and with the further benefit of brightening the colours; and a spindle oil gave the spinner a cheaper and superior material than sperm oil for lubricating his machinery. Pure glycerine was, in quantities at least, an almost unknown material till Price's Company produced it by an entirely new process, and in large quantities. Its uses, both medically and industrially, at the present time, are endless. The factory, however, does not claim merit only for its skilful manufacturing processes, and its varied organisations for the education and well-being of its *employés* havo a reputation not confined to this country alone. How all these things were brought about is told by Mr. Wilson in a clear and simple story, addressed to his children, showthem, to use his own phrase, "how their grandfather became a candle-maker."

GENERAL NOTES.

Meat Supply.—A report from Smithfield states that the importation of meat from New York, by the freezing process described in the *Journal* for February 25th, has been successfully continued during the summer, even through the recent hot weather. On Tuesday last, the 22nd inst., as much as 1,300 quarters were sold at fair prices. The importers expect a largely increased supply during the coming winter.

Hygeia.—It appears that Dr. Richardson's ideal "City of Hygeia," as suggested in his address delivered before the Sanitary Section of the Social Science Association, is about to take actual form. It is understood that an association has been formed, and an estate purchased on the Sussex coast, for building houses of a superior character, and on the most approved principles, so as to secure as far as practically is possible all the advantages so eloquently depicted by Dr. Richardson in describing his model city of health.

Chinchona Cultivation in India.—On the Government plantations on the Nilgiri hills, there were in 1875, 2,659,423 plants, the tallest being 30½ feet in height, and 28½ inches in girth near the ground. As many as 290,447 plants and 503½ ounces of seed have been distributed, and there are now many flourishing private plantations in the south of India. 28,659 lbs. of chinchona bark were shipped to England from the Government plantations alone for sale in the London market during 1875. The chinchona plantations in Ceylon and in other parts of India are equally flourishing, and Mr. Wood, the able and indefatigable quinologist, expects soon to be in a position to manufacture 4,000 lbs. yearly of an efficacious chinchona febrifuge at the cost of less than a rupee per ounce. The trade in East Indian chinchona bark is rapidly increasing. In 1875, there were 879 bales, bags, or packages, sold in the London market, containing about 87,000 lbs. of bark, and realising about £14,000.

Patent Office.—The issue of the specifications in the new form, which was announced some time back, has just commenced. They are printed in smaller type so as to occupy less space, and the drawings are reduced by photo-lithography to quarto or octavo size, instead of being the same size as the originals. At present only a few are on sale, but a great number are in course of preparation and will soon be issued. They will be sold singly, as heretofore, in the ordinary blue covers, but at a very much lower price, and also bound up in volumes of about a hundred numbers, with indexes. These indexes only refer to the contents of the volume, so that towards the end of each year it will be necessary to search through a great number of separate small indexes instead of, as now, through only one. Assuming that a hundred numbers are included in each volume, it will require over forty volumes to contain the four thousand and odd specifications filed annually, and there will thus be forty separate indexes to be consulted. The index published up to the present time, but now about to be discontinued, is kept up to date, week by week, each number superseding all previous issues. The labour of a search will thus be materially increased under the new system. One advantage, however, will be secured, that the enormous bulk of the publications issued annually will be reduced. The reduced drawings are in some cases quite as good as the originals for all practical purposes. In many other cases, however, it is to be feared that they will be of little real use. The letters of reference boing of course reduced with the drawing, become often quite illegible, and when minute details are given in the original, they become compressed and indistinct in the reproduction.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PROGRAMME OF EXAMINATIONS FOR 1877.

The Programme for 1877 is ready, and can be had on application to the Secretary. The Society's Examinations now comprise the following divisions:—

1. Commercial Knowledge.
2. Domestic Economy.
3. Fine Arts applied to Industry.
4. Music.
5. Technology of Arts and Manufactures.
6. Elementary.

MISCELLANEOUS.

THE LOAN COLLECTION OF SCIENTIFIC APPARATUS AT SOUTH KENSINGTON.

The Long-focussed Huyghenian Telescopes.

In a recent article on the astronomical instruments comprised in this collection, allusion is made (page 851) to Huyghens having contrived some very ingenious apparatus for the adjustment of his long-focussed lenses, which had to be used without a continuous tube, but by an oversight it was not observed that this very apparatus itself is contained in the collection, and is well worthy of passing notice. It is ranged against the wall immediately behind, or level with, the glass case which contains the series of Huyghenian lenses.

This apparatus, it will be seen, consists, in the first place, of a strong cast-iron plate and frame, which carries a pillar and ring suspended by pivots on a cross-arm. When the circular counterpoise, which forms a kind of foot to the pillar beneath the ring, is screwed up, this entire piece becomes free to turn upon its cross-arms, but the ring also revolves, by a collar, vertically on the pillar, so that there is thus a free double motion. The plate at the bottom of the frame is intended to be bolted firmly on some elevated support. The copper tube, which carries a long tail-like arm, is then clipped into the ring by two binding screws, and the object-lens is inserted into the tube. By means of a cord, or chain, attached to the long tail-like lever, the observer is then able to direct the lens in any way that he may desire. The series of cylindrical blocks which are ranged by the side of these supports, and look like sundry dirty oil cans of different sizes, are in reality the eye-pieces which were employed down below to magnify the image formed in the primary focus of the object glass. They are specimens of the first early form of tho combination which has since become so generally known amongst astronomers as the Huyghenian eye piece.

Instruments used for Astronomical Observation.—Astrolabes and Quadrants.

It is generally considered that the first man who attempted to mark the movements of heavenly bodies by a direct reference to scientific principles was Hipparchus, a native of the old province of Bithynia, on the southern coast of the Black Sea, who lived somewhere between 160 and 125 years before the Christian era, and who certainly was engaged with astronomical observation within that period on the island of Rhodes. It is, however, somewhat remarkable that the exact year of neither the birth or death of this distinguished man is known, and that our acquaintance with his actual work is only such as has been derived from the allusions of Ptolemy, the Alexandrian astronomer, who lived some two centuries and a half later than Hipparchus. Delambre, one of the greatest authorities on ancient astronomy, believes that the most important of the theories of Ptolemy were based upon the observations of Hipparchus.

The first instruments which were employed for scientific observation of the movements of the heavenly bodies wero unquestionably of the nature of what is termed the "armillary sphere." This astronomical "Bracelot" (*Armilla*), in the simplest form, is virtually a hollow sphere in which certain of the "great circles," now known as the "Equator," "Ecliptic," and "Meridian" are left in the proper positions, and in solid attachment, whilst all the rest of the surface of the sphere is cut away. It is, properly, the skeleton of a sphere. There is no very adequate specimen of this primary form of astronomical "measuring instrument" contained in tho Loan Collection of Scientific Apparatus at South Kensington, but its absence is practically supplied by a large photographic representation, which hangs high up on the wall of the Room L, immediately at its southern entrance on the right hand. There may be seen a very good photograph of a notable bronze armillary sphere which stands at the present time on the terrace of the astronomical observatory at Pekin, and which was made by tho Chinese mechanic, Ko-show-king, at the end of the 13th century. The circles of the sphere in this very interesting instrument are supported by bronze dragons, which appear to have some mythological significance.

It was, in all probability, with some such instrument as the ono which is represented in this photograph, that the great father of astronomy, two thousand years ago, established the first tangible notion of the movements of the sun, and of the mean movements of the moon, and approximately fixed the inclination of the earth's axis. The errors of observation with which astronomy had to deal in that early dawn of its methods were such quantities as the full diameters of the moon or sun. The first estimato of the elevation of the Pole, or, in other words, of the inclination of the earth's axis to the plane of its orbital motion round the sun, was in error one half the diameter of the sun's face. Yet out of such a beginning that science has grown which now deals in absolute certainty with a tenth part of a second,—that is the eighteen-thousandth part of the breadth of the sun's face.

One of the first practical improvements in the work of observation was, however, that which was made by the father of the science, when he conceived the idea of converting the early form of the armillary sphere into the instrument now known as the "planisphere;" in which the circles of the celestial sphero are represented as projected upon a plane, and by the omployment of which the most important of the problems of spherical motion can be resolved much more exactly and conveniently than when the original form of the skeleton sphere is used. The old term "astrolabe" is loosely applied to both these forms of instrument, the skeleton

sphere and the planisphere with the circles referred to a plane.

Of the planisphere astrolabe, the Loan Collection contains a very rich series of specimens. In the third case to the north of the Galileo telescopes and busts, there are not less than eleven distinct specimens, of which the very fine instrument numbered 1757*a* may be taken as the type. It is a specimen contributed by the School of Mines of Madrid, and is of very great historical interest, as having belonged to Philip II. of Spain. It will be observed that this astrolabe is a flat disc of brass 23 inches across, with a handle on one part of the rim, by which the instrument can be suspended in a vertical plane. It has also a moveable arm pivoted upon its centre, with sights at each extremity, by means of which altitudes can be taken when the disc is hung from its handle. The point vertically beneath the suspension being taken as zero, the arm is obviously ranged in a horizontal position when it reads 90 degrees from it, and at all elevations above 90 degrees gives corresponding angular altitudes above the horizon. In this form the instrument was readily employed in observing altitudes at sea. One small instrument of heavy bronze, seven inches in diameter (without catalogue number), which has been contributed by Mr. Lecky, is a marine astrolabe of this character. The instrument was found under a rock off the island of Valencia, within view of the place where three vessels of the Spanish Armada were wrecked. It is graduated into simple degrees on one face, and is read by an arm terminating in index-points at both extremities, and carrying sights only two and a half inches asunder. The sights are perforated with exceedingly minute holes. The other astrolabes of the series are all almost identical in pattern and form. They have all a small excentric circle, adjustable within the primary one which carries the leading arm upon its centre, engraved with the signs of the zodiac, and very elaborate and complicated scroll work, inscribed with the names of sundry standard stars. The fine typical instrument of Philip II. bears the date of 1555; but a small instrument, contributed by Professor Buys Ballot, of Utrecht, which is only four inches in diameter, is of still earlier date by 30 years; and there is also another very old specimen, sent by Mr. A. C. Baldwin, of Chester, which is not more than four inches in diameter. The finest specimens, after the most remarkable one of Philip II., are No. 1,757, belonging to the beginning of the 16th century, with a diameter of 13 inches, contributed by the University of Leyden; an altogether similar instrument of about the same date from the Royal Museum at Cassel; 1,757*d*, a seven-inch astrolabe, contributed by the Archæological Museum at Madrid, is 1774 in date, and bears an Arabic inscription, as does also 1,757*c*, from the same museum, nine inches in diameter, and marked as of Toledo manufacture. There is another specimen with an Arabic inscription, of six inches diameter, from Cassel; and one of eight inches (No. 1,755) from the Royal United Service Institution, has a Persian inscription. No. 1,756 is a nine-inch astrolabe from the Observatory at Leyden, and appears to be consecrated to astrological service by the inscription, "Qua fata trahunt retrahuntque sequamur." All these instruments are engraved upon both faces, and in this particular are distinguished from the Philip II. astrolabe, which has its engraved circles only on one side, but which may, nevertheless, on account of its large size and fine execution, be advantageously studied as the typical form of the plain sphere of Hipparchus. The arc of the instrument, it will be observed, is graduated into ten minutes, and is read, without vernier or sub-division of any kind, from an arm with notched sights. The instrument, when in use, would have been held in the plane of the meridian, or of the prime vertical, for ordinary altitudes, and would then have given altitudes from either the south, east, or west points of the horizon. But it might obviously be ranged as well on planes that would give altitudes from any other intervening points of the horizon. This instrument appears to have been made by Walter Arsenius ("Frisii Nepos Louani") in 1555, "Philip being king." The very beautiful work of the scrolled bands, which are engraved with the names of standard fixed stars, is worthy of especial notice. The 16th century twelve-inch astrolabe (No. 1,757*b*), also from the Archæological Museum at Madrid, is remarkable for being mounted upon a brass pillar. Philip II.'s astrolabe is only eclipsed in the collection, in matter of size, by one instrument, which looks very much as if it might have been the prime original of the shield of Achilles, where it stands at the end of the case next beyond the one which contains the bust and telescopes of Galileo. This large astrolabe, which is exhibited by Lord Dudley, has a diameter of 27 inches, and is read by a projecting index carried along the face of the graduated rim by an inner revolving circle. Beyond this it has neither altitude bar nor sights, but it has a curious flat revolving arm pivoted on the centre of the circle, and fashioned of successive steps like the spokes of a ladder. There is one notable astronomical circle amongst these astrolabes (namely, No. 1,762) contributed by the Observatory at Leyden, which appears also to be the work of the maker of Philip's large astrolabe, Walter Arsenius, grandson of Gemma Frisius ("Frisii Nepos"). Its date is 1752; it is five inches in diameter, and has two several indices, one devoted to the sun, and one to the planets and the moon. There are two sights on the back of the circle, carried upon a curious three-jointed arm, capable of being folded back out of the way, or extended for use, and furnished with a glass bead carried upon a silk thread, which no doubt did duty as a plummet.

Before passing away from the era of the astrolabe it is as well to make a brief passing visit to a member of this venerable fraternity which dwells by itself under a bell-shaped glass, at the opposite side of the room to the large case; it is appropriately pillared upon a capstan, and is marked by a large label intimating that it was the astrolabe constructed for Sir Francis Drake before his first expedition to the West Indies in 1570. This instrument was given to Greenwich Hospital by King William IV. It has great interest from its historical associations, but was obviously little more than a philosophical toy. The reading arcs unfold from a central piece, which when folded up is contained in a double case, and is then capable of being suspended from a handle. The instrument, which is numbered 1,753 in the catalogue, is very much like a flat watch when closed. The valves of the case are engraved with the various astronomical circles, and astrological hieroglyphics. But the arc of the graduated circles is so small that the instrument could never have been of any really practical use in processes of navigation. Its possible errors must easily have amounted to degrees instead of minutes.

In using the old astrolabes the highest altitude of the sun above the meridian was easily observed. A gnomon, or shadow-piece, of convenient form, was fixed in the centre of the circle, and a corresponding shadow-piece was then shifted along the further part of the circular rim until it was exactly covered by the shadow. This then gave the altitude of the sun in degrees of the circle. It does not appear that there was any known plan for fixing the principal circle in the plane of the meridian before the days of Ptolemy. It was most probably done much as the southing of the sun is now ascertained by nautical men at sea, that is by taking the height of the luminary at the instant of its greatest apparent altitude. The Arabian astronomers first practised the plan of getting equal altitudes of the sun when east and west of the meridian; but they probably did not obtain more than a mere approximation to the meridian, as they knew nothing of the variation of declination of the sun during the interval that occurred between the two observations. The distance between the tropics was one of the first exact observations of an

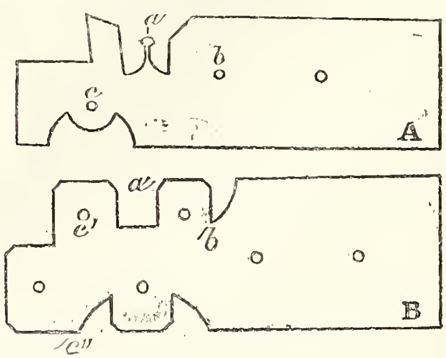
astronomical character that was ever made, and it no doubt was effected exactly in this way. It was merely the difference of the highest and lowest altitude of the mid-day sun, referred to the angular measure of a circular instrument of this character. Eratosthenes, a contemporary of Archimedes, who had charge of the Alexandrian library in the reign of the third Ptolemy, and who belonged to an age nearly a century earlier than the time of Hipparchus (about 270 B.C.), appears to have so fixed the distance between the tropics at eleven eighty-third parts of the circumference of a circle. The obliquity of the ecliptic, which is necessarily the half of this quantity, was estimated at 23° 51′ 19·5″ from this observation of Eratosthenes, and this is singularly near the truth (probably within 23 minutes, or a third of a degree) considering the rudeness of the instruments with which the measure had to be made. This astronomer appears to have used a gnomon constructed a short time previously by Timochares and Aristyllus. Hipparchus, however, accomplished a very much more marvellous feat than this measure of Eratosthenes. He was aware that there were 94 days and 12 hours between the sun's crossing the plane of the earth's orbit in the spring and its greatest altitude in the summer, and only 92 days and 12 hours between this greatest altitude and its again crossing the plane of the earth's orbit in the autumn, and he referred this inequality of time to its true cause, namely, the eccentricity of the orbit of motion, then, however, conceived to be the sun's motion round the earth. Hipparchus also must have used the astrolabe for the measurements of angles out of the plane of the meridian, for he could only have acquired his knowledge of the exact instant when the sun crossed the plane of the earth's orbit from measurements of the angular distance of the sun from the fixed stars. This, it will be seen, must have been a very difficult matter to secure, when there was no exact measure of intervals of time, and no fixed points of reference for mutual distances, as the sun and the stars could not then be seen at the same time. Hipparchus overcame this difficulty by the shrewd expedient of measuring the distance of the sun from the moon in the daylight, and of then measuring the distance of the moon from certain standard fixed stars as soon as the sun had sunk sufficiently beneath the horizon for the stars to become visible, allowance being made for the rate of the moon's movement in the interval, which, of course, could be at once inferred from direct measurements of the moon's progress along the starry sphere.

Claudius Ptolemy, the Alexandrian mathematician, of the beginning of the second century, appears to have been struck with the idea that a part of the circle could be used to as good account as the whole. He was the first who used the quadrant for astronomical purposes. Two fine specimens of very old quadrants, which have been sent from Breslau (No. 1,776), and are marked as the property of Prince Pless, of Fürstenstein, very well illustrate the passage of the astronomical planisphere into the quadrant. One of these, with a radius of eight inches, is on a square brass plate, with a pointed plummet suspended by a silk cord, and has sights fixed to the upper edge of the square, so that when the eye looks through them the plummet marks the elevation of the range by the part of the arc which it cuts.

The other specimen is remarkable for being mounted on a pillar, with a ball-and-socket joint, and for having a heavy rigid plate pivoted on the centre of the arc, to serve as a plummet. The sights are carried on the reversed face of the quadrant. This instrument was obviously used simply by raising the sights into proper alignment with the object, and then reading off the altitude in degrees of the arc intervening between the central line of the plummet and the edge of the observing arm. The ball-and-socket support, however, enables the quadrant to be placed in any required plane from vertical to horizontal. The radius of this instrument is five inches and a half. There is another characteristic form of the early astronomical quadrant, with a plummet, and with two perforated studs for sights, constructed by Lewis Evans. This instrument has only 4½-inch radius.

The most interesting specimen of the quadrant of small size contained in the collection is, however, one which also bears the name of Prince Pless, and which has been sent from Breslau. It is designed solely for altitudes of the sun, and consists essentially of a cross-bar supported between the tops of two brass pillars, with a curved quadrantal strap of brass, divided into degrees, in front of it. The cross-bar is the same height as the pillars, that is, seven inches, and the base of the pillars stands coincident with the zero of the quadrant. The shadow of the bar would thus be thrown upon the foot of the quadrant by a vertical sun, and upon the top, or 90th degree, of the quadrant, by a horizontal sun. All other intervening altitudes of the sun would be marked by the shadow falling upon corresponding parts of the graduated quadrant. These old Breslau quadrants are all contained in the same case with the astrolabes.

By far the most important of the quadrants of pre-telescopic age is, however, the noble instrument for which the collection is indebted to the Royal Museum of Cassel; this is numbered 1,775 in the catalogue, and labelled "Quadrant formerly belonging to Tycho Brahé;" it occupies the next case to the astrolabes towards the south. The quadrant is carried upon a cast-iron frame about three feet high. The frame has four legs, and revolves about a central pillar which is itself attached to a massive substructure of iron, supported upon four levelling screws, with a graduated azimuth circle of polished brass of sixteen inches radius, so placed that the four legs, of which one is pointed into an index, are carried round immediately above the graduations. The circle is divided simply into degrees without any kind of vernier. The quadrant itself, also of polished brass, is graduated into ten minute divisions, and is also read without a vernier. The observing arm, which is pivoted upon the centre of the arc of the quadrant, is simply a movable radius with projecting bars at each end to constitute the sights. These "sights," however, are the most remarkable portion of the instrument. They project from the radial arm three and a half inches, and have the very extraordinary shapes which are drawn beneath:—



A is the sight which is carried by the near, or eye end of the arm, and corresponds with the centre of the arc; and B is the sight which is looked at at the further end, and which has to be brought into visual contact with the object that is observed. In other words the observer would have had to look along over the round-headed pyramid (a), which is placed in the centre of the inner notch of A, at the centre (a') of the first square notch in B, or through the first of the upper small holes (b) in A, to the bottom of the second triangular notch (b') in B. The lower hole (c) in

the semicircular plate of A apparently corresponds with the first upper hole (c') in B, or with the commencement of the first triangular notch (c'') in the lower edge of the sight lying immediately beneath. The sight A has two bifurcated notches, a half-notch, three holes, and three tongues, or projections. The sight B has four notches, one half-notch, and six holes. The multifold irregularities were, in all probability, turned to account upon the same principle as the five or seven wires of the transit instruments. A series of observations were made with several pairs of them, and the mean of the series was then used by the observer. The irregularity of the figures of the sights served the convenient purpose of preventing mistakes from being made in using the wrong pairs. There does not appear to have been any means of fixing the arm during the process of an observation. It was simply held in place by the pressure of a spring tongue acting upon the back of the graduated arc. A very small brass plummet is attached to the quadrant by a silken cord. Tycho Brahé followed the path of the comet of 1577 by just such an instrument as the one which is here shown. But he had instruments of the same class with a radius of 6 feet, and reading to a quarter of a minute. One quadrant, with a radius of 9 feet, was fixed to the face of a wall placed in the plane of the meridian, and read to ten seconds. It will be observed that the quadrant here shown comes from the Royal Museum of Cassel. The Landgrave of Hesse Cassel, who was a contemporary of Tycho Brahé, was himself an observer of no mean skill, and is honourably known as an enlightened patron and friend of the great astronomer. He observed, with Tycho, the new star which appeared suddenly in the constellation of Cassiopeia from December 3rd, 1572, to March, 1573. The date of this particular quadrant is probably shortly after 1577, when the observations at Uranienburg were commenced.

Tycho Brahé had the same difficulty to contend with in observing the fixed stars that has been alluded to in speaking of the labours of Hipparchus, that namely, that the stars and the sun could not be seen at the same time. He, however, made a very great improvement on the method of Hipparchus, by using the planet Venus instead of the moon as the intermediary point to connect the sun with the stars. This had the advantage of substituting a luminary which had a much slower proper motion than the moon, and of being comparatively free from parallactic displacement in consequence of its greater distance from the earth. The right ascensions of a very considerable number of the most brilliant stars were very accurately fixed by this expedient. The visitor to South Kensington, who looks at this venerable instrument, should well understand that by its means, and the co-operation of the other instruments of the same class which were constructed at Uranienburg, the half degree errors of Hipparchus were reduced fifteen times; that is, were restricted within the comparatively trifling limits of two minutes of angular measure. But the thought which beyond all else leaves a bright halo of glory round this interesting relic, is perhaps the memory of the part which it had to play in the labours of Kepler. In the last year of the 16th century, and subsequently to his removal from Uranienburg. Tycho Brahé was engaged with Kepler at Prague in reducing the entire series of the Uranienburg observations to the form of tables, which were named "Rudolphine" in honour of the astronomer's new patron and protector, the Emperor Rudolph II., and it was to the observations which were classed together in these tables the world owes the discovery of the great laws of elliptical motion by Kepler. It is hardly possible to contemplate this venerable quadrant of Tycho Brahé's without thinking of the part which it has played in bringing out the theories of the passage of the radii vectores of planetary orbits through equal areas in equal times; of the establishment of the sun in one of the foci of the elliptical orbit; and of the deduction of the fixed mathematical relations of the revolutionary periods and solar distances of the planets.

Some thirty or forty years after the construction of the Rudolphine tables from the observations of Tycho Brahé, the next great step was made in increasing the powers of the instruments of observational astronomy. Morin, a French astronomer, about the year 1635, ascertained that the stars can be seen by the telescope in the daylight. The immediate inference was that the comparison of the places of the sun and stars, after the method of Hipparchus and Tycho Brahé, by the intermediate agency of the moon, or of the daylight seen disc of Venus, would no longer be needed. By the employment of the telescope the measure of the sun's place would obviously be taken direct from some star. The Prussian astronomer, Hevelius, upon whose shoulders the mantle of Tycho Brahé had fallen, and whose astronomical labours occupied the middle portion of the seventeeth century—that is from 1630 to 1680—and who completed a magnificent catalogue of 1,500 fixed stars, fought valiantly against the innovation. He used the quadrant without telescopic sights, and depended for the accuracy of his observations upon the size and perfection of his unmagnified arcs. He was, however, the last of the old school of observers. His instruments gave the position of the stars in the celestial sphere within a minute of the truth. They were incapable of accomplishing more than this, because it was found that, when they were made of their largest size, their mere bulk and weight introduced unavoidable incidents of derangements and inaccuracy of performance.

The efficacy of the telescope, when applied to the instrument of astronomical measurement, depends upon the fact that it magnifies the space intervening between the stars, even when it does not magnify the star itself, so that the exact value of that interval can be more exactly and delicately estimated. It will be remembered that the adoption of the convex lens for the eye-piece of the telescope enabled Gascoigne to introduce a web, or thread, into the visual field of the telescope, which could be seen simultaneously with the object which was to be observed, and which could therefore be used as a fixed line from which the measure of the position of the object could be made by a direct instrumental contrivance. There are three large quadrants standing upon pillars along the wall of the Room L, and behind the case which contains the untelescoped quadrant of Tycho Brahé, which illustrate this advance in instrumental construction. All these quadrants carry telescope-arms upon their pivots. The earliest of the series, and the one which is therefore worthy of the first notice, is the instrument which is marked 1,773 in the catalogue, and which is of additional historical interest on account of having belonged to Napier, of Merchiston, the inventor of Logarithms. This quadrant has a three feet radius, and is mounted, it will be observed, on a central worm-eaten pillar of wood, steadied by binding bars of iron, upon a three-clawed base furnished with levelling screws. This instrument has a very ingenious form of attachment to the supporting pillar. An altitude semicircle carries a second semicircle at its end on a transverse plane, and both these semicircles are toothed and racked at the edge, so that, by the motion of the rack-work, the face of the quadrant can be turned into a horizontal plane. There are two telescopes, one fixed at the top of the quadrant, as an immovable radius capable of being directed towards the horizon, and the other acting as a movable arm, and capable of being turned to the object, whose angular position in reference to the horizon is to be marked. The slow movements are communicated from a square-keyed hole, which is intended to receive the end of the handle held by the observer. The square collar turns an endless screw, which works on the teeth of the rack. But this instrument introduces a new and very ingenious expedient for the increase of the discriminating power of the graduated arc. The graduation is furnished with

what is now known as the diagonal scale. There are ten concentric circles, and the arm of the instrument ranges diagonally across these, so that each division of the graduation can be sub-divided into ten parts by observing which circle is intersected by the arm. The graduation of the scale is carried to five minutes, but as each of these graduations is then capable of being sub-divided into ten parts by the diagonal scale, the instrument itself reads to 30 seconds. This expedient is well worthy of notice, as being the first practical step towards the employment of a vernier. By this contrivance the minutes of the scale of Hevelius at once become of double value as halved minutes. Napier was born about the middle of the 16th century, and there is a letter to Tycho Brahé, bearing the date of 1594, oxtant, which alludes to the progress Napier had made at that time in "superseding the tedious operations of multiplication and division in arithmetical calculations," and thus approximately fixes the age of this instrument. It must have been used by Napier shortly after that time. The two other quadrants of similar form, which are associated with this one, are of later date. The French quadrant of Langlois, "Ingénieur du Roi" (No. 1,777*a*) of the catalogue), contributed by the Conservatoire des Arts et Métiers, belongs to the year 1750. It has a 32 in. radius, and a telescope, with an inch and an eighth aperture. The scale is divided into 30 seconds, and it has the diagonal arrangements, with the further convenience of a true vernier to read off its divisions. The arc of the quadrant is clipped by a binding screw at its edge, and the instrument is mounted on a vertical brass pillar, furnished with a small 5-inch azimuth circle and vernier, the whole being carried on a massive iron frame with four feet and levelling screws. Another French quadrant, by Butterfield (No. 1,774 of the catalogue), has a 25-inch radius, with a fixed telescope of ½-inch aperture at the top, the arc being read by a vertical plumb-line protected by a glazed case or frame. The plummet line falls across a diagonal scale. The quadrant is carried on a circular pivot, mounted on an iron frame with four feet and levelling screws, and it is steadied by a sliding rod.

The most interesting specimen of the telescoped quadrants is, however, unquestionably, one which is deposited in the lower part of the glass case containing the astrolabes, and labelled "Azimuth quadrant by Uletz," without any catalogue number. This instrument is contributed by the observatory at Leyden, and is so large that it at once catches the eye. Its date is 1700. It consists of a slender telescope, two feet long, carried horizontally on a flat quadrant, which is very beautifully divided into 90 degrees. The special interest, however, of this instrument is, that it introduces the method of sub-dividing the fundamental graduation of the arc by the micrometer screw. It will be observed that the edge of the quadrant is clipped by a brass plate carrying a tangent screw, driven from a milled and indexed head by a pair of toothed wheels of equal diameter. Four turns of the spiral screw shift the scale of the quadrant through one degree. But the circular plate, upon which the pointed handle that drives the screw turns, is itself divided into 300 graduations. It is, therefore, capable of marking one 300th part of a quarter of a degree, or 15 minutes, that is, it reads to three seconds of arc. The slender telescope is ingeniously carried in a brass frame, which has a levelling adjustment by screws, and is obviously intended only for reading horizontal angles. It has a crossed thread in the focus of its eye-piece, and must possess considerable delicacy and power as an angle-discriminating instrument. This quadrant, taken in connection with the pillared and mounted instruments previously described, further illustrates tho division at this time of the instrument designed to give azimuthal or horizontal readings from that which is intended for the reading of altitudes, so that greater accuracy of performance might be secured in each instance.

In a case on the opposite side of the room to the astrolabes, a little further north, and facing one of the windows, is another quadrant of a somewhat later date, but of the highest historical interest, on account of its having been the astronomical instrument employed by the great navigator, Captain Cook. This quadrant is mounted on a central pillar with levelling screws, and is furnished with a small azimuth circle read by a vernier. It is of comparatively small size, but its powers are considerably increased by the employment of a spirit level, as well as of two plummet lines, which are read off in connection with the arc by microscopes. The plummets are also perforated metallic cases for suspension in water. There are two telescopes; one fixed along the top of the quadrant, to be directed to the horizon, and one constituting a movable radius carried along the arc by a fine tangent screw. The arc is read off by a vernier, as well as by the vertical threads and microscopes. The date of this quadrant, which is manifestly capable of excellent work, must be about the middle of the 18th century.

(To be continued.)

THE PHILADELPHIA EXHIBITION.

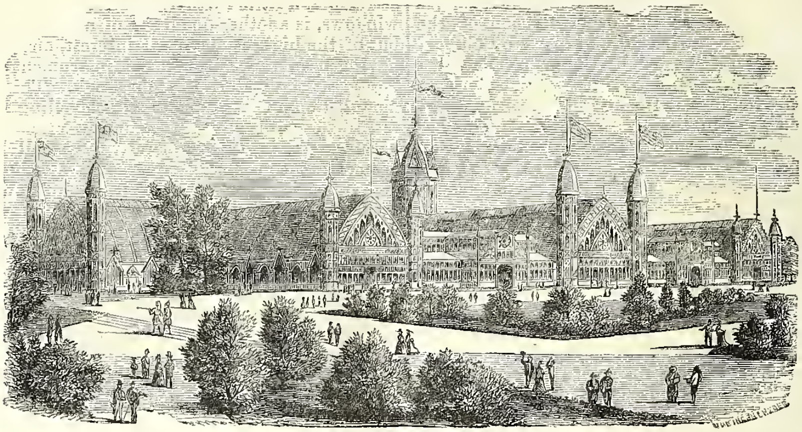
One of the special features of the Philadelphia Exhibition is the immense number of buildings through which the contributions from different nations are distributed. These are scattered at considerable distances over Fairmount-park, so that the task of making a thorough examination of the whole is one which requires more time than the visitors in general can spare. Merely to explore the miles and miles of building in the Centennial grounds takes up a long time, and the chances are that very few of even those who visit the exhibition rather for business than pleasuro will have time to make themselves thoroughly acquainted with the whole of it before the show is closed.

It will be remembered that there are five principal buildings, to which all others are subsidiary; the Main Building, the Memorial Hall, the Machinery Hall, the Horticultural Hall, and the Agricultural Building. Illustrations of four of these were given in the *Journal* for July 9, 1875, and a view of the remaining one, the Agricultural Building, is now added. The size of this is five hundred and forty by eight hundred and twenty feet, with ten acres and a quarter under roof. The nave is a hundred and twenty-five feet wide, with an elevation of seventy-five feet. The materials are wood and glass.

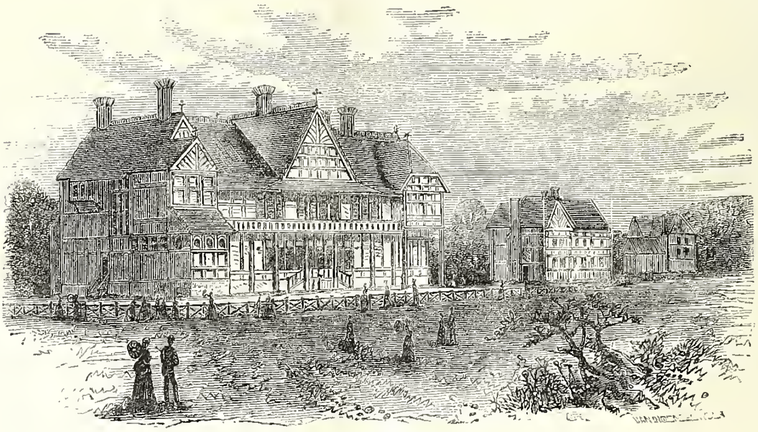
Besides these principal buildings, however, there are the numerous smaller erections which have been erected for various purposes, such as the head-quarters of the State and foreign commissions, the United States Government building, the Women's Pavilion, the Judges' Pavilion, the building for the accommodation of the press, restaurants, &c. Views of some of the buildings of the foreign commissions, and a view of the Women's Pavilion, are given in the following pages, and it is also intended to illustrate a few of the buildings erected by the different States of the Union. In each case it has only been possible to select a few of the more striking or specially interesting from among the entire number.

Among the buildings of the foreign sections, the British buildings will, perhaps, be most interesting to English readers. The others of which woodcuts are given are also remarkable features in the Exhibition grounds.

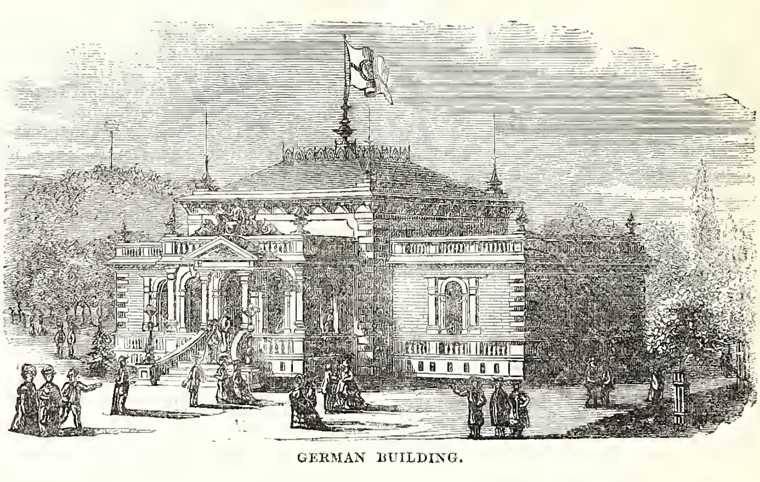
The Women's Pavilion is a speciality of the Exhibition. It is erected out of a grant made for the purpose, and is filled with specimens solely of female work. It has an area of thirty thousand square feet.



AGRICULTURAL BUILDING.



BRITISH BUILDINGS.



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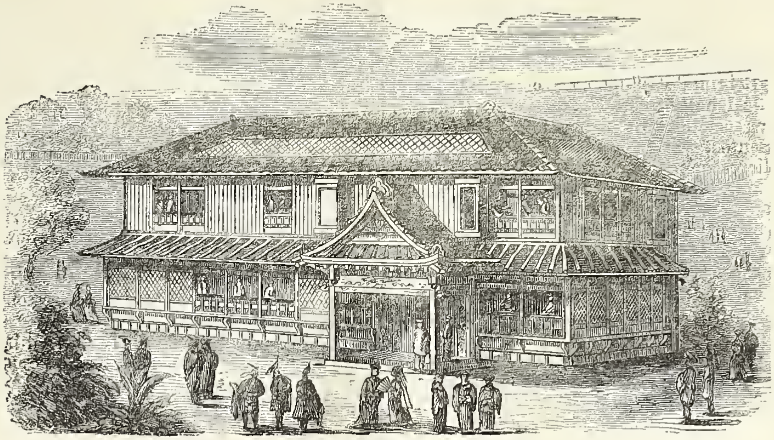
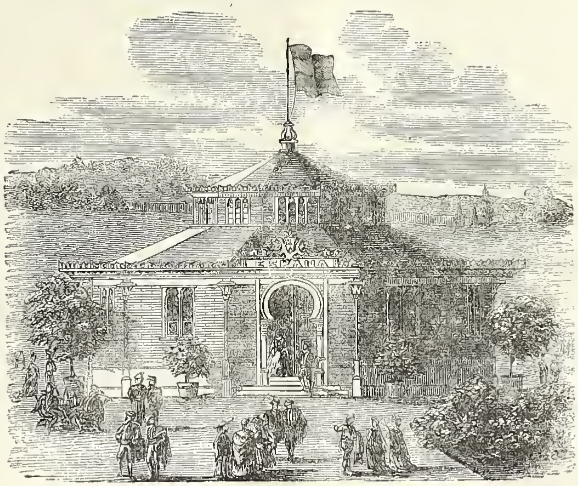
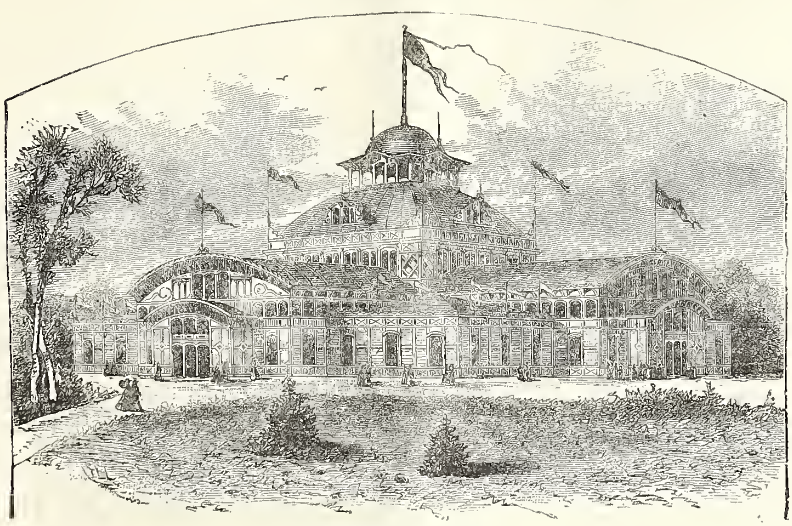


JAPANESE BUILDING.



SPANISH BUILDING.



WOMEN'S PAVILION.

CONGRESS OF BELGIAN SCIENTIFIC BODIES.

The first Congress of the Confederation of the Scientific Bodies of Belgium was opened on the 16th July, in the Academical hall of the University of Brussels. Of the eleven societies in federation, eight were officially represented, viz., the Malacological Society, the Belgian Microscopical Society, the Geological Society of Belgium, the Medico-Chirurgical Society of Liége, the Liége Veterinary Society, the Instruction League, the Liége Council of Public Health, and the Hasselt Philharmonic Society; but there were present members of the three remaining bodies, viz., the Federation of the Horticultural Society of Belgium, the Hainault Scientific Society, and the Namur Archæological Society.

Dr. Crocq traced the history of the Confederation, refuted several erroneous opinions concerning it, and expressed the hope that it would soon embrace all the learned societies of Belgium.

After each society had handed in a report of its labours, the three sections of physics and natural science, medicine and pharmacy, and history and literature, were formed for deliberation during the session.

After debating the first question, viz., the obtaining of greater facilities for the transmission of scientific objects, it was resolved to demand from the Government: (1) transmission of scientific specimens under certain rules; (2) the removal of absolute prohibition to the transport by post of glass and liquids; (3) free carriage of the publications of the scientific societies (as has been accorded to the Syndical Union and the Committee of the Hygienic and Life-saving Exhibition); and (4) a reduction of 50 per cent. on railway fares for members of the Confederation attending meetings of the allied societies.

The second question, as to the opening of public scientific institutions at hours more convenient to the scientific public, and specially that the libraries and museums of the State should be placed at the disposal of students in the evening and during Sundays, was, after discussion, adopted as far as the libraries are concerned, but modified with respect to the museums.

On the following morning, the consideration of the third question, as to the interchange of reports of the proceedings of the federated societies, was deferred. In connection with the fourth subject, viz., the organisation of libraries and scientific collections in the towns and communes, M. Ch. Buls read a paper, in which he pointed out that, as popular libraries existed in almost all the towns, it would be sufficient to add to them such scientific works as were recommended by the federation; the exact list might be supplied by tho Instruction League. As no scientific collections existed in the country it would be useful to establish them; and the initiative should be taken by local societies. These small scientific museums would chiefly comprise geography, geology, and the *flora* and *fauna* of the surrounding country, having also divisions of history, archæology, manufactures and agriculture.

The following resolutions were then adopted:—(1) Statistics as to the Belgium libraries shall be compiled; (2) a catalogue shall be prepared of the scientific works recommended for these libraries; (3) a circular setting forth the utility of the local museums shall be addressed to the scientific bodies of Belgium; and (4) the communal authorities shall be memorialised to encourage the establishment of these museums by a suitable local *octroi* duty.

The fifth question, as to the publication of small elementary treatises on different branches of science, was also brought forward by M. Ch. Buls, who stated that a certain English learned society published, under the title of science primers, elegantly bound volumes, containing a hundred pages, for a shilling. It would be sufficient to translate the greater part of these treatises, written by the most eminent of English scientific men, and free from those abstractions which render the study of science so dry to the general reader. The description of the local museums, dealt with by the fourth question, would also be an excellent theme for these small works. It was in this spirit that Dr. Meynne, of Bruges, had just published the first volume of a series of treatises which he intends to devote to the history and description of the Belgian maritime zone, and entitles "Lectures de la Plage." M. Buls' report was adopted, without, however, any decision having been arrived at as to the means by which it was to be carried out.

In the afternoon the whole Congress considered the question proposed by the Malacological Society:—Would it be useful to possess in Belgium, in one of the littoral towns, an institution appropriated to all studies connected with the coast, and what would be the best means for carrying this out? M. Lefèvre, in support, lamented the backwardness of Belgium in this respect. France possessed several of these institutions, the chief of which are at Roscoff, Vimereux, Concarneau, Arcachon, and Marseilles. The Roscoff Institution of maritime zoology, founded five years ago by M. Lacaze Duthiers, was especially adapted to the study of marine *fauna* and *flora*. It is arranged so as to receive four naturalists, and places at their disposal all the appliances necessary to their labours, as well as a library consisting principally of works on the *fauna* of the French coasts. There is also an aquarium where they may study living examples of the species collected in their excursions. Two shore-boats, manned by the State, are constantly at the disposal of the naturalists. M. Lacaze Duthiers publishes in "Les Archives de Zoologie Expérimentale" papers containing the results of his observations.

The establishment at Vimereux is due to one of the members of the Malacological Society. It has only cost 3,000 francs (£120) during the first year, and has already aided in important works, several of which have been published in the bulletin of the Académie. At Concarneau experiments in pisciculture have been carried out by Coste de Gerbo and Pouchet, while Marseilles has facilitated the researches of Lespès and Marion.

After referring to the aquariums in England, and the zoological collections of the British Museum, the Royal College of Surgeons, and the Zoological Gardens, M. Lefèvre observed that Naples possessed the finest zoological institution in the world, founded but a few years ago by Dr. Dorn, at a cost of 400,000 francs (£16,000), and subsidised by England, Prussia, Russia, and other countries, the German government having just granted a sum of 30,000 francs (£1,200) for a steamer, to be used in dredging the bottom and excursions in the Bay of Naples. All European countries were, in fact, represented at the international station of Naples, except Belgium; even Holland was about to inaugurate an institution for zoological study like that of Naples, and it was impossible for Belgium to remain in the background in this respect. The Congress, supporting M. Lefèvre's paper in its entirety, decided that the Federation should take the necessary steps to obtain from the Government the foundation of a zoological institution in one of the maritime towns.

MM. Vincent, Ruthot, and Vanden Broeck then read papers on the geological formation of the neighbourhood of Brussels; and, on the 18th, these gentlemen conducted an excursion with the object of substantiating their views.

At the closing *séance* in the afternoon, the questions not disposed of were adjourned to the Congress of 1877, which is to be organised at Mons by the Hainault Scientific Society; it was also decided that the Congress of 1878 shall be held at Liége under the auspices of the Geological Society of Belgium. The Secretary read a *résumé* of the proceedings by Dr. Crocq, and the Congress was closed.

PRODUCTS AND INDUSTRIES OF BRAZIL.

The principal productions of Brazil are coffee, sugar, cotton, tobacco, cacao, and india-rubber. A considerable diminution has taken place of late years in sugar and cotton, which retrogressive movement is attributable to the great check sustained by this branch of agriculture in consequence of the increasing scarcity of slave labour, to the oppressive scale of taxation, as well as to the obstacles in the tenure of land. There are other circumstances, however, intimately connected with the development of this branch of industry, stated by Consul Valentine in his report upon the trade of Rio for the year 1875, and more particularly the want of a comprehensive and reliable system of intercommunication over the vast empire. No country in the world depends more for its prosperity on this indispensable medium, yet even Paraguay, in proportion to its geographical area, has a larger railway mileage than Brazil. A further explanation of the declining power of production in these staples lies in the want of application of the improvements introduced by science. The system of cane planting and sugar manufacturing is limited to the primitive routine and machinery of a bygone age, while other countries have long since passed to the adoption of modern scientific systems, and the most improved implements and machinery. Had Brazil, blessed now for a period extending over half a century with almost uninterrupted peace abroad and at home, followed boldly and resolutely in the wake of other races, and developed those amazing resources of which they are ever prone to boast, and for the performance of which they cannot allege the want of anything but determination, Mr. Valentine says, the empire would by now be enjoying the greatest commercial prosperity.

It is stated on good authority that there are districts where wheat and barley give a return of from 30 to 60 to 1, lands where, from the square of 4,000 bracas, may be derived the following results. From 1,800 to 2,000 lbs. of cotton, or 826 to 918 kilos; 1,500 lbs, or 680 kilos, coffee; 3,636 litres, manioc; 1,818 litres, Indian corn. The topographical disposition, the varied climates, and abundant supply of water, render the land suitable for the cultivation of nearly all the products of the globe. Thus, while some flourish in the warmer regions of the north, others thrive equally well in the more temperate or cooler provinces of the south. The advantages for the production of coffee are notorious. A hectare (2,066 square bracas) will contain 918 coffee trees, which in inferior soil will yield 674 kilos, in second rate or average soil 1,384 kilos, and in the richer 2,022 kilos. An active labourer can take care of 2 hectares or 4,132 square bracas, of coffee, the annual return from which is estimated, in the first case, at 404 milreis (about £45), in the second, at 830 milreis (£90), and in the last 1,213 milreis (£120), basing the value at the low rate of 300 reis per kilos. On an average coffee estate, the production of each labourer, independently of age or sex, is said to be on an average £65. The whole belt of soil from the Amazon to San Paulo is suitable to the cultivation of the sugar cane, although it is more fully developed in the northern provinces of Pernambuco, Alagoas, Bahia, and Rio Janeiro. About seventeen varieties of this plant have been acclimatised and cultivated in Brazil, and considerable quantities of plants are annually distributed to planters by the Imperial Institute of Agriculture. Its cultivation is remunerative, especially the one particular species which yields 11 to 14 per cent. of juice. In new lands a single hectare yields 100,000 kilos during fifteen months. An active, intelligent labourer is supposed to take care of two hectares, which would produce 1,000 kilos of sugar, worth £150. The cost of production in Rio, where wages are high, is about £14 per hectare, leaving a net profit in two hectares of £60. But the profit is greater when the condition of the land admits of the use of the plough and other improvements. In the manufacture of sugar great advantage has attended the use of steam as the boiling medium of liquids at a low temperature, and that of turbines for the forced clearing of the crystallised material.

The cultivation of cotton affords profitable employment to agriculturists of limited means from the fact of the requisite machinery involving less outlay of capital. A hectare, 2,066 square bracas, affords space for 4,545 trees, which, according to condition of soil, will produce, more or less, 2,066 kilos or 4,708 lbs. A single person can easily take care of three hectares sown with cereals as well as cotton, producing annually £83, even at as low a valuation as 125 reis per kilo. The vine has been cultivated successfully of late in the provinces of San Paulo, Rio Grande do Sul, and also in certain portions of Rio de Janeiro, and elsewhere. Last year about 800 pipes, or 320,000 litres of wine, were produced, of an average value of £17 each pipe. In many places 1,000 vines would yield 10 pipes or 4,000 litres. The American vine commands a preference. Of the mandioca, thirty varieties are grown in the country; it flourishes in all intertropical and temperate regions, but more luxuriantly in loose, dry, and especially sandy soils. Of all productions it is the one that gives the best return and least trouble, and the flour (farina) made from its root furnishes the universal staple as food to the inhabitants. An intelligent planter of Campos states that the square of 220 metres of land will grow 40,000 mandioca plants, which, even in inferior soils, produce regularly 80,000 lbs. or 36,720 kilos, and this at the lowest valuation, 60 reis a pound, affords a revenue of £520, a result superior from that derived from coffee, sugar cane, cotton, and nearly all the other articles of produce, in spite of its demanding less care, and scarcely any capital. It will grow in almost any soil, while the preparation of tapioca from it is equally easy and inexpensive, and also profitable. Mandioca has the further advantage of serving as food for animals.

According to the constitution full liberty in agricultural industries and others is accorded to all in Brazil. The capital as well as the provinces possess numerous manufactories, some few subsidised by the State, some protected under the patent law for periods ranging from ten to twenty years, the maximum, and the rest originating out of private enterprise. The principal industries deal with chemical products, optical and nautical instruments, engineering and surgical instruments, boots and shoes, oil cloths, carpets, Morocco and polished leather, glass, carriage building, varnish, liqueur distillation, vinegar and alimentary articles, paper of all descriptions, asphaltum, artificial marble, cardboard, snuff, tobacco, cigars and cigarettes, &c. There are eleven foundries for the construction of all sorts of machinery and iron works, exclusive of arsenals and public establishments, employing about 700 workmen, and producing a revenue of £214,000. Six are for the manufacture of brass, copper, and bronze works, producing about £32,000, and employing a relative number of artisans. There are beer and mineral and soda-water factories, affording employment to a large staff at good rates of wages, producing annually 100,000,000 bottles, or 66,700,000 litres of beer, and consuming 6,000 to 7,000 barrels of malt, and 20,000 kilos of hops. Twenty-three hat factories employ 500 workmen, besides steam-power in some cases, producing annually 34,000 silk, 406,000 felt, and 30,000 straw hats, total value £160,000. In the fabric for imitation of Chili hats, the produce of a factory founded under the auspices of the Imperial Institute of Agriculture, which figured at the Vienna Exhibition, the material used is the fibre of the "Bombonassa," a plant recently introduced from Peru. The attention of this institute is at present directed, amongst other things, to the development on a large scale of certain textile plants lately discovered in the forests. These plants afford a first rate fibre, the excellent quality of which has been proved in London and Manchester, at examinations made by order of Government. It is already ascertained

that their acclimatisation and cultivation are easy, and not expensive. According to the report of the examiners in England, the fibre is worth upwards of £84 per ton, or 11d. a pound, thus exceeding the value of flax. Candle, soap, and oil factories exist in all the provinces. In twenty-five contained in Rio, about 260 hands, besides steam-power in some cases, are employed. They produce annually, upon an average, 850,000 boxes of candles, 43,000 boxes of soap, and 780 pipes, or 312,000 litres of oil, valued respectively at £575,000, £170,000, and £14,000 sterling. In 1871, over 1,000 hands were employed in cotton factories, and 4,510,000 metres of cloth made, estimated at £250,000 value; but to-day much more attention is devoted to this industry, which has extended to some of the provinces. The most flourishing and best managed is the Petropolitan Cotton-spinning and Weaving Factory, situated about two miles from Petropolis. Its nominal capital is £100,000. Its motive-power is water, with a fall of 250 feet, capable of developing 2,000 horse-power. It is provided with all the buildings necessary for the staff, and is said to be capable of employing, so far, 200 hands, 120 looms, and 5,000 spindles. It consumes from 3,000 to 4,000 lbs. of cotton per diem, and produces about 6,000 yards of white and coloured heavy goods daily. The working profit of this establishment is represented at between 30 and 40 per cent., with its present limited capital; but there is no doubt that it would yield even a greater return if fully developed, as there is no limit to the demand for all that it can produce.

The employment of adequate capital in the manufacture of this staple would soon lead to the production of sufficient for consumption in the empire, and eventually Brazil might compete successfully in foreign markets. It only remains, says Consul Valentine, for those who are in power and should be eager not to lose a single opportunity to advance the interests of their country, to devise the most direct means of attracting the attention of foreign capitalists, and afford them any reasonable inducements to embark in safety in so profitable an undertaking. There is no doubt that this could be done without the remotest contingency of onus to the public exchequer, at the same time developing, on a safe principle, one branch of immigration, consisting of the staff that, at least in the outset, would have to be introduced from European centres. On the other hand, it is not unreasonable to expect that a stimulus would ultimately be given to the cultivation of the staple, inasmuch as its production, released from the tax levied in exportation, would to that extent, or at any rate to a great extent, be more profitable to the planter.

ROUMANIAN WOOD INDUSTRY.

The following details on this subject are from the *Roumanian Economist*:—The industries carried on in the forests of Roumania are turnery, the manufacture of staves, cooperage, the sawing of wood, and basket-making. Turnery is one of the most important industries of Roumania, on account of the almost universal employment of wooden vessels among the rural population. In the town vessels of various materials are made use of; but in the country wood replaces almost entirely metals, earthenware, and glass, in furniture, in dishes, and in domestic utensils; excepting articles of rude pottery, all household furniture, water vessels, tubs, pails, boxes, pitchforks, shovels, spindles, weaving looms, plates, cans, spoons, basins, &c., all are of wood in the house of the Roumanian peasant. There are bands of wandering gipsies or Tziganes (Zingari) who are more especirlly engaged in this industry. They locate themselves in summer in the woods, where they find the necessary materials, and work away there till winter. The woods most frequently employed in this industry are the poplar, the willow, the beech, the alder, the oak, and the fir. From the forests also come articles of wheel work and rude carpentry, which the peasants carry about and sell wholesale in the towns and markets of the plain. There are in Roumania, at the foot of the mountains, about 600 saw-mills which employ about 1,000 workmen, These saw-mills, of which the moving power is the water of torrents and rivers, are, for the most part, of primitive construction. They cut up especially planks of pine, to the number of about 40 per day each mill. The pines, rolled to the foot of the mountains in their bark, are floated to the saw-mills; there they are piled up, and sent through the mill just as they are wanted. The abundance and good quality of the timber of the oak cause the manufacture of staves to be one of the most important. The staves are used in the country for the manufacture of casks, which are sometimes as much as 200 and 300 *vedres* in capacity (the *vedre* is equal to about thirty pints), as also for barrels and buckets of small dimensions. They usually bind these vessels with hoops of elm, oak, and even hazel. The casks are made principally in the region of vineyards, at the foot of the Carpathian mountains. The export of staves is less considerable than it would be if the roads were better in theso districts. Were this the case the commerce in woods would assume very large dimensions in Roumania. Basket-making is carried on in the woods which clothe the hills and cliffs. For this manufacture the young shoots of willow are used. Ornamental basket work has not yet been introduced into the country. These immense forests of beech and oak produce large quantities of mast and acorns, which are used to feed pigs that consume them on the spot. The fruit of the alder is used for tanning, as also the bark of the young beech trees, and especially of the black oak. The myrtle-leaved sumach is also used in tanning. The reed and the bulrush are used for the manufacture of mats, an extensive industry in Roumania, principally in the district of Prahova. The reed is also employed in roofing, for fences, and for the manufacture of fishing tackle. The climate of Roumania, very warm during summer and cold during winter, renders the timber of excellent quality. It is hard, and endures for a long time, and if in the forests it is not always found to be in good condition the fault lies in the want of regular culture. As to the dimensions of trees, it is sufficient to state that oaks, pines, and other trees are found the trunks of which have a diameter of 8 ft. and a height of from 65 ft. to 80 ft.

GENERAL NOTES.

South African International Exhibition, 1877.—An International Exhibition will be held in Cape Town in 1877, in a building to be erected for the purpose, by consent of the Colonial Government. It will include manufactures of all kinds. The date fixed for the opening is February 15th, and everything intended for the exhibition must be shipped from London not later than during the first week in December, 1876. Intending exhibitors should communicate immediately with Mr. Edmund Johnson, Commissaire Délégué, at the European Central Offices of the Exhibition, 3, Castle-street, Holborn, London. The exhibition will be arranged in the following classes:—Class 1.—Alimentation. Class 2.—Chemicals, perfumery, medicines, and surgical appliances. Class 3.—Furniture. Class 4.—Fabrics, clothing, watches, jewellery, ornaments, precious stones. Class 5.—Means of transport, travelling equipments, harness, saddlery, &c. Class 6.—Hardware, edge tools, cutlery, metal work of all kinds. Class 7.—Machinery, materials and construction. Class 8.—Agricultural, &c. Class 9.—Science and Education. Class 10.—Miscellaneous.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PROGRAMME OF EXAMINATIONS FOR 1877.

The Programme for 1877 is ready, and can be had on application to the Secretary. The Society's Examinations now comprise the following divisions:—

1. Commercial Knowledge.
2. Domestic Economy.
3. Fine Arts applied to Industry.
4. Music.
5. Technology of Arts and Manufactures.
6. Elementary.

MISCELLANEOUS.

THE LOAN COLLECTION OF SCIENTIFIC APPARATUS AT SOUTH KENSINGTON.

(*Continued from page* 919.)

Instruments used for Astronomical Observation.—Transit Circles, Altazimuths, and Equatorials.

The time was, however, ultimately reached when the quadrant had once again to give place to the circle as an instrument of astronomical measurement. Ptolemy had introduced the quadrant, from perceiving that he could adopt a larger scale of graduation when he employed a fourth part of tho circle than when he encumbered himself with the entire circumference. The distinguished Danish astronomer, Roemer, in a letter to Liebnitz, at the very beginning of the 18th century, pointed out that the quadrant was virtually a mistake, and that in reality better work could be secured with a circle of four feet diameter, than with a quadrant of ten feet radius, on account of the corrections of its own readings which the circle furnished at opposite points of its circumference. On assuming the direction of the Danish Observatory, he, on this ground, constructed a circle five feet and a-half in diameter, which was fixed in the plane of the meridian upon a transverse axis, formed in the shape of a double cone, and was read off at opposite points of the circumference by two microscopes. The field of view of the large telescope which was mounted upon the face of this circle carried seven vertical threads, which the centre one was made to correspond with meridian. This meridian circle (Rota Meridiana) of Roemer was virtually the first transit instrument ever employed in the service of astronomy, and it was in use between the years 1704 and 1711, when the observatory which held it was unfortunately destroyed by fire. Most of the observations which were made by it were lost in this accident, but, fortunately, a small standard list of the right ascensions and declinations of stars derived from it was saved. The time of the passage of these stars over three of the vertical wires is marked to the fractions of a second. This instrument was properly a "meridian circle," for the determination of declinations of stars, as well as of right ascensions, and it was therefore of the character of "the transit circle," which will presently have to be more definitely described as having been more recently introduced by Sir George Airy. But Roemer had in his "Observatorium Tusculaneum" also an altitude and azimuth instrument, with circles three feet five inches, and three feet eight inches in diameter, and an equatorial instrument which he employed for measuring the differences of right ascensions and declinations of near stars. This renowned Dane had, therefore, the distinguished merit of being the father of the four great standard instruments of the modern observatory.

The character and virtues of the "transit instrument," which was thus introduced into use by Roemer, will be best understood by a glance at one of the modern forms in which this piece of astronomical apparatus is now employed. This instrument No. 2,950 of the catalogue, is labelled as a Portable Transit Instrument by Troughton, and is placed amongst surveying instruments, three cases away from the astrolabes, towards the north. It will be observed that a telescope is mounted upon a transverse arm, by means of which it can be shifted vertically up and down, without any possibility, however, of lateral movement. There is a long striding level, which is used to make the transverse axis exactly horizontal, and the instrument is then carefully placed so that the telescope looks toward the south point of the horizon when it is sufficiently depressed in that direction. The telescope can, however, only turn over through the zenith between the north and south, and the central vertical thread which can be seen in the middle of its field of view is then virtually the visible representation of "the meridian," or line of the sky which is everywhere equally distant from the rising and setting of any celestial body; the "half-way" station, so to speak, of every diurnal or nocturnal course. Any luminary that is seen touching this line is, at that instant, upon the meridian of the sky, or making its midway passage in the visible hemisphere. It will be noticed that the instrument has only a very small vertical circle upon one end of its axis. This is used simply for setting the instrument to any required height, and not for doing anything in the work of measuring. Tho entire principle of this instrument is that it is independent of circles of silver or brass; the circle which it employs is the great circle of nature, and the graduations by which this circle is marked are the minutes and seconds of time. Any given star which appears upon the meridian thread of the instrument will appear there again, having made a complete revolution of the heavens, after a lapse of 86,400 seconds. If a second star appears upon the meridian thread 1,440 seconds after it, that second one is the twenty-fourth part of the full circle of the sphere away from the first. The clock, therefore, in this way plays the part of the divisions of a circle. All that is required in using the instrument is that a clock beating true seconds with a loud tick shall be within hearing whilst the movement of the stars across the threads of the instrument is watched. Each second of the clock corresponds with what would be fifteen seconds of arc upon a graduated circle divided primarily into 360 degrees, and then with each degree further subdivided into minutes and seconds. The tenth part of a second of time, which can easily bo estimated by a practised eye and ear, corresponds with the angular distance of a second and a half of arc; that is to say, a star is apparently carried by the earth's movement round its axis, though a second and a half of the great circle of

the heavenly sphere, in a tenth of a second of time. It will hence be apparent what delicate work even a small portable instrument of this character can be made to perform through the intermediation of a clock. The reason why Tycho Brahé and his predecessors were compelled to accomplish all measurements of this class by actual reference to circles was, that in those days they had failed entirely to construct any clock whose performance could be relied upon to furnish equal intervals of time.

In the more important fixed observatories, very large telescopes are now used in this way for taking the time, and the differences of the time, of the meridian passage of the stars, and these large telescopes are mounted by very firm transverse arms and pivots upon massive pillars of masonry. Large telescopes are thus used, in order that faint and small stars may be seen in their passage over the meridian as well as large ones, and in order that the sub-divisions of the seconds of the clock may be

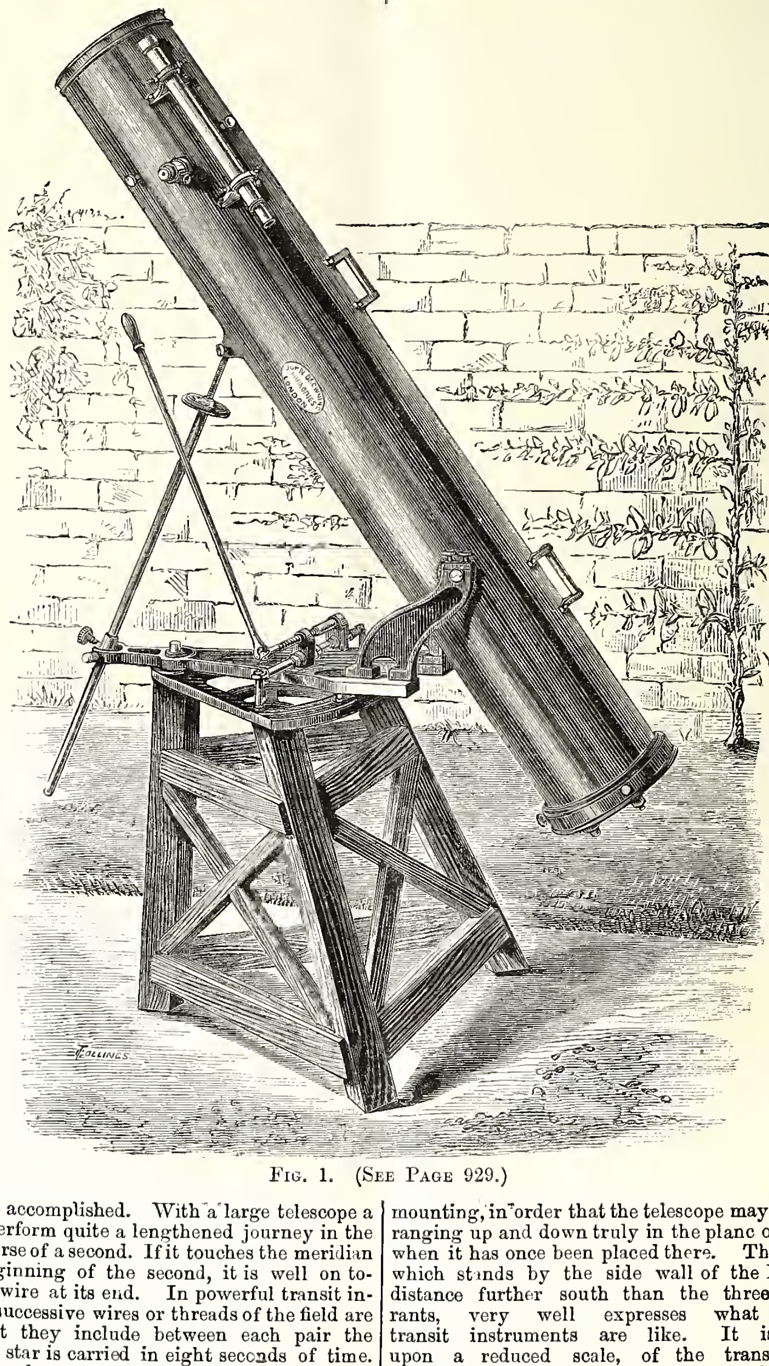

Fig. 1. (See Page 929.)

more certainly accomplished. With a large telescope a star seems to perform quite a lengthened journey in the field in the course of a second. If it touches the meridian wire at the beginning of the second, it is well on towards another wire at its end. In powerful transit instruments the successive wires or threads of the field are so placed that they include between each pair the distance that a star is carried in eight seconds of time. Massive piers and very strong arms are used in the mounting, in order that the telescope may always remain ranging up and down truly in the plane of the meridian, when it has once been placed there. The model, 1,780, which stands by the side wall of the Room L, some distance further south than the three pillar quadrants, very well expresses what these large transit instruments are like. It is the model, upon a reduced scale, of the transit instrument which was in use, until recently, in the Royal

Observatory at Greenwich. The massiveness of the large supporting piers of masonry, the rigid strength of the transverse axis, and tho large size of the telescope, which is carried so firmly and truly upon that axis, are in this way very adequately expressed. The apparatus which stands above the ends of the transverse axis is merely a contrivance for lifting the weighty instrument off from its piers, when certain of the adjustments of its position have to be looked to, and does not require any particular notice. The principal part of the work which goes on so unceasingly in the Observatory at Greenwich from year to year, and from century to century, is performed by its transit instruments, and

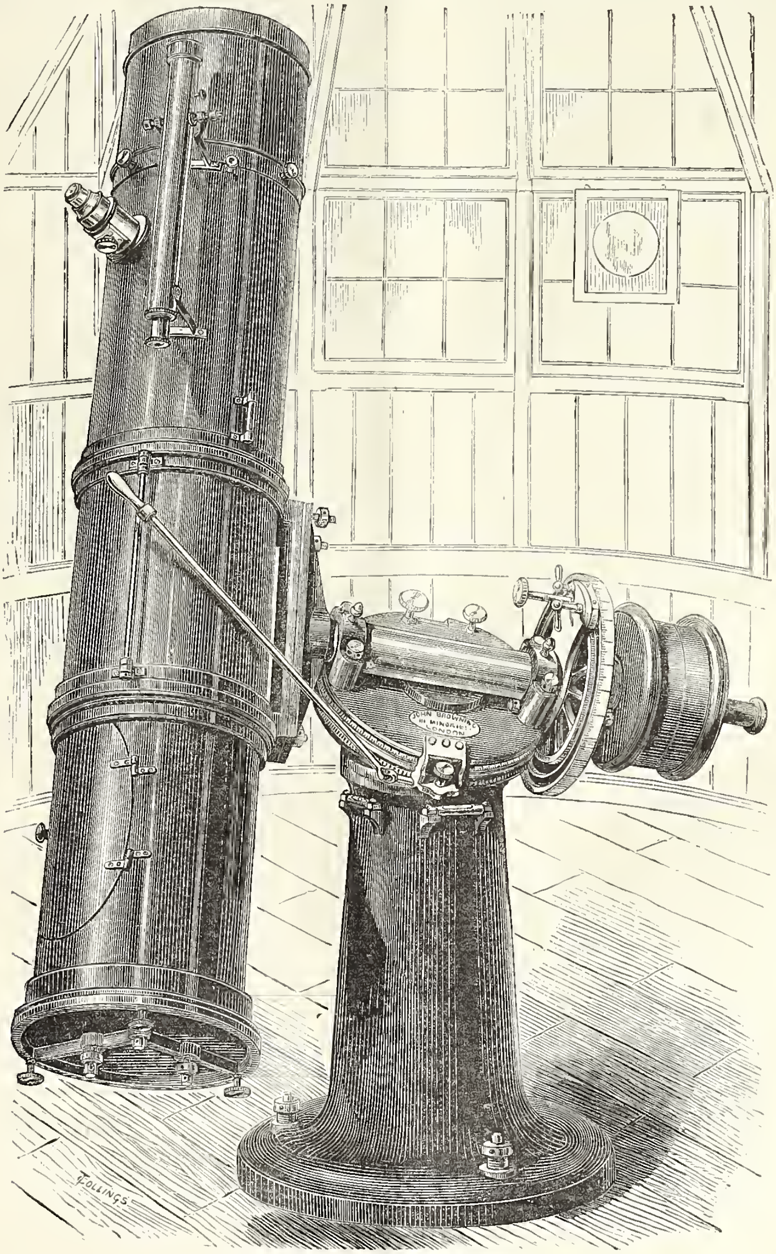

Fig. 2. (See Page 929.)

consists essentially in marking the differences of the time at which the moon and sundry standard stars make their successive passages over the meridian. These particular observations are still carried on to perfect man's knowledge of the exact movements of the moon, and to enable the bright satellite's position amongst the tars at future times to be used by navigators in fixing the position of their vessels upon the trackless sea. The series of observations at Greenwich commenced in 1676, when the observatory was built by King Charles the 2nd, "for rectifying the tables of the motions of the heavens, and the places of the fixed stars, so as to find out the longitudes of places, for the perfecting of the art of navigation," and it has been uninterruptedly continued

through the two centuries that have elapsed since that time. The subtle influence which necessitates all this elaborate watching, calculating, and tabulating of the moon's movements, before they can be turned to account as guides on the pathless sea, is the perturbing effects which the sun, earth, and moon make upon each other as they lie at continually different distances and in continually varying relative positions. Not only does the earth pull the moon, to make that satellite circle round it in a curving orbit, but the sun also pulls the moon, and the moon pulls the earth, and the earth pulls the sun, and each of the three bodies does this in a direction which alters at each successive instant, and from a distance and with a force that is also changing at each instant. The result is, intricate swayings to and fro, instead of a steady circling round of the various bodies, and all these irregular swayings to and fro have to be taken into account by observational astronomy before the prognosticated places of the moon amongst the stars can be printed in the "Nautical Almanac," which is issued three years before-hand, for the service of sailors. The first of the irregularities of this kind, which places the moon at times more than a half its own breadth before or behind the position it would occupy amongst the stars if it moved round the earth in a regular circle, at an unvarying and undisturbed pace, was discovered by Ptolemy eighteen centuries ago. Since that time as many as forty other distinct irregularities of the moon's movement have been detected and tracked to their source, and so examined and discussed that every one of them can now be taken into account in the astronomical forecasts that have to be made. This work of refined correction is consequently now reduced to very narrow limits; but it is, nevertheless, not complete. It is still being carried on. There is still some unascertained irregularity which makes the true and the calculated and anticipated positions of the moon vary, after long intervals, to the extent of 6·79 seconds, and 4·93 seconds; that is to say, the moon sometimes arrives at certain fixed positions of her path 6·79 seconds before she is expected there, and sometimes 4·93 seconds after she is considered due; and it is now one of the great aims of national observatories to discover the causes of this irregularity, and to remove this residual inaccuracy and blemish from their work.

It will readily be understood from these remarks, how very much more conveniently the examinations of this exquisitely refined character can be carried out at the present time, with the facilities afforded by the transit instrument, than they could be in Tycho Brahé's time, when the apparent positions of the sun and moon had to be measured by the actual graduations of instruments. When Tycho Brahé took an observation of the sun, to fix the exact position of the earth amidst the stars, he had first to measure the angle between the sun and the moon during daylight, and then, after sunset, to measure the angle between the moon and some fixed standard stars, and next also to allow for the movement of the moon in the intervening interval. Now all that is necessary is to note by a clock the time when the edge of the sun crosses the mid-line of the transit instrument, and when the twinkling point of the star afterwards passes the same thread. If the star passes the thread 21,600 seconds later than the sun, the distance between the star and sun is 21,600 $\times$ 15 seconds, or 324,000 seconds of angular measure in right ascension away from the sun. In the same way any other difference in time can be at once converted into differences of angular measure in space. All that is necessary is to consider that each second of time in any observation represents fifteen seconds of space, or the 240th part of a degree. The intervals of time are now very accurately recorded in large observatories by the electrical transmission of a signal to a recording drum. The instrument by which this is accomplished is called a "chronograph." The form and general character of this very ingenious piece of apparatus is shown in the Room K, near to the entrance from the outer grounds, and almost opposite to the large reflecting telescope of Browning, which is a sufficiently conspicuous object to catch the eye readily. The instrument (No. 1,874 in the catalogue) is labelled "Carrington's Astronomical Chronograph," is exhibited by Dr. Stone, and is of Messrs. Smith and Beck's manufacture. It consists principally of a long brass drum, which when the apparatus is in use is covered with paper, and is carried round at an even pace by clock-work placed at one end of the drum. Above the drum there are four sharp styles, or points, which it will be observed are fixed to a frame that runs along upon an endless screw at the top of the drum as it turns. Each is connected with an electro-magnet, and whenever a current is sent through the coil, the point is drawn down by the magnetism, so as to make a prick on the paper. Imagining the drum to be turned once every two minutes by the clock-work, and that the points are being slowly slid along lengthwise upon the drum as it revolves, then, if one of the magnets is connected electrically with a clock at each beat of the pendulum, a point is magnetically pricked upon the paper at each corresponding second. If another of the points is then pulled down, by another magnet, at the instant when the observer sees a star passing across the meridian wire of the transit, an observation-prick is interpolated among the time-pricks made by the clock, and, if compared with them, shows the precise moment when the observation was made. The four points enable three observers to work with the instrument at one time. There is another very pretty form of the chronograph by Yvon Villarceau (No. 1,873 of the catalogue) placed in a neighbouring case, in which a pen is carried along upon the revolving drum, so that it leaves a continuous straight trace upon the paper, unless when a signal is communicated electrically, either by a clock or by the observer; the pen is then twitched on one side by the magnet, at the instant of the signal, and the twitch is marked by a loop ——⌒——⌒—— being formed in the track left by the pen. This loop then becomes a record either of a second of the clock or of an interpolated signal, accordingly as it has been formed by an electrical current turned on by the pendulum of the clock, or by the observer's finger.

It is, perhaps, worthy of remark, as a further illustration of the oscillations that occur in the progress of science, that in the very splendid instrument which is now used for meridian observations at Greenwich, and which has superseded the instrument that is represented by the model No. 1,780 contained in this collection, there is again a very large altitude circle attached to the transverse arm of the telescope, so that altitudes of stars can be read simultaneously with their passage over the meridian. For a considerable interval of time it was the practice to use different instruments for obtaining meridian passages of stars, and for noting their polar distances, or declinations and altitudes, in order that the utmost possible care might be expended in making each particular instrument perfect for the work which it has to perform. Sir George Airy, however, has proved that instruments can now be satisfactorily constructed which allow both these objects to be efficiently secured by the same piece of apparatus. He has, therefore, introduced the form of instrument for meridian work which is known as the "Transit circle." The transit instrument which is employed at the Greenwich Observatory at the present time has a large altitude circle of eight feet diameter attached to its axis, the graduations upon which are read by eight microscopes so diagonally ranged from nearly the centre of the circle that the eye at that spot can command the eight remote parts of the circumference to which they are directed. Exquisitely refined observations of altitude can be made with this instrument by the same observer, who records the passage of the star across the meridian by the chronograph. The observer first ranges the telescope

so that the star to be observed crosses the middle of the field. He then makes his dots upon the chronograph at the instants when the star passes the vertical wires or threads of the instrument, and he afterwards reads the altitude by the eight microscopes, and fuses the eight readings into the mean, which is forthwith registered as the altitude or declination of the star at its instant of meridian passage.

The altazimuth instrument is a form of astronomical apparatus which is still employed with the best of results in large observatories, on account of the facilities which it affords for observing the heavenly bodies away from the meridian. Thus, supplementary observations of the moon are made at Greenwich by an instrument of this class on all occasions when the moon and fixed stars can be seen, and especially at those times of its position in its orbit in which observations of it cannot be taken upon the meridian. Sir George Airy considers that by the employment of the altazimuth instrument upon this work he secures just three times as many observations of the moon as he would be able to get if he were restricted entirely to meridianal observations. The altazimuth instrument thus employed is simply the quadrant of Tycho Brahé with its quadrant enlarged into a circle, and with a telescope fixed to the face. The beautifully perfect form which is given to this useful instrument by the skill of modern mechanicians is very admirably illustrated by the fine specimen (No. 1,763 of the catalogue) by Troughton and Simms, which is placed in the fourth case to the south of the astrolabes. It will be observed that in this instrument the circles are twelve inches in diameter, and that a telescope with an aperture of two and a half inches is carried upon the vertical one. The frame of the instrument stands upon three firm feet furnished with levelling screws, and there are striding and fixed spirit levels for securing the horizontality of the base, and of the transverse axis of the instrument when in use. The transverse axis is carried between two pillars, which revolve vertically with the azimuth circle upon which they are reared. The altitude circle is read by three microscopes from a zero fixed for horizontality by a spirit level. The azimuth circle is read by two microscopes, of which one is fixed and one carried upon a moveable bar. Especial notice should be taken of the very beautiful way in which the numbering and graduation of the scales of these circles is executed. The wires of the telescope are illuminated for use at night by a lanthorn, which throws its light through the hollow arm of the transverse axis, upon a mirror so placed that it reflects the rays into the tube of the telescope. This instrument, it will be observed, becomes virtually a transit instrument when it is so fixed that the vertical axis and the telescope can only range in the plane of the meridian. There is a second instrument (No. 1,763*b*) by Watson, of equally beautiful construction, exhibited close by the side of that of Troughton and Simms, which has one peculiarity that is worthy of remark. The telescope is carried between two large altitude circles, which thus become a check upon each other, and there are also two smaller altitude circles to be used in setting the instrument to the required range. The reason for this peculiarity of construction is that the fixing and moving of the telescope in altitude is performed through the instrumentality of these small circles, and the large circles upon which the detailed readings are taken are left free from all mechanical strain, which they would experience if they were employed for the purpose. The azimuth circle also consists of an inner circle, revolving within an outer one, which gives great delicacy of definition, and there is a supplementary telescope beneath the azimuth circle intended to fix any permanent zero for horizontal reading. Both these beautiful instruments are, as a matter of course, furnished with a very perfect system of verniers. A theodolite belonging to the Ordnance Survey of Berlin, which is grouped in the same case with these instruments, affords a convenient opportunity for comparing the best class of German work with these fine specimens of English artists. The large 24-inch theodolite by Troughton and Simms (No. 2,946), which stands in a case just to the north of the astrolabes, and the Ramsden theodolite (No. 3,036), which is placed against the side wall a little further north, illustrate the more massive form which the altitude and azimuth instrument (altazimuth) assumes in the observatory. The "theodolite," it will be understood, is simply an altitude and azimuth instrument in which a large special development is given to the azimuth circle, for measuring horizontal angles. Thus, in the Ramsden circle it will be observed that the altitudes are read upon both sides of a twelve-inch circle by two microscopes placed opposite to each other; whilst the horizontal angles, or azimuths, are read upon a much larger three or four feet circle by four microscopes.

The "equatorial," it will be understood, is simply an altitude and azimuth instrument in which the azimuth circle is tilted up, until it is parallel to the plane of the earth's equator, at any place where observations are made by the instrument, and in which the vertical axis and movements which are at right angles to the azimuth circle are also tilted back until they lie parallel to the axis of the earth. This arrangement is very well illustrated in a small equatorial instrument which stands in the end case of Room K against the wall. The oblique axis which is terminated below by the hour circle, and which is so easily identified by the eye, is to be conceived in this instrument to be parallel to the tilted axis of the earth. The axis which is placed transversely across the inclined one carries the telescope and a counterpoise at either end. The telescope can be raised upon this counterpoised axis to any elevation that may be required, and as the inclined axis is parallel to the axis of the earth, the telescope can be then shifted round upon it in compensation to the earth's movements on its axis, or in other words to the apparent movement of the heavens, by one motion. If the telescope is once fixed upon a star, that star can be followed from its rising to its setting, hour after hour, by simply turning the telescope on the oblique axis by a handle acting upon the edge of the hour circle by rack and pinion movement. This is the great convenience of the equatorial arrangement of stand. If a clock is put in the place of the hand, and set to do the turning work by means of the rack and pinion connection, the telescope then keeps upon the star, instead of the moving star shooting across the field of view, and passing quickly out of sight. The difference between the altitude and azimuth, and the equatorial mounting of a telescope will, however, be more easily understood by a glance at the accompanying figures. In the sketch (Fig. 1) on p. 926, one of Browning's silvered glass reflectors is shown mounted upon an altazimuth stand of a very simple and excellent form of construction. The wooden tripod can be placed upon the ground in the position that is approximately convenient for use. The horizontal frame which lies across the top of the tripod can then be turned slowly in azimuth, or horizontally, by the rack-work and handle which is seen resting across the frame. This carries the telescope gently from left to right. The telescope at the same time is supported on pivots at one-third of the length of the tube, and the long oblique steadying rod holds it upon these pivots at any elevation that is required. When the milled head near the top of the steadying rod is turned, this gently lifts or depresses the telescope; and the two milled-head screws placed over the pivot at the side give convenient means for clipping fast the telescope at any particular range. In the sketch (Fig. 2) on p. 927, the telescope is shown on the other hand mounted equatorially. The massive iron pillar is sloped at the top to the angle of the plane of the earth's equator, and an azimuth circle is there seen with a slow screw movement and angle attached to the rim. A transverse axis lying

across the sloping top of the pillar has the telescope at one end, and a counterpoise and graduated altitude circle at the other. The telescope can be raised or depressed to any required angle of elevation upon this axis, and it is then carried round "equatorially," or in the plane of the sloping top of the pillar, to follow the movement of the star, by the action of the rack movement and handle. In Fig. 3, a very simple form of stand is also shown, the peculiarity of which is that by turning the sloping block immediately under the azimuth handle half round, the stand can be made either into an altitude and azimuth, or into an equatorial instrument at will. This simple form of stand is contained in the collection, and is placed by the wall of Room L (No. 1,786 of the catalogue), not far from the model of the Greenwich transit instrument. The altazimuth mounting is also shown with the four-inch

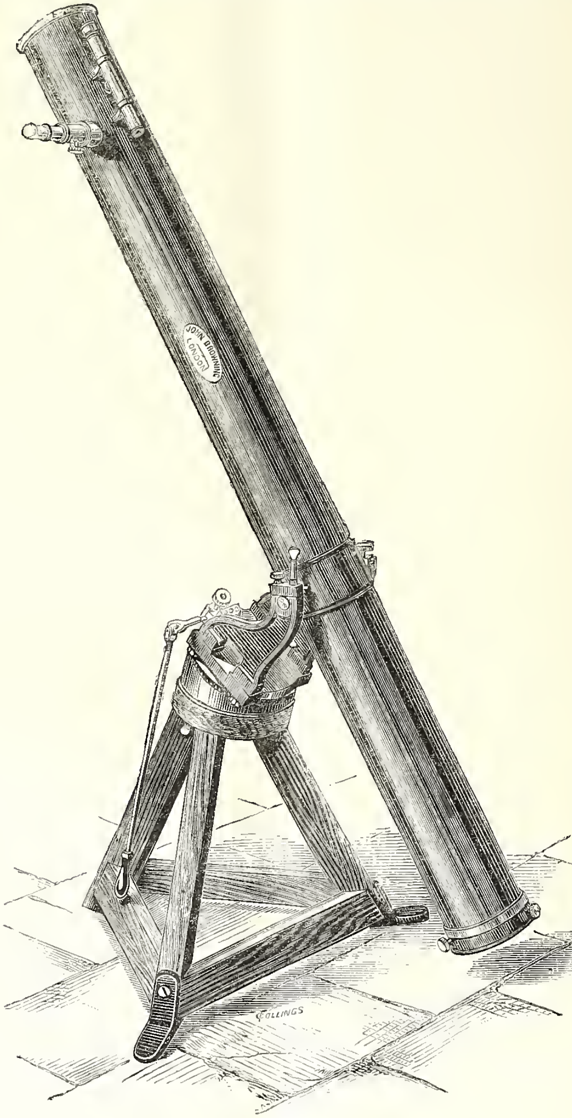

Fig. 3.

refracting telescope (No. 1,765 of the catalogue), which is in the wall-case at the end of Room K, towards the north. In this a small amount of altitude movement is conveniently communicated by a rack-work acting upon the end of a lever arm.

A prominent object near to this end of the Room K. is the excellent equatorial mounting for a large $8\frac{1}{2}$-inch silvered reflector by Browning for a fixed observatory (No. 1,785 of the catalogue). It will be observed that the telescope stands on a massive iron pillar, which is furnished with spirit-levels and levelling-screws to secure horizontality of the base. This pillar has the form of a hollow iron frame with a sloping top which is adjusted to the plane of the earth's equator, and carries in that plane a twelve-inch graduated hour circle. A solid transverse axis lies across the sloping plane, and carries the telescope at one end, and an altitude circle and counterpoise at the other. This altitude circle is graduated to 20 minutes, and is read off by a vernier at the top. The inclined axis, it will be noticed, is prolonged downwards from the

hour circle to a toothed circle, which is drawn round by a tangent screw, connected with a train of clockwork, lodged in the space between the two sides of the hollow frame. The clock is driven by a weight, which is wound up by the strong transverse arm at the side, and the rate is regulated by a pair of centrifugally-acting governor-balls. When the stand is duly placed, and this clock is in action, the telescope is carried along steadily with the star, as it moves across the sky, under the earth's rotatory movement. This stand, which is very good, both in design and work, furnishes an excellent illustration of the kind of equatorial mounting which is adopted for observatory work. Steadiness, truth of position, and smoothness and evenness of motion, are the conditions that are to be aimed at, and these are all fairly secured in this instrument.

The equatorial serves, like the altitude and azimuth instrument, to enable observations of the heavenly bodies to be made away from the meridian; but the graduated circles with which this form of instrument is furnished are not relied upon for any scientific purpose. They are simply used for placing the instrument in any desired position. A further contrivance is employed for giving scientific exactness and value to the observations. A small piece of apparatus termed a "micrometer," or "measure of small intervals" of space, is added to the eye-piece. In this there are fine threads so arranged in the field of view that they can be made to approach or to recede from each other, by a milled head and screw movement. The head is so marked that the hundredth part of one turn of the screw can be noted. If, then, one complete turn of the screw amounts to one minute of the circle of the sky, one division of the head is equal to one hundredth part of that quantity. In using the micrometer, the measure is made from some fixed star visible in the field of view of the telescope. One wire is caused to cover that standard point, and the other wire is placed in apparent contact with the object whose position is to be marked. The exact distance in angular measure between the two threads is then estimated by turning the screw until the threads are brought together, and by noticing how many turns, and parts of turns, of the screw have to be performed to produce this coincidence. Another system of wires in the micrometer enables the position of the star and the object in regard to each other to be at the same time referred to the equatorial line in which stars are carried across the field by the earth's motion. The micrometer is also, however, very ingeniously applied to make even the measurements of large circles by their own graduated divisions more exact. The thread of the instrument and the nearest degree on the circle are looked at together by a strong microscope, and the number of turns of the screw which would bring the thread and that division into apparent contact is then noticed. That quantity thus becomes a very delicate measure of the exact position of the circle, and consequent range of the telescope. In the great Ramsden theodolite already alluded to (No. 3,036), the four microscopes which read off the large azimuth circle have micrometers of this kind. It will be observed that they all have graduated milled-head screws for shifting the threads contained in the field of view, so as to measure in turns of the screw how far the central thread is from any mark on the circle when an observation is made.

The models 1,791, 1,792, placed against the wall of the Room L, towards its southern end, illustrate how very large telescopes are now mounted in observatories, so as to be used under the convenient arrangements of equatorial motion. The model No. 1,791 represents the mounting of a splendid reflecting telescope of four feet diameter, on a scale of one-sixteenth the full size, which has recently been made for the Melbourne Observatory, by Grubb, of Dublin. The lattice-work form of the tube in this telescope, intended to contribute lightness and to secure free ventilation of the interior, is worthy of notice. The model 1,792 represents the form of a large refracting telescope of 27 inches aperture, which is in preparation by the same skilful hands for the Imperial Observatory at Vienna. The long and slender outside tubes which are seen clinging round this instrument are most admirable contrivances for reading off all the distant circles of the instrument from the eye-end of the main tube of the telescope. They are telescopes for looking at the marks on the circles of the telescope which is looking at the stars. All the various adjustments of this most noble instrument are well worthy of close study. It will be observed that the giant is upon so vast a scale, that even one of its own finders carries a smaller finder upon its back.

This description of the marvellously beautiful contrivances that have been matured for the scientific observation of the positions and movements of the stars cannot be brought to an end without drawing attention especially to a very interesting form of astronomical clock, which is exhibited by Messrs. Dent. This clock (No. 1,843) which is placed against the wall of the Room K, and is the first of a long range of time keepers there marshalled, is an exact counterpart of the sidereal clock which furnishes true time for all tho time operations of the Royal Observatory at Greenwich. The pendulum consists of a heavy leaden cylinder suspended by its centre of gravity, and hung upon a zinc tube, which is itself carried by a steel rod. The dimensions of the zinc tube and steel rod are so apportioned to each other as to constitute a compensation for changes of length brought about by varying temperature. This form of compensation is found to be more immediate and lively than the long used mercurial compensation. This pendulum takes up a change of temperature in four minutes, which the old mercurial jar pendulum would be twenty minutes in accomplishing. But the pendulum has also a further compensation for varying density of air. A dense and heavy atmosphere, such as is marked by a high barometer, gives more resistance to the swing of a pendulum than a rare and light atmosphere, such as is indicated by a low barometer. In this clock it will be observed there is a barometer at the side of the case. A float rests upon the mercury in the cistern of the barometer. When the mercury is pressed up into the tube of the barometer the float falls; but when the float falls it carries down with it the end of a transverse arm to which it is attached. The other end of the transverse arm is then carried up, like the opposite end of a scale beam; but that end lifts with it a horse-shoe magnet, which will be seen arching up towards the swinging hob of the pendulum. A close inspection will show that just above this horse-shoe there is a bar of bright steel fixed perpendicularly on the side of the weight of the pendulum. That bright bar is also a magnet, and its poles are so placed that it is drawn down by the attraction of the magnetic horse-shoe beneath; but it is drawn down *more* or *less* according as the horse-shoe is brought nearer, or carried further away. The horse-shoe is brought nearer when the transverse arm is lifted by heavy air acting upon the barometer. That makes the horse-shoe magnet pull more forcibly upon the straight bar, or the swinging weight of the pendulum. The pendulum is hence caused to swing more quickly by this increased pull. The swing of the pendulum is thus quickened by the magnet just to the extent that it is impeded by the denser air, and that constitutes the barometric compensation of the clock. It is found that this clock approaches very nearly indeed to keeping accurate time. The great practical importauce of a very accurate clock of this kind to astronomical observations will readily be perceived when it is borne in mind, as has just been explained, that in astronomical observations seconds of time are measures of the divisions of the great circles of the celestial sphere.

The wall case at the north end of the Room L contains a very fine series of sextants, which deserve particular notice as illustrating the great improvement which was made in the construction of this class of instruments by

John Hadley, probably under a suggestion from Sir Isaac Newton, at the beginning of the eighteenth century. The principle of the instrument consists essentially in a small arc being made to perform as much service as a large one in measuring angular distance, by causing the image of one object to be reflected from a bright mirror. By this reflection the angular interval is doubled. Thirty minutes becomes a degree. The pillar sextant (No. 1,778), by Browning, which is intended for use in the observatory, is a good illustration of the type of these instruments. The reflecting circle is merely a sextant with its arc completed into a circle of 360 degrees, in order that several different parts of the circle may be used simultaneously as a check upon each other. Want of space alone prevents a more detailed notice of the various excellent forms of reflecting sextants and circles which have been here brought together. In the meantime it will be quite worth while for any one to institute a passing comparison between the pillar sextant of Browning (No. 1,778), and the 12-inch quadrant by Bird (No. 1,781), belonging to the Royal Society, in the corresponding wall-case by the window, or the Captain Cook's quadrant (already described), to get a clear idea of what astronomical science owes to Hadley for this application of mechanical skill and ingenuity.

A DANGEROUS OCCUPATION.

Mr. Alexander Redgrave, Inspector of Factories, in his report to the Home Secretary on the factories in his district, describes in great detail the dangers of the manufactures of white lead, and makes some valuable suggestions for diminishing them. He says that a short time since his attention was called to the subject of lead poisoning and the condition of the persons employed in white lead factories, and he requested the Metropolitan Sub-Inspectors to make special inquiries into the matter. Sub-Inspector Henderson gave the following description of the manufacture:—"The processes in the manufacture of white lead are few and simple. The raw material is received in the form of pigs of lead, which are melted in an open furnace. The metal is then cast into moulds, in a form which admits of its being acted upon freely by the acetic acid with which it is placed in contact in the next process. This acid is contained in open earthenware vessels, and the lead being placed in them, a layer of tan bark is laid over it. A fresh layer of vessels containing acid and lead follows, and another of bark, and so on in succession until what is termed a 'stack' is formed. The lead remains in this 'stack' exposed to the action of the acid for about eleven weeks; by the end of this time it is thoroughly carbonised. Up to this point the processes, so far as the workpeople are concerned, are quite innocuous. Carbonic acid gas is evolved from the 'stack' in large quantities, but, as the roof and sides of the building are pierced with numerous openings, no accumulation of this dangerous gas takes place. It is in removing what may now be termed the carbonate of lead from the 'stack' to the grinding mill, and from the grinding mill to the stoves or drying-rooms, that the workpeople are exposed to its deleterious influence. To a partial extent they inhale it in the form of dust, but it is mainly absorbed into the system by contact. The earthenware vessels in which it is contained become coated with the bicarbonate of lead, and as they are handled without gloves, the hands, arms, and dresses of the workpeople soon get covered with it also. Another deleterious process in white-lead manufacturing is the packing of it in tins or barrels in a dry state. Where the manufactured lead is ground with oil and sent to market in the moist state, the evils attending the dry packing do not arise." Such being the nature of the work, the first inquiry that suggested itself was the condition of the atmosphere in which those engaged in white lead works were constantly exposed. Analysis proved that the air was not dangerous. The injuries from which those employed in lead works suffer arise, therefore, from actual contact with the lead itself, causing them to imbibe from it, either through the lungs or the stomach, those particles which eventually lay the seeds of paralysis. Very great improvements have been introduced into the trade of late years, reducing very much the causes which produced illness and disease. But taking things at their best, the following evils exist in the manufacturing of white lead:—White lead dust is let loose, and is both inhaled and settles upon the person and clothes of the workpeople. White lead in a moist state undergoes various manipulation by hand or machinery, and adheres to the clothes and persons of the workpeople. No general rules are laid down or carried out in white lead works. All depends upon the extent of the precautions thought necessary by the manufacturer himself. In all, however, hot water and soap is provided, cleanliness of hands enjoined, and Mr. Redgrave says it is a rule that no one should be allowed to leave the premises unwashed. In some gloves and respirators are provided. In others caps and dresses for the women; and slops, canvas trousers, and boots for the men. Medicine and acid drinks are also kept on the premises of some works, and a surgeon provided for those who are ill, full wages being paid while ill. With these varying precautions there is, nevertheless, much suffering among these people."

Mr. Oram, Sub-Inspector for the East Central and Eastern portions of the Metropolis, visited a large number of persons actually suffering, some at their own homes, and others in the London Hospital, the Stepney and Poplar Sick Asylums, and the Poplar and Whitechapel Workhouses. The descriptions show the precise manner in which they were affected, and thus enable us to follow out the processes, and see in what way manufacturers have endeavoured to deal with an unhealthy occupation, and possibly suggest some further amelioration which may be of service to the workpeople. The first questioned said:—"I have worked off and on for 20 years. I did not suffer from the lead until five years since, when I was laid up for seven months from paralysis in the hands I very seldom had a pain in my stomach before that time. I got over that attack of paralysis, and, not having any way of getting a living for myself and two children, went to work again. I never worked at the stoves, but took the white lead from the vats to the settling vats. The lead was wet. I had no dress to wear only my old clothes. I had no respirator or gloves. I never worked anywhere but for this firm. Since the attack of paralysis, five years since, I have had very slight attacks of colic, but nothing more, until last Good Friday, when I had an attack which ended in paralysis again. I had plenty of soap and soda and towels, and a nice wash-house; there is every convenience there for them. I washed at dinner time and before leaving of an evening and sometimes oftener. I wore my shoes and stockings, and never went without. If the hands could be kept covered, it would be well, because the lead-water gets over the hand. I would not mind wearing gloves, or any thing to prevent water penetrating." Another said,—"I worked for four years; have occasionally taken castor oil at home when not feeling well, but this is the first time I have had to stay away on account of it. I had a pain in my chest on Wednesday, and thought it best to have some medicine at the infirmary, but it has not prevented my moving about. I have not been at the stove above six times since I worked there, as they do not compel any to work there unless they like. I worked in the new bed in forming new stocks. Sometimes the old crates are used, and dust arises from them. Those from the new bed go in the cook-house to breakfast about half-past eight o'clock, having to go up to wash first, and the man at the engine watches each one that goes in, and if there is the least bit of white lead he sends them back to wash again. The same occurs at dinner-time and tea-time. In the evening we have ten minutes be-

fore the bell rings to wash ourselves, but can stop as long as we like to have a thorough wash. When at the stove I wore a flannel respirator and long night dress, which they give you to put on over your own clothes. I always have put something over my head, and generally take a handkerchief to put over my head when working at the stove. I do not think any woman would be allowed to work by this firm with her shoes and stockings off." A third,—"I did not wear a respirator because I do not like it; the firm would have let me have one if I wished. I wore a smock at the stove. If I had gone to the dining-room without washing, the man would have sent me out again. There is plenty of hot water and soap and everything to wash. I have worked there 18 years. I have had a pain in my bowels, but am suffering from rheumatism as well. I wore my shoes and stockings when at work." And a fourth,—"I placed the earthenware pots which had been used before, and consequently contained white lead dust, in the stack, and the dust would consequently get about me. I did not wear a respirator or smock. A smock would be in my way. I should have an objection, as it would come in the way of my legs. Canvas trousers would be a great protection, as the dust works through the trousers. I have nothing to do with taking out. In another firm the pots are washed and dried in a kiln before being used again, which is a great protection." Others gave similar accounts. From the inquiries which have been made, it is clear that strong objections are made to two most important precautions by the workpeople themselves—the use of gloves and the respirator. Gloves are objected to by the workpeople, on the ground that they cannot handle the implements freely, and that they cause so great heat as to be a hindrance to them in their work. Mr. Redgrave does not give much weight to this objection. In many works gloves are worn in operations in which their use is desirable. Mr. Sub-Inspector J. A. Redgrave upon visiting a very large establishment found every workman wearing gloves. It was the rule of the establishment, was insisted upon, and was observed. As a contrast, he reports visiting on the same day another establishment, in which no precautions existed, but a trough of hot water and supply of soap. He saw a man shovelling the fine powder of lead into a hopper, but the manufacturer pointed out how carefully the man used his spade, so as not to cause the fine dust to rise. With a respirator the work would have been done in half the time, and possibly was accelerated when their backs were turned. At this place, too, where a man is said to be stationed at the outer gate to see that people are washed before they got out, the Sub-Inspector saw a woman go out, covered on the hands, face, hair, and clothes with white lead; and the sanitary guardian explained that the woman was not gone for good, but only to fetch some beer, which when consumed in the works would, of course, carry with it no inconsiderable quantity of lead dust into the stomach. There does not appear to be a really reasonable objection to the use of a respirator, although a variety of difficulties are suggested. Mr. Redgrave quotes the opinions of many of the persons examined,—"Have no respirators; do not know why." A woman had a handkerchief over her mouth, and "found it an advantage." Another woman,—"I should not inhale all the dust if I wore a respirator, but I can work better without one, I fancy." Another woman,—"I have no respirator; I could not keep it on." Another,—"I cannot bear a respirator in the warm weather." Again,—"I should like to wear a respirator if the manager would give me one." Again another opinion,—"I used to wear a respirator, but the people threw them about, not caring for them." "Could not wear a respirator." "Don't care about a respirator, thank you all the same." Upon a second visit paid to one establishment, Mr. Oram made inquiries of a number of men. One said, "I have never worn a respirator before to-day." Another said,—"The heat of the flannel makes it difficult to breathe. I would rather be without it than with it. The heat caused by the respirator makes you giddy. I consider having it on a punishment." Another said,—"The respirator is very warm. I did not want to wear it this morning, but the manager said I must." Another,—"The respirators are so warm they make you sweat awful. I did not wish to wear it, but the manager ordered me to do so, and said I should have no money for my work if I did not." The result of the inquiries show that there is considerable danger to health in white lead works; that in works in which full precautions are provided, and their use insisted upon, ill-health and disease are reduced to a *minimum*, and that sufficient attention is not paid by manufacturers, who offer employment to workpeople, to free that employment from the serious evils which carelessness and ignorance are sure to entail. The Inspectors do not think it sufficient for an employer to say that the operatives who come to him accept the work with its consequences. Is he justified in placing men and women in jeopardy without providing and insisting upon the adoption of some sufficient precautions? The people employed in these works are all adults; the women especially are of the poorest class, and loss of employment means deprivation of sustenance to a whole family, which then has to be supplied by the relieving officer. But the ground taken by some of the manufacturers in this trade is the proper and humane one—to do all that is possible to make their work innocuous as a duty undertaken voluntarily, although it entails trouble and saddles them with expense. He thinks, therefore, that the rule should be carried out in all white lead works:—Clothes, gloves, and caps should be provided, to be worn in the works; waterproof boots to be provided for those working with the moist white lead; respirators to be provided for those working with the dry white lead; none to be allowed to leave the works unwashed or in the factory dress, and that the manufacturers should be empowered to make special rules which should render any of his workpeople amenable to law for disregarding them. When we see how soon a fatal consequence may ensue from utter inattention to simple precautions, we may feel justified in making some apparently stringent regulations, which, as they are carried out in some establishments, can be observed in all.—*Times.*

NETTLEFOLD'S SCREW, WIRE, AND NAIL WORKS.

These works, situated at Birmingham-heath, were thrown open to visitors for the first time on the occasion of the visit of the members of the Institution of Mechanical Engineers last month. They are the most extensive in existence, turning out no less than 200,000 gross of screws a week. About 200 tons of iron, made at Wellington in Shropshire, is drawn into wire in one week. As being the largest screw manufactory in the world, and the one best exemplifying the most recent applications of automatic machinery to the making of screws, some account of these works may perhaps be interesting to readers of the *Journal.*

In making the "blank" for the future wood screw, the wire of different sizes is fed cold into a machine, which not only cuts a piece off to the length required, but also forms the head, whether cupped or of the ordinary conical shape. The dies for the countersunk heads are formed of square pieces of steel plate with half the hole and countersunk portion taken out of each of the four sides, so that two plates together are required to make the head; but, as there are four half-holes in each plate, one pair of dies can be changed four times before being worn out. When the head is formed, the dies are drawn apart by an automatic arrangement, and allow the blank to fall out. The blanks are then placed in a shallow bowl, continually revolving, which forms part of the feed apparatus of the next machine. A pair of fingers

descends at intervals, feels as it were among the blanks, and, when through the rotation of the bowl it has picked up by their heads a sufficient quantity, it is again raised and allows the blanks to slide by their own weight down an inclined groove, finally delivering them in a horizontal position within reach of a pair of nippers. This automatic action of the fingers much resembles the action of a long-beaked bird like a crane, dipping its bill into water, and then raising its head to allow the water to run down its gullet. The nippers hold the blank until it is inserted in a chuck by an advancing punch; here it is held while a tool turns the head, when it is brought within range of a small circular saw, which cuts the nick. Another finishing cut is then taken off the head; and the blank falls down ready for the next operation. This consists of cutting the thread, or "worming," as it is called. The blanks are put in another revolving bowl, and fingers, similar to those of the last machine, place them one by one in a chuck, the dies of which open to receive them. A diamond-pointed tool advances to make the point; and then another tool runs along the blank, cutting the thread in from 4 to 12 cuts according to the size of the screw. There are some quick "worming" machines which turn out seven screws in a minute.

All these automatic machines, improved from American models, with others of a less complicated character for drilling and tapping nuts, are made on the spot. There are upwards of two thousand machines under one roof, and the *coup d'œil* from a gallery, when all are working together, with the revolving trays full of glistening white or yellow brass screws, is very striking.

The tools for the various operations constitute an item of no little importance. The tools for turning down the heads are put into a kind of rest which traverses the edge of the grindstone, thus wearing it down evenly; when the stone is too much reduced in diameter for this purpose, it is driven at a greater speed, and the sides are used for grinding the face of the punches that head the screw blanks. The diamond-pointed tools for cutting the thread are formed by turning an annular-shaped plate in a lathe to the proper section, and then dividing it radially, each segment forming a tool. The circular saws for cutting the nicks are first punched out of a steel plate, then screwed tight on a mandril, about 14 dozen at a time, and forced vertically through ten dies to form the teeth. The saws are hardened in lard oil mixed with half suet, and then tempered to dark blue.

After the "swaff" is shaken out in oscillating trays, the screws are washed in water impregnated with soap and soda, and then polished in revolving barrels with saw-dust, which is dried on a plate kept hot by steam. The screws are then examined one by one to see that they are perfect, being fed up by the bird's-bill arrangement above described.

The wire-drawing forms a separate department. Besides wire of different sizes for screws, spikes, "Paris points," &c., bottling wire is also made.

In the nail mill, the Paris points are cut off from the wire, as it is fed in, headed and pointed at one operation, sizes up to one inch being turned out at the rate of 360 a minute. In the manufacture of spikes, the punch for making the head is propelled by springs, which are compressed by a cam, and then released at each stroke; two cutters worked by side cams on the same shaft cut off the wire and make the point. A steel finger then advances and knocks the finished spike out of the way to make room for the next. Wire staples, three inches long, are turned out at the rate of a hundred a minute; the wire is pushed forward into the machine, and cut off on the bevel to form the points; a hook rises, catches the wire, and draws it down into the proper form, when the staple falls out complete.

About 2,000 hands, including women and girls, are employed in the screw works, wire mill, nail mill, and bolt works.

GENERAL NOTES.

Laboratory of the French School of Mines.—This institution, founded in 1845 for analysing gratuitously any substances required by manufacturers, iron-masters, mine-owners and others, has made 767 analyses last year; the total number from the commencement to the end of 1875 being 23,571. The substances brought for analysis comprise fuels; alloys and metals; antimony and silver ores; ores of gold, lead and mercury; cobalt and nickel ores; tin, copper and zinc ores; iron and manganese ores; iron and arsenical pyrites; limestone; clays, kaolins, earth and sand; sea and other salts; manures and phosphates; water and mineral waters.

Australian Silk.—Some interest, says the *Australian and New Zealand Gazette*, has been excited by the exhibition in the window of a Melbourne draper of articles of clothing manufactured from Australian-grown silk. The articles consisted of a pair of socks, made at the Australian Silk Growers' Depot, Charles-street, Grosvenor-square, London; and a lady's scarf made by Messrs. Potts, Wright, and Co., Macclesfield. The raw silk from which these things were made was taken to Europe by Mrs. Bladen Neill, in December, 1875. There is also a skein of carded and spun silk from the mills of Mr. Brocklehurst, Macclesfield. The experts who have examined these articles report very favourably on their quality, and say that Australian silk is considered by manufacturers to be much superior to Italian or Chinese silk. It is therefore expected that silk-growing will become a most important industry in the Australian colonies.

The Patent-office Report.—The Patent-office Report shows the usual steady increase in the number of applications for patents during the year with which it deals. In 1875 there were no less than 4,561 applications, or 69 more than in 1874. The growth, however, is smaller than that of the year before, for 1874 exceeded 1873 by 198. The lessened increase is attributed to the somewhat depressed state of many industries. It is calculated that of all the patents granted only 28 per cent. survive their third year, and only 10 per cent. their seventh. 1,173, or more than a quarter of the applications in 1875, are already dead, never having got beyond their six months of provisional protection. During the year a profit was earned of £110,950, after payment of all costs and charges, including the sums of £24,000 for paper and printing, £18,000 for salaries and office expenses, &c. Last year this income amounted to £110,618. Since the establishment of the office on its present footing in 1852 it has produced over a million of money, the exact sum being £1,229,772. The number of printed specifications, down to the end of 1875, is 95,791, of which 14,359 were filed before 1852. Beyond the above statistics, the Report contains nothing new. It is embellished with the usual map of a proposed site for a new office on the Embankment, which has formed part of the Report for the last eighteen years.

THE LIBRARY.

The following works have been presented to the Library:—

The History of the Silk Industry in America, by L. P. Brockett, M.D. Presented by the Silk Association of America.

Catalogue of the British Section of the Philadelphia Exhibition, 1876. Presented by the Duke of Richmond and Gordon.

The Indian Problem Solved: Undeveloped Wealth in India, and State Reproductive Works.

Notes on Building Construction. Part 2. Commencement of Stage or Advanced Course. Presented by the publishers, Messrs. Rivingtons.

Plumbing and House Drainage, by W. P. Buchan.

Proceedings of the Royal Colonial Institute, Vol. 7, 1875-6. Presented by the Honorary Secretary.

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Al communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PROGRAMME OF EXAMINATIONS FOR 1877.

The Programme for 1877 is ready, and can be had on application to the Secretary. The Society's Examinations now comprise the following divisions:—

1. Commercial Knowledge.
2. Domestic Economy.
3. Fine Arts applied to Industry.
4. Music.
5. Technology of Arts and Manufactures.
6. Elementary.

MISCELLANEOUS.

THE TRADE OF TRIESTE.

By Captain R. F. Burton.

H.B.M. Consul at Trieste.

The following study of the commercial position and the actual trade of Trieste is based upon an excellent pamphlet, "Die Bedeutung des Hafens von Trieste für Oesterreich," 1873, by M. Franz Rziha, Ober-Ingenieur. This was translated into Italian, and appeared in the columns of the official *Osservatore Triestino;* an edition also in a separate form was soon exhausted. For the figures and calculations, which are borrowed bodily from that able author, he is solely responsible, whilst I alone am accountable for the remarks added to his observations. I need hardly call public attention to a paper which shows so clearly and incisively the amount of injury effected, despite all the gifts of Nature, by monopoly and by neglect in extending modernised communication.

Part 1.—General Considerations.

Section 1.—*Statistics.*

Although Trieste, the chief and indeed the only harbour of Austria Proper, is equally important to the Empire, politically as commercially, this is not the place for entering into the former consideration. The object of this paper must be simply to establish its significance as the head quarters of import and export, not forgetting, however, that the power of a flourishing commerce, with its various factors, is of momentous consequence to the status of an empire, and to the rank which it can hold amongst the nations of the world.

Before pronouncing upon the value of Trieste we must consider its double relation, first to the community of trade in general, and secondly to that of the Empire.

The world of trade, that exchange of produce which connects all nations, reposes upon the certain base of local and general wants, and upon influences which compel mankind instinctively to seek gain and usufruct, progress and civilisation. It arises from, as it subsists by, the intercommunication of peoples; its steps are to be traced from the foot-path to the railway; from the canoe to the coasting smack, the sailing ship, and the steamer; from the running courier to the postal car; and from the beacon or fire-signal to the electric telegraph.

Statistical data prove an astonishing increase of facility in communication during the last decade. The lines of highway in 1865, exclusive of Greece, Russia, Portugal, Switzerland, and the Netherlands, represented 906,704 kilomètres. During the same year canals and rivers, without including the above-mentioned countries, or Germany and Italy, afforded 69,201 kilomètres of navigation. Thus, in 1865, one part of Europe represented a total communication of more than a million of kilomètres.

At the end of 1871 the lines of rail were thus estimated:—

	Kilomètres.
Europe	112,693
Asia	8,769
America	110,207
Africa	1,773
Australia	1,812
Total	235,254

equal to 31,703 geographical leagues.

The annual movement of passengers amounted to 960,000,000 head, and to 16,000,000,000 of centners (or Austrian hundredweight).* The work was effected by 50,000 machines, and by 1,333,000 railway cars; and thus the yearly total per square league was 280 persons, and 50,000 centners of goods.

In the year 1870 the post-offices of the civilised world conveyed:—

3,504,907,000 letters,
937,857,000 stamped papers,
629,881,000 newspapers.

Total .. 5,072,645,000 items = 15 per head.

The network of electric telegraphs in 1871 measured 77,620 leagues of distance and 226,540 leagues of wire. The latter carried in Europe alone 52,000,000 messages, and a grand total of 67,000,000. Thus, for each inhabitant of the civilised lands, there are $\frac{2}{10}$ths of a league of distance and $\frac{2}{10}$ths of a message, whilst 53 letters necessitate a single telegraphic despatch.

In 1870 some 7,800 steamers and 121,560 sailing-ships carried 17,250,000 centners of goods, or double the amount of the total railway freightage.

The extension of the world's commerce is an enormous total whose money value can be estimated only by an approximation. The most moderate calculations assume that the 350,000,000 individuals who use the railway, annually consume 240 florins (£24) per head, whilst the expenditure of the remaining 1,050,000,000 may be rated at 80 florins (£8). Thus, the entire mercantile movement, expressed in money, reaches about 168,000,000,000 of florins (£16,800,000,000) per annum.

The yearly imports and exports of the world expressed in florins (each = 2s. sterling) have been calculated as follows:—

* The Austrian centner = 123 English lbs. avoirdupois, whilst the English cwt. = 90·5 Austrian lbs. The Austrian ton (tonne, or tonnelata) contains 1,810 Austrian lbs. = 2,240 English lbs. avoirdupois.

In Europe	15,965
„ America	4,188
„ Asia	1,985
„ Australia	595
„ Africa	437
Total	23,170

As regards the material of commerce, the following principal items may be considered:—

(*a.*) Cereals whose averages during the late years are thus returned in millions of centners.

Russia	sells	650	England	buys	80
United States	„	430	France	„	340
Austria	„	180	Belgium	„	90
Galicia and Ibraila	„	117	Switerland	„	4
Denmark	„	64	Netherlands	„	57
Canada	„	62	Italy	„	58
Egypt	„	12	Norway	„	?
Chile	„	5	Sweden	„	?
Zollverein	„	5	Greece	„	?

and the annual grain trade of these nations is estimated at 2,230 millions of francs (£89,200,000, whilst that of the world rises to 5,000 millions (£200,000,000).

(*b.*) The annual consumption of flesh in Europe is computed at 40 Austrian pounds* per head.

During the last few years the preserved meats imported from America and Australia have risen to an average value of 30,000,000 of francs. The civilised States of Europe, of North America, and of Australia are calculated to own 115,000,000 head of black cattle, 265,000,000 of sheep, and 65,000,000 beasts for slaughter.

(*c.*) The production of cane sugar throughout the world in 1869 is set down at 38,100,000 centners (Neumann); the beetroot sugar of Europe, in 1870, at 18,600,000; and maple and palm sugars (Kolb) at 3,000,000. For 1868 the consumption per head in England is 36·0 Austrian Customs pounds†; in France, 14·3; in the Zollverein, 9·4; in Belgium, 6·4; in Italy, 5·2; in Austria, 4·9; in Turkey, 2·0; and in the United States, 24·7.

(*d.*) In 1871 the world's production of coffee reached a total of 7,500,000 centners (Neumann). Of these Brazil furnished 3,200,000; Java and Sumatra, 1,400,000; and Ceylon, 1,000,000; the rest was distributed over Santo Domingo (500,000), British India (333,333), Mocha (44,000), Porto Rico, Costa Rica, Venezuela, Guatemala, Penang and Cuba also contributed. During 1870, the consumption of Austrian Customs' pounds reached in Belgium, 8·8; in Switzerland, 6·8; in the Zollverein, 4·4; in France, 3·2 in Austria, 1·4; in England, 0·8; in Russia, 0·2 per head.

(*e.*) The exportation of tea-growing countries is estimated at 2,800,000 centners, of which 2,000,000 are the produce of Eastern Asia. Europe consumes 1,600,000, and North America 400,000. The most recent calculations allow annually to England 3·3 Austrian Customs pounds, to North America, 1·0; to Russia, 0·25; to the Zollverein, 0·04; to France, 0·02; and to Austria 0·01 per head.

(*f.*) The annual produce of tobacco reaches at least 12,000,000 centners, of which North America sends 2,000,000; Austria, 1,000,000, and Germany, 560,000. The total value represents 240,000,000 florins. The consumption per head is of 3·0 customs lbs. in North America; 2·3 Austrian lbs. (pfund) in Cuba; 2·8 in Austria; 3·1 in Germany: 4·75 in Holland; 1·5 in Italy; and 1·5 in Russia.

(*g.*) The annual crop of hops is valued at 1,413,000 centners (Russ), of which England grows 620,000; Bavaria, 200,000; Bohemia, 120,000; North America, 250,000; and Belgium, 180,000.

(*h.*) The wine produce in Europe reaches 125,000,000 of Prussian eimers* (Kolb); of which France contributes 70,000,000; Austria, 28,100,000; Spain and Italy each, 8,000,000; and Germany, 3,900,000.

(*i.*) During late years Europe and North America brewed 11,500,000,000 (11½ milliards) litres of beer per annum. The yearly consumption per head is 219 litres for Bavaria; 154 for Würtemburg; 145 for Belgium; 118 for England; 60 for Saxony; 34·5 for Austria; 14 for Russia; and 26 for North America.

(*k.*) The raw materials of manufactures throughout the world of late years are produced as follows (Neumann):—

	Centners.			Florins.
Coal	4,300,000,000 at	$\frac{1}{7}$ florins	=	616,000,000
Iron	235,000,000 at	1½ „	=	362,000,000
Cotton	26,000,000 at	30 „	=	780,000,000
Wool	12,000,000 at	62 „	=	744,000,000
Silk	22,000,000 at	10 „	=	220,000,000
Total				2,722,000,000

In 1865 the production of coal per head amounted in England to 59 centners; in Belgium, to 40; in Saxony, to 26·50; in Prussia, to 25·50; in the Zollverein, to 12; in France, to 5·4; in Austria, to 2·6; and in Bavaria to 1·5. Of late years the annual production of raw iron, per head, in England, reached 200 lbs., in Belgium and the United States, each 100 lbs.; in France, 70 lbs.; in the Zollverein, 60 lbs.; in Austria, 20 lbs., and in Russia, 13 lbs.

(*l.*) The actual currency of precious metals is valued at 8,200,000,000 worth of dollars in gold, and 10,500,000,000 in silver; at the same time hardly half is converted into money, the rest being absorbed by industry and luxury.

The credit of Europe and North America, in 1871, was represented by—

	Florins.
Foreign Trade	18,250,000,000
Bills of exchange	2,923,000,000
Deposits	1,771,000,000
Circulation (in notes)	4,234,000,000
Clearings	118,224,000,000
Effective	1,378,000,000
Total	146,780,000,000

(*m.*) Movement of commerce—In 1866, the money value of the produce of Europe was valued (the "Berggeist" for 1866)—

	Dollars.
For the mineral kingdom at	983,500,000
„ animal kingdom at	4,331,000,000
„ vegetable kingdom at	9,627,000,000
Total	14,941,500,000

Section 2.—Historical Sketch of the Commercial Lines of Communication.

The earliest regular lines were, doubtless, the navigable streams, such as the Nile, the Tigris and Euphrates; the Indus, the Oxus, and Jaxartes; the Ganges and the Chinese Hoang-ho and Yangtse-Kiang. The river valleys and basins would be the first to support a thickly-settled population, and, in process of time, they would become the meeting places of nations. The increasing traffic of civilised empires would presently demand highways, for instance, between Egypt and Arabia *via* the Isthmus of Suez, between Syria and Persia across the desert and along the Mesopotamian streams to the Indus; through Afghanistan *via* the passes south of the Hindu Kush between Persia and India, and over the Eastern Himalayas between Hindostan and Central or High Asia. The first overland route doubtless lay through the wastes east of Syria to the Levant; its

* The Austrian pfund (funto) = 1·235 English lbs. avoirdupois.
† The Austrian Customs hundredweight (Zoll-centner) = 89 lbs. (pfund or funto), or = 50 kilos.

* The Prussian eimer = 12·44 English gallons = 0·565 French hectolitres. The litre here alluded to is doubtless the French = 1·76 pint = 0·22 gallon.

stations were Palmyra and Baalbak, Tyre, and Sidon, and a Euphrates-Valley Railway will, before many years, revive the glories of these old depôts. The third great line would be the Phœnician coasting trade, along the shores of the Mediterranean to Tartessus (Tarshish), in the Bay of Gibraltar and *via* the Red Sea to Ophir (Sofala in South Eastern Africa ?) till Himilco and Hanno the Carthagenians (circâ B.C. 500) boldly struck out into the North and South Atlantic, whilst the Egyptians effected the circumnavigation of Africa. After these gigantic steps had been taken, the Greeks attempted, by their progress in arts and arms, to monopolise the commerce of the known world, and at the end of their history the Macedonians established the great central emporium, Alexandria (B.C. 332). Followed Marseilles, the daughter of Phocœa, and Rome, which again were succeeded, after their decline and fall, by the Empire of the Caliphs (A.D. 631) ; the latter connected Baghdad with Egypt and Yemen, with Sind and Hind, with Basreh (Bussora) and Bokhara, with Merv, Balkh, and Samarkand.

Still the islands of Britain, the columns of Hercules, and the mouths of the Rhine limited the world trade to the west and north-west; the Ganges to the east; Ceylon and Sofala Ophir to the south; and the Danube northwards; when Byzantium (A.D. 324), succeeded by Constantinople, extended her powerful arms along the Black Sea into Central and Upper Europe. Her traffic passed eastwards through Asia Minor to Persia, where the great road forked. The northern branch leading over the Hindu-Kush and the Himalaya Passes met the China trade on the banks of the Oxus and at Yarkhand; while an offset from the Oxus to the Caspian founded Astrachan. The southern branch, which dated from far older times, still ran to the Indus and thence ramified over Hindostan. Thus Constantinople became a grand centre, whence merchandise passing the Balkan and the Danube reached Ratisbon; while from Astrachan the Kazan road followed the Volga, and the Kiew line ascended the Dneiper.

The Crusades (A.D. 1096-1291), which caused two immense currents of humanity to collide upon the uplands of Syria, and which the civilised world during nearly two centuries, were eventually most beneficial to trade communication. The general movement of the Moslem East, bent upon repelling the West from the Holy Sepulchre, restored unexpected importance to the first overland highway between the Levant and the Persian Gulf, and opened from Northern Arabia a network of paths extending over the nearer East. The Astrachan line lost much of its preponderance chiefly through the disorders in Russia under the rule of Vladislaw I., whilst the various Tartar and Osmanli (Turkish) invasions, ending (A.D. 1398) with the capture of Dihli (Delhi) and Constantinople (A.D. 1453), also favoured the Southern lines. Hence the rise of Venice, which, after overcoming her rivals Genoa (A.D. 1381) and Pisa (A.D. 1405), was able, at a most important time, singly to take in hand the reins of Western traffic.

Venice found her fairest field of profit in Germany. Her roads, like the rails of the present day, lay over the Brenner Pass to Inspruck, and thence, as Trieste still desires, over the Fern Pass and Füssen to Kempt (Campidomia), and to Augsburg (Augusta). Here the road divided. On the left (west) it passed, *viâ* Strasburg, Metz, and Verdun, straight to north-western France; on the right it ran through Bohemia and Moravia to Silesia; whilst Vienna was fed either by the Danube or Trieste *viâ* the Semmering Pass. From the central point, Nürnberg, the trade again flowed to the left hand, *viâ* Cologne, to Amsterdam, and to the right, through Königsberg, Posen, and Dantzic.

These bifurcations of the Venetian roads northward and eastward were also travelled over in opposition by the Hanseatic League (Hansa), which, at the height of its prosperity (about A.D. 1370), contained some 66 cities. The commerce of Venice presently fell; the first blow was the discovery of the New World; the second was the triumph of Ivan II. (A.D. 1462–1505) on the Caspian Sea. He succeeded in finally repelling the Mongolian hordes who, under Gengis Khan (Jenghis Khân, A.D. 1223) and the Amír Taymûr (vulgarly Tamerlane, *i.e.*, limping Taymur),* had monopolised (A.D. 1336-1402) the northern road from Asia to Europe over the Hindu-Kush, through Samarkand and Bokhara, the latter being the capital of the Timurides. Prepared by the mathematical and geographical studies of Martin Behem (Behaim), of Nürnberg (A.D. 1430), two great explorations now took place, one branch directed westward by Columbus (A.D. 1493-1497) and by Vincente Janez Pinson and Pedralves Cabral (the discoverers of the Brazil, A.D. 1500); the other line led eastward, by Vasco da Gama, to the shores of Malabar (A.D. 1497). Both had a common object, the wealth of the Indies, and both opened up wholly new routes to the commerce of the globe. The Spaniards and Portuguese divided between them the two hemispheres; the former took possession of the gold countries, the latter of the spice regions. The oceans which wash the coasts of the world were converted into highways. Trade flowed down the channels laid open by the nations that ruled the waves, and that could at once take and keep the lion's share. Thus, within the course of a few years, the monopoly of trade passed from the hands of the Spaniards and the Portuguese successively to the Hollanders, the French, and the English. The supremacy of the Venetians and the Hanseatic League was torn from them never to be recovered. And after Lisbon, Antwerp, Amsterdam, and London had been in turn supreme as the capitals of the world's commerce, America entered into the general competition, and every trace of a central point was, so to speak, obliterated.

Hence it happened that, when the United States and Canada proved too powerful for Mexico and for Central and Southern America, the trade of the world based upon navigation fell into a straight line with one extremity at New York, the other at Calcutta, Great Britain being the half-way station. And England again, whose conquests had won, and whose garrisons had settled at the western extremity, was able in India and the further east to triumph over the rest of her European rivals. Her position was now made. For the west she was the gateway of Europe, whose commerce she could direct how and where she willed, while eastward she extended her traffic relations to Australasia. And although the introduction of steam on land and sea bore the impress of universality, it only strengthened instead of shaking the trade Empire of Great Britain. Her territorial position, aided by unlimited supplies of coal and iron, enabled her to command the hardware and cotton-marts of the globe, and thus materially to settle and to determine the great central line of universal commerce. Then, during a prolonged period of peace, came the railway network which covered Europe and North America, and the increase of machinery, emancipating man from the labour of the lower animals. Inland countries began to enjoy all those benefits of labour and inter-communication which were at one time almost reserved for the coasts. The non-maritime peoples would no longer endure the vicious circles of commercial intercourse; and the traffic of the world, after seaming continents with rails, prepared to pierce them. The Lesseps Canal (of Suez) is the first of many, to be followed by those of Corinth and Panama, Holland, and the French line which will connect the British Channel with the Mediterranean, whilst in the New World, the Central Pacific Railway already has rivals both north and south. These triumphs over Nature combined only to confirm that middle line which had already girdled the globe, and whose future development can be a growth of breadth, not of length. We still see the trade of the world gathering and crystallising about this mighty zone. Assuming London as a *point de départ*, the other links in the chain are Gibraltar,

* The word is a corruption of demir, "iron."

Malta (probably Candia in the time to come), Port Saïd, Suez, the Red Sea, (Perim), Aden, and now Socotra; India, Sumatra, China, Japan, San Francisco, the United States, New York, and London again. A multitude of feeding lines converge towards this central channel, which every year tends to gain width, and it requires no prophetic spirit to foresee that what now is one will in a few years become many. A couple of decades must compel the Old to follow the example of the New World, by extending the railway from Europe through India to China. England will then be connected by an almost straight line *viâ* Paris, Vienna, Constantinople, Baghdad, Basreh (Bussora), and Karáchi, with Calcutta, Burmah, Cochin China, Canton, Nankin, and Pekin, whilst the steady advance of Russia across the plains of Central Asia will unite by rail and canal the Black Sea with the Caspian, the Caspian with the Aral, and thus to the furthest east. These movements are simply a question of time.

Section 3.—Development of Modern Navigation.

Thus, we see, the first steps and the earliest progress of human commerce and civilisation were connected with the most economical form of transit, the great navigable river; thence they extended to the coasts, and finally they led to the development of canals and to the piercing of isthmuses. These historical facts explain the sudden and prodigious rise of ancient Greece, when first fecundated by the vivifying contact of Psammetichan Egypt, and the successive transfer of commercial empire from Greece to Rome, and from Italy to France and Great Britain. Hence also the superior condition of Europe, the quarter which has the greatest amount of coast and riverine lines, while for the inverse reason Africa is still, as she has ever been, and for countless ages will be, the most barbarous.

The following table show that:—

	Square Superficial Leagues of Land.	To Leagues of Coast.	Proportion of Square Leagues of Interior to one Linear League of Coast.
Europe contains	180,188	4,300	42
North America ,,	417,000	6,100	48
South America ,,	327,000	3,400	97
Australia ,,	162,000	1,900	99
Asia ,,	821,415	7,700	107
Africa ,,	537,980	3,500	150

Not to mention the Weser, the Ems, the Po, the Adige, the Ebro, the Guadalquivir, the Guadiana, the Tagus, the Garonne, the Seine, the Maas, the Scheldt, and the Thames, Europe is traversed by the following lines of

First-rate Streams.	Square Leagues of Basin.	Length of Course in Leagues.
Volga owning	28,840	510
Danube ,,	14,630	385
Dneiper ,,	10,600	270
Elbe ,,	2,620	171
Theiss ,,	?	180
Rhine ,,	4,030	150
Rhone ,,	1,760	140
Vistula ,,	?	130
Loire ,,	2,400	130
Oder ,,	2,100	120

And, assuming North America to be the nearest approach to European civilisation, we find the same rule prevail both as regards coasts and streams, all important factors in the sums of rapid progress. Thus its king of rivers, the Mississippi, has a basin of 61,400 square leagues, and a length of 948 leagues; and the figures of the St. Lawrence are respectively 18,600 and 430. South America is even better supplied with shores and rivers than the northern continent, and already she has progressed, despite all obstacles, beyond many parts of the older hemisphere. Central America, bounded eastward by the Gulf of Mexico, the Mediterranean of the New World was, at the time of the discovery, the only seat of an indigenous civilisation, but local causes, all due to man, have arrested her fair development.

We may, then, look upon ships as so many bridges which, spanning the seas between various continents, allow free transit to commerce, humanity, and civilisation, and upon the war-navy of a first rate nation as perhaps the greatest and most significant engine of its power. In fact, a country without a coast is a colossus without legs; a state of the highest rank must always end, under these conditions, either by conquering a seaboard, or by fusing into itself some maritime nation. We see this truth exemplified equally by the most barbarous African tribes and by the most civilised European peoples. Thus Russia covets the Bosphorus, and Germany looks with concupiscence upon Denmark.

Hence, too, we conclude that Austria cannot maintain her high and independent position without developing the comparatively small amount of coast line which belongs to her, and without adopting the measures which will be proposed below for the object of giving the greatest importance to her litoral.

The following table approximately shows the proportion of our seaboard to that of other European Empires amongst which it occupies a low rank:—

	Square Leagues of Interior.
Italy to one league of coast has	10
England (not including Ireland)	23
Spain and Portugal............	26
France	33
The German Empire	45
Austria-Hungary..............	95
Russia in Europe..............	127

Part II.

Section 1.—Trieste and her Position.

The historic importance of our port is its site at the head of the Adriatic, which, penetrating far into Southern Europe, offered a highway of water to the East even before the Mediterranean and Red Sea were united. And as Venice was the key to France, Germany, and Hungary with its adjoining countries, then little developed, so Trieste in our modern days has succeeded to the post. Moreover, the ancient Queen of the Adriatic, unless severe and costly means are taken, is threatened by a gradual and natural warping of the soil which will eventually make her, like Aquileja, an inland town.

The field of action opened to Trieste is defined by the exactest limits. Westward she communicates, *viâ* the Brenner Railway, with the Lake of Constance; Eastward the Save unites her to the Danube, and Northwards she passes through Germany to the Baltic. This vast area of some 16,000 square leagues was politically connected in the days of the Romans, the Carlovingians, and the Hohenstaufen, with the actual litoral of Trieste; she can still command it; and the shores of the Küstenland and of Dalmatia ensure her favourable position as a harbour for general commerce.

Nor must we undervalue her present development, although much still remains to be done. Estimating the annual trade of the world at a figure of 23,170,000,000 florins, half of which (15,965,000,000) appertains to Europe, we see that in 1871 Trieste contributed no less than 179,000,000 of florins, or 5 per head of population in Austria.

External commerce during the last few years has reached the following development (Neumann):—

		Per head of population.
Great Britain	(1868)	calculates 174 florins.
France	(1867)	„ 83 „
Zollverein	(1867)	„ 40 „
Belgium	(1868)	„ 248 „
Netherlands	(1868)	„ 234 „
Austria	(1871)	„ 31 „
Russia	(1867)	„ 10 „
Italy	(1868)	„ 24 „
Spain	(1868)	„ 20 „
Turkey	(1866)	„ 17 „
Sweden	(1868)	„ 35 „
Portugal	(1867)	„ 24 „
Norway	(1867)	„ 57 „
Denmark	(1863)	„ 37 „
Greece	(1863)	„ 37 „
Roumania	(1865)	„ 16 „
Servia	(1864)	„ 12 „

Which assigns to Europe an average of 52 florins.

Section 2.—Exports and Imports of Trieste.

The following table of exports and imports, valued in Austrian florins, shows the position occupied, in the general trade of Austria, by Trieste, which has doubled her transactions during the last decade:—

Year.	Austria.	Trieste.
1861	580,937,000	80,212,000
1865	648,996,000	96,898,000
1866	625,574,000	96,596,000
1867	774,819,000	105,256,000
1868	882,332,000	132,016,000
1869	923,731,000	136,372,000
1870	902,391,000	156,247,000
1871	1,123,204,000	178,893,000

This calculation conclusively proves the intimate connection between the prosperity of the empire and her principal port.

The following table shows a comparison between the exports and imports *viâ* Trieste and those that pass to and from the other confines of Austria:—

In A.D. 1871 to and from	Millions of Florins.	Per head in Austrian Florins.	Per Centage.
Saxony	341·4	9·3	30·0
Southern Germany	256·0	7·0	22·8
Trieste	178·9	5·0	15·9
Prussia	129·8	3·6	11·5
Turkey	110·8	3·0	9·8
Italy	60·9	1·7	5·4
Russia	33·6	0·9	3·0
Fiume and other Ports	7·0	0·2	0·6
Switzerland	4·7	0·1	0·4
Total	1123·2	31·0	100·0

Thus we see Trieste actually holds only the third rank in the trade of Austria, contributing hardly 16 per cent.

The table (p. 940), extracted from official sources, shows the increase of commerce both in Trieste and Austria for the 16 years beginning with 1856, the latter being taken as the *point de départ* (= 1), and the value being expressed in thousands of florins. It will be observed that this table confirms the former, showing that the trade *viâ* Trieste is less than that which passes through Saxony and Southern Germany. We deduce from it the following important facts:—

(*a.*) The traffic of Austria with the South German frontier shows the greatest increase, 1 in 1856 and nearly 6-fold (5·873) in 1871.

(*b.*) The trade of Trieste with Austria-Hungary follows; more than trebled (3·243) within the same period.

(*c.*) The commerce of Austro-Hungary evidences on the whole the satisfactory progress of 2·000, and the increase is regular, an important consideration.

(*d.*) The trade to and from all the frontiers is in constant augmentation, except that to and from Switzerland, and Fiume with other parts. We shall presently consider the important consequences of this fact; suffice it here to record that the former branch (Swiss) has fallen from 1 to 0·106, or absolutely from 44½ millions to 4$\frac{7}{10}$ millions, and the latter (Fiume) to 0·493, that is a difference between 14 and 7 millions. And from the constant and regular effect of years we must draw the conclusion that a similar decadence will be the result of not adopting the most energetic remedies.

(*e.*) Within these sixteen years the general commerce of Austria has risen in round numbers from 556 to 1,123 millions, a proportion of 1 : 2·000, whilst that to and from

	In 1856	Rose in 1871 to	
South Germany	44 millions	256 millions	(=1 : 5.9)
Saxony	27 „	341 „	(=1 : 2·3)
Prussia	79 „	130 „	(=1 : 1·6)
Russia	23 „	34 „	(=1 : 1·5)
Turkey	69 „	111 „	(=1 : 1·6)
Italy	47 „	61 „	(=1 : 1·3)
Trieste	55 „	179 „	(=1 : 3·2)

And now, turning to Trieste, we find the trade consist of the following articles of import and export; their quantities are officially given in this table:—

IMPORTS.

Cotton	27·8 millions of florins.
Oils	6·7 „
Wool	3·6 „
Coffee	3·3 „
Tobacco	5·5 „
Hides	3·2 „
Rails (iron)	3·0 „
Petroleum	2·8 „
Raw iron	2·4 „
Colonial produce, fruits, &c.	1·6 „
Meerschaum	1·5 „

EXPORTS.

Meal	8·9 millions of florins.
Refined sugar	4·9 „
Timber	4·6 „
Silk	4·3 „
Woollens	3·9 „
Merceries	2·4 „
Linen goods	2·2 „
Matches	1·1 „
Clothes	1·1 „
Paper and stationery	3·5 „
Cereals	1·6 „
Pulse	1·3 „
Fine ironware	1·5 „

A narrower examination of the principal items supplies the results given in p. 941.

GENERAL VIEW OF THE AUSTRO-HUNGARIAN FOREIGN TRADE (1856—1871).

YEAR.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863	1864	1865.	1866.	1867.	1868.	1869.	1870.	1871.	REMARKS.
Import and Export..........	556,452	531,278	583,812	561,476	565,066	580,937	588,638	606,533	623,856	643,996	625,674	766,819	888,332	923,731	902,391	1,123,204	Import and Export (precious metals included).
Progress	1	0·954	1·049	1·009	1·016	1·044	1·058	1·090	1·131	1·157	1·124	1·378	1.596	1·660	1·621	2·000	The year 1856 as *pointe de depart.*

Of these (precious metals included), were transmitted to and from—

YEAR.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863	1864	1865.	1866.	1867.	1868.	1869.	1870.	1871.	REMARKS.
South Germany.	43,598	46,776	49,932	59,705	70,699	91,174	102,300	118,069	134,107	146,930	182,432	199,455	229,652	236,078	230,850	256,056	Import and export.
	7·8	8·8	8·5	10·6	12·5	15·6	17·3	19·4	21·5	22·8	29·1	26·0	25·8	25·5	25·5	22·8	Per cent.
	1	1·073	1·145	1·369	1·622	2·091	2·346	2·708	3·076	3·370	4·184	4·575	5·267	5·415	5·295	5·873	Progress.
Saxony	150,039	160,007	160,608	164,533	183,504	166,434	157,119	148,998	160,749	171,281	151,838	215,088	240·064	249,080	239,211	341,375	Import and export.
	26·9	30·1	27·5	29·3	32·4	28·6	26·7	24·5	25·7	26·6	24·3	28·0	27·0	26·9	26·5	30·4	Per cent.
	1	1·066	1·070	1·097	1·223	1·109	1·047	0·933	1·071	1·141	1·012	1·433	1·600	1·660	1·594	2·275	Progress.
Prussia	78,926	67,006	54,633	61,706	57,225	66,400	75,810	74,516	58,435	60,844	70,971	65,662	83,119	86,443	86,338	129,822	Import and export.
	14·2	12·6	9·3	11·0	10·1	11·4	12·9	12·2	9·3	9·4	11·3	8·5	9·3	9·3	9·5	11·5	Per cent.
	1	0·849	0·692	0·782	0·725	0·841	0·960	0·944	0·740	0·771	0·899	0·832	1·053	1·095	1·094	1·644	Progress.
Russia...............	22,755	20,383	19,289	21,666	25,559	27,154	26,731	24,616	27·832	25,683	25,983	28,324	33,606	31,901	34,165	33,609	Import and export.
	4·1	3·8	3·3	3·9	4·5	4·6	4·4	4·0	4·4	4·0	4·1	3·8	3·8	3·4	3·7	3·0	Per cent.
	1	0·896	0·848	0·952	1·123	1·193	1·159	1·082	1·223	1·129	1·142	1·245	1·477	1·402	1·501	1·478	Progress.
Turkey	69,430	65,395	61,467	70,876	76,444	87,105	79,544	83,916	89,262	77,804	78,200	103,554	114,228	122,887	102,600	110,817	Import and export.
	12·5	12·3	10·5	12·6	13·5	15·0	13·5	13·8	14·3	12·1	12·5	13·5	12·8	13·3	11·3	9·8	Per cent.
	1	0·942	0·885	1·020	1·101	1·254	1·145	1,208	1·285	1·120	1·126	1·491	1·615	1·769	1·478	1·596	Progress.
Italy	47,288	40,418	67,442	54,646	44,336	29,940	29,221	30,700	31,779	32,571	9,470	38,542	45,989	50,672	43,549	60,970	Import and export.
	8·5	7·6	11·5	9·7	7·8	5·1	4·9	5·1	5·1	5·1	1·5	5·0	5·2	5·2	4·8	5·4	Per cent.
	1	0·854	1·426	1·155	0·937	0·633	0·618	0·649	0·672	0·688	0·200	0·815	0·972	1·071	0·921	1·289	Progress.
Switzerland	44,429	33,359	44,109	15,035	3,831	3,150	3,655	3,781	3,937	3,281	3,717	4,073	3,295	3,630	3,761	4,698	Import and export.
	7·9	6·2	7·5	2·7	0·68	0·54	0·61	0·62	0·63	0·51	0·59	0·53	0·37	0·39	0·41	0·41	Per cent.
	1	0·751	0·993	0·339	0·086	0·071	0·082	0·085	0·088	0·074	0·084	0·091	0·074	0·081	0·084	0·106	Progress.
Fiume, &c.	14,105	14,230	11,834	8,937	10,576	8,729	8·415	7,992	7,658	8,410	6,367	6,855	6,364	6,668	5,670	6,962	Import and export.
	2·5	2·7	2·0	1·6	1·9	1·5	1·4	1·3	1·2	1·3	1·0	0·9	0·7	0·7	0·6	0·6	Per cent.
	1	1·009	0·839	0·634	0·749	0·619	0·596	0·566	0·543	0·596	0·451	0·486	0·447	0·473	0·402	0·493	Progress.
Venice	30,721	26,405	45,918	38,806	22,384	20,549	20,149	19,671	18,897	20,291	...	...	...	...	...	...	Import and export.
	5·5	4·9	7·8	6·9	3·9	3·5	3·4	3·2	3·0	3·1	..	...	...	...	...	...	Per cent.
	1	0·859	1·494	1,263	0·728	0·669	0·655	0·640	0·615	0·660	...	...	...	...	...	...	Progress.
Trieste	55,158	57,299	68,580	65,566	70,507	80,212	86,054	84,274	91,199	96,898	96,596	105,256	132.010	136,372	156,247	178,893	Import and export.
	9·9	10·7	11·8	11·7	12·5	13·8	14·6	13·9	14·6	15·0	15·4	13·7	14·9	14·7	17·3	15·9	Per cent.
	1	1·039	1·243	1·189	1·278	1·454	1·560	1·527	1·653	1·757	1·751	1·908	2·393	2·472	2·833	3·243	Progress.

TABLE I.—COLONIAL PRODUCE AND SOUTHERN FRUITS (TEA, COFFEE, COCOA, SUGAR, SAGO, TAPIOCA, DRUGS, &c.)

In the years.	Were imported, a total in Austrian florins.	Value of imports *via* Trieste (Austrian florins).	Value of imports *via* Trieste (Austrian florins).
1851	19,654,672	11,006,546	3,714,722
1852	21,360,870	11,158,288	4,941,410
1853	28,447,604	13,444,392	7,393,129
1854	17,587,222	6,440,259	4,810,266
1855	24,196,452	8,074,690	7,984,893
1856	23,851,745	7,549,868	8,937,544
1857	20,603,797	6,549,716	7,442,141
1858	21,868,731	6,927,948	8,334,188
1859	16,689,975	5,065,155	7,949,336
1860	15,740,554	4,623,638	8,430,064
1861	15,775,664	4,630,157	8,853,062
1862	20,726,000	5,438,711	12,641,101
1863	20,893,000	....	....
1864	19,584,000	4,344,867	13,071,863
1865	20,232,000	3,934,748	14,125,081
1866	18,668,000	4,694,804	13,419,031
1867	21,020,000	4,499,371	15,934,783
1868	22,977,000	4,675,198	17,505,829
1869	23,816,000	5,220,331	17,912,260
1870	25,181,000	....	....
1871	29,270,000	6,629,747	21,734,493

The total of which, for the whole of Austria, ranges between 20 and 25 millions of florins. This table shows great decline in the prosperity of Trieste. Whilst in 1851 she imported 11 millions, and only 3·7 millions passed through Southern Germany, Saxony, and Prussia, in 1871, only twenty years afterwards, her trade declined to $6\frac{6}{10}$ millions, and that of her rival rose to 21·7 millions. But the great fall took place in 1852-53 and 1861-62, for reasons into which we will presently enter.

TABLE II.—RAW COTTON.

Imports Valued in Austrian Florins.

Year.	For all Austria.	Of which passed *via* South Germany.	Of which passed *via* Saxony.	Of which passed *via* Trieste.
1852	22,542,000	....	....	10,383,000
1854	20,665,000	....	....	6,716,000
1856	24,934,000	....	....	6,398,000
1857	23,179,000	....	....	5,742,000
1858	25,642,000	....	....	7,670,000
1859	23,950,000	....	....	6,538,000
1860	28,775,000	....	....	8,115,000
1861	35,273,000	4,798,000	15,043,000	9.256,000
1862	27,083,000	....	....	6,986,000
1863	33,539,000	....	....	5,971,000
1864	37,979,000	....	....	8,364,000
1865	38,233,000	....	....	13,215,000
1866	41,976,000	....	....	11,990,000
1867	33,120,000	5,238,000	14,841,000	9,331,000
1868	35,053,000	5,321,000	14,851,000	13,155,000
1869	33,567,000	3,875,000	14 443,000	11,955,000
1870	34,251,000	4,101,000	11,790,000	14,966,000
1871	49,377,000	3,671,000	13,249,000	27,768,000

It may be further observed that, according to the recent publications of Dr. Peez, the demand for cotton throughout Europe rose

			Millions of lbs. English avoirdupois.
Between	1846-50	to a total of	920·8
"	1851-55	" "	1,260·4
"	1856-60	" "	1,557·3
"	1861-65	" "	1,088·1
"	1866-70	" "	1,641·1
In......	1871	" "	2,286·0
"	1872	" "	1,954·3
"	1873	it was estimated at	2,073·3

And the supply of 1872 was drawn as follows:—

	Millions of lbs. English avoirdupois.
From the United States	891·8
" India	610·6
" Egypt	241·1
" Brazil	161·1
" West Indies............	49·8
Total	1,954·3

According to the same authority the port of Trieste took the following part:—

For the Year.	Exported to Austria (in Zoll-Centners.)	For transit through Germany (Zoll-Centners.)
1862	....	19,736
1863	....	26,999
1864	....	32,159
1865	....	....
1866	....	....
1867	270,550	....
1868	326,567	89,568
1869	343,375	104,361
1870	461,859	183,433
1871	775,233	....

In 1871 the cottons imported into Trieste were from—

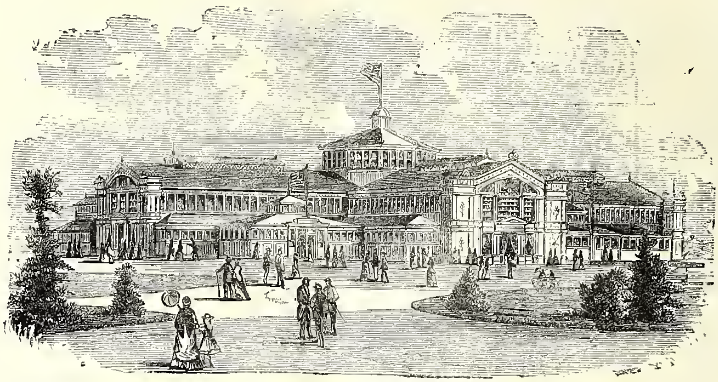
	Zoll-Centners.
India, to the extent of	307,965
Egypt " "	212,216
Turkey " "	136,809
England " "	88,141
United States "	19,978
Greece " "	4,238
Brazil " "	1,703
Other countries "	4,183
Total	775,233

TABLE III.—COFFEE.

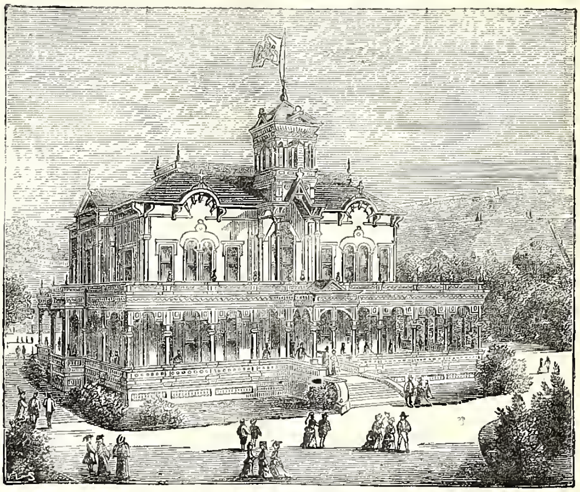
In the Year	In all Austria.	Which passed *via* Trieste.	South Germany.	Saxony.	Prussia.
	Florins.	Florins.	Florins	Florins.	Florins.
1852	8,103,000	2,860,000	966,000	2,082,000	669,000
1854	7,214,000	1,631,000	905,500	2,235,000	470.000
1856	9,858,000	1,544,000	1,859,000	3,765,000	542,000
1857	10,256,000	2,135,000	1,687,000	3,708,000	563,000
1858	11,140,000	2,049,000	1,491,000	4,641,000	800,000
1859	10 160.000	1,939,000	1,417.000	4,622,000	776,000
1860	10,407,000	2,149,000	1,242,000	4,934,000	807,000
1861	15,390,000	3,441,000	2,166,000	5,976 000	2 034.000
1862	14,325,000	2,287,000	2,638,000	5,264,000	2,649,000
1863	15,497,000	1,907,000	4,115,000	5,242,000	2,759 000
1864	15,445,000	2,330 000	4,557,000	5,487,000	1,565,000
1865	16,150,000	1,943,000	4,832,000	5,709,000	1,062,000
1866	14,681,000	2,537,000	5,428,000	4,863,000	1,493 000
1867	16,468,000	2,225,000	5,646,000	6,202,000	2,032,009
1868	17,707,000	2,007,000	5,693,000	6,705,000	2,902,000
1869	17,869,000	2,336,000	5,052,000	7,541,000	2,533,000
1870	19,575,000	2,898,000	5,952,000	7,556,000	2,810,000
1871	22,590,000	2,292,000	6,067,000	8,570,000	4,300,000

(To be continued.)

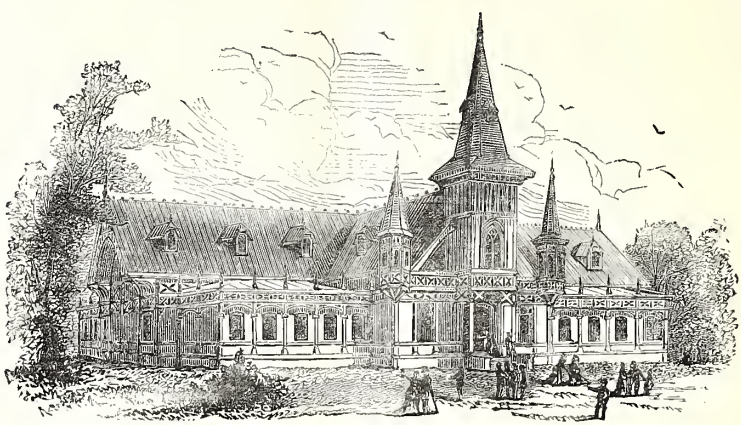
PHILADELPHIA EXHIBITION.



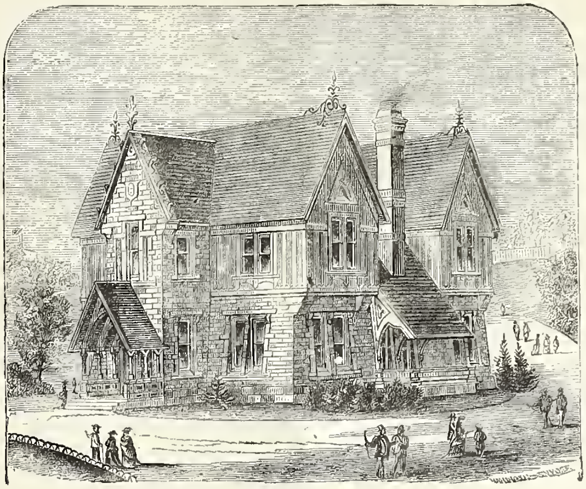
UNITED STATES GOVERNMENT BUILDING.



NEW YORK BUILDING.



PENNSYLVANIA BUILDING.



OHIO BUILDING.

NEW JERSEY BUILDING.

The above illustrations represent a few more of the buildings of the Centennial Exhibition. Those given a fortnight back were mostly foreign buildings, but the present series are all American.

The most important of these is the United States Government building, occupying about two acres of ground, and intended to contain collections adapted to "illustrate the functions and administrative faculties of the Government in time of peace and its resources as a war-power." There are besides this smaller structures for the illustration of hospital and laboratory work.

Of the State buildings, some are very characteristic, those illustrated perhaps serving to give as good an idea as any of the general characters adopted. Of course they vary in appearance, but the most picturesque appear to be those erected respectively by the New York, Pennsylvania, Ohio, and New Jersey. There are, however, others well worthy illustration did space permit.

Besides these, there is a host of smaller buildings, some intended to be permanent, but the majority only meant to last during the time for which the Exhibition is open.

Some samples of a new "Milk Food," composed of dried milk compounded with various starchy substances, arrowroot, rice, &c., have recently been submitted for examination to the Society's Food Committee, by Mr. N. W. Lobb.

MANUFACTURE OF DYNAMITE.

M. Sobrero, the discoverer of nitro-glycerine, has communicated to the Académie des Sciences the results of some experiments, which he thinks may be useful to manufacturers of dynamite.

While acknowledging the importance of M. Nobel's idea of giving to nitro-glycerine the consistency of a solid body by causing it to be absorbed by a silicious substance, so as to be more easily employed in mines, M. Sabrero has always been struck with the frequent occurrence of explosions in dynamite factories. He has often thought that these accidents, the details of which are very imperfectly known, may be caused by the manipulations which take place, either in preparing the paste of nitro-glycerine and the absorbent substance, or in moulding and compressing the paste for giving it the form of cartridges. Compression and friction against hard substances are so many causes which easily bring about an explosion of nitro-glycerine.

It seemed to M. Sabrero that these causes of danger might be avoided by modifying the manufacture of dynamite in the following manner:—The siliceous substances, of the nature of *Kiesel-guhr*, &c., although only slightly plástic, are capable of being moulded after moistening with a little water, and take a consistency which is not inferior to that of dynamite cartridges. He made some cylindrical cakes with Santa Fiora fossil meal, which after being dried at 100° Cent. (212° Fahr.), to get rid of the water, were plunged vertically into the nitro-glycerine, so as to become saturated therewith.

The experiments to determine the quantity of nitroglycerine which cakes were capable of absorbing, were not made with the liquid itself for fear of accident, but with olive oil, which is nearly of the same consistency.

The author is convinced that dynamite with 75 per cent. of explosive substance, as is generally required, may readily be obtained by his process; while, at the same time, all violent pressure or friction is avoided. The cakes, after leaving the bath of nitro-glycerine, have only to be placed to drain, and then wrapped in paper, when they are ready for use.

TEMPERING GLASS.

Some considerable time has elapsed since De la Bastie first manufactured his tempered glass and obtained his first patent. Specimens of tempered glass are, we believe, to be bought at a few shops, but at present it does not seem to have taken that prominent position which was confidently predicted for it when it was first announced, and the reporters had seen specimens and tested them in the City of London. Other patents have had to be obtained in order to secure the modifications which M. de la Bastie has introduced; but despite the fact that he has at least three rivals in the field, the efforts to introduce the new glass into commerce are very feeble and badly supported. It is unquestionable that to De la Bastie belongs the honour of first bringing the art of tempering glass to a practical issue; but his rivals seem determined to forstall him in those improvements which will make the invention commercially successful. It seems that some difficulty is experienced with the bath of grease or paraffin which De la Bastie uses for tempering his glass; and he has had to devise a means of preventing the ignition of the inflammable constituents of the bath, which means has to some extent added to the complication of his process. In the presence of this difficulty other inventors found their opportunity, and besides the process invented by Herr Siemens, of Dresden, Herr Pieper has also devised a method of tempering and hardening glass, which is so far successful that the German glass-makers have given £15,000 for the exclusive right to use it in their country. The new process consist of submitting the glass, while at a red heat, to the action of superheated steam, a process which of course effectually disposes of the difficulty and danger attendant on the use of an inflammable bath. Although the German glass-makers have purchased Pieper's patent, it does not appear that its practical success has been fully established, though it is obvious that if the superheated steam will effect the same changes in the glass as the dip into the heated oil of Bastie's bath, and effect them as rapidly, M. de la Bastie will lose that pecuniary reward which his discovery merits. The steam process, too, would appear to remove the difficulty which is found in tempering shaped articles of glass—a difficulty which Herr Siemens surmounts by making costly platinum sheaths or moulds, with which he protects the articles during the operations. Amongst the minor rivals of De la Bastie may be mention Herr Meusel, of Thüringen, who has so far modified the original process that he plunges the blown articles while still on the tube into the tempering bath, which is composed of similar substances to those employed by De la Bastie. The latter, on the contrary, shapes the articles in the ordinary way, and then re-heats them before plunging them into the tempering bath. The original process is not likely to suffer much from the competition of Herr Meusel, for it yields far better and more regular results in practice, as it is found that, however quickly the blown glass may be transferred to the bath, the portion attached to the blower's pipe or tube is so speedily cooled by the surrounding air that it is impossible to obtain the desired effects in the tempering bath.

There are several modifications of the tempering process, including the English patent of Mackintosh, under which the glass is submitted to the action of a very low temperature; but, with the exception of the processes of Pieper, Siemens, and the original Bastie, none of them seem likely to soon furnish us with a article for which there is already an inquiry, and for which there will undoubtedly be a considerable demand, if it can be supplied at a reasonable price. We believe that sheet-glass and various glass articles which have been tempered, toughened, or hardened, are to be bought in London, but at what price we do not know.—*English Mechanic.*

GENERAL NOTES.

Extinction of Fires in Theatres.—Experience having proved that the stage and scenery are the usual starting points of fires in theatres, Inspector Stehle, of the Theatre Royal, Munich, caused to be erected in the ceiling nine transverse injector tubes, working in groups of three, and capable of deluging in less than five seconds any fire that might break out. Each tube is pierced with two hundred holes arranged in eight rows. Two copper pipes establish a communication with eight large cisterns capable of keeping up the rain for ten minutes. The tubes are provided with two valves, which are always open excepting at time of repairs, and the attendant has only to turn a single cock to open the three tubes, which may be done from a side gallery away from the stage.

Re-planting of Timber in Canada.—The importance of replacing by fresh efforts extinct forests, or those which are in process of gradual removal, is receiving considerable attention in Canada. An Act of the Dominion Parliament passed last session grants an additional quarter section, on payment of a trifling fee, to every settler on Dominion lands who plants 32 acres in successive annual instalments. The Americans are waking up to the necessity for pursuing a similar policy, and on the line of the Northern Pacific much progress in tree-planting has been made. Cuttings of cottonwood, Lombardy poplar, and willow, planted within two years, are said to be from 10 to 14 feet high, while the seeds of box elder, white and red elm, hard and soft maple, and bass-wood, have yielded shoots already from three to five feet in height. The rapid growth of vegetation of all kinds in the prairie region affords every possible encouragement for this form of enterprise.—*Architect.*

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No. 1,244. VOL. XXIV.

FRIDAY, SEPTEMBER 22, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

HEALTH AND SEWAGE OF TOWNS.

The following letter has been addressed to various London and provincial newspapers by the Secretary:—

SIR,—In the general interest of public health, the Council of the Society of Arts appeal to the inhabitants of the metropolitan districts, and to the public generally, to send to the Society evidence of cases showing the various evils which have occurred from the present imperfect system of the Drainage of Houses. At the Conference on the Health and Sewage of Towns, lately held at the Society, and attended by numerous representatives from various towns and localities in the kingdom, the importance of greater attention to the House Drainage, as distinct from the sewerage, was especially brought to the notice of the Society.

It was pointed out that, however good the general sewerage might be, unless the drainage proper of the house and its connection with the sewers were carefully planned, executed under due supervision, and maintained in proper order, there was imminent danger of typhoid and other diseases, from the imperfect exclusion of sewer gas.

The Council are well aware of the extensive powers which are given by Act of Parliament to Vestries in the Metropolitan District to deal with this matter. As regards buildings erected and in course of erection since 1855, the date of the Metropolis Local Management Act, no doubt a large amount of supervision is exercised; plans of the House Drainage are frequently deposited, and are open for inspection to the ratepayers. But the powers of the local authorities are rather remedial than preventive of disease, and are more or less imperfectly exercised. The evidence already collected shows that in most of the metropolitan parishes, only a small proportion of the total number of the houses in them has been dealt with, and consequently the plans of House Drainage are, on the whole, comparatively few, even in parishes on the outskirts, where a considerable extension of building has taken place in the last few years. Neither owner, nor lessee, nor intending purchaser, as regards houses built previous to 1855, unless in some few exceptional and accidental cases, has any means of ascertaining whether the house is or is not well drained, or properly connected with the sewers, and, if defective, how or in what direction amendment is to be sought. It is with a view to remedy this admitted evil, which reduces the usefulness of the main sewers on which millions have been spent, that the Council of the Society of Arts, in the interests of improved Public Health, have taken up this question. They have already memorialised the Metropolitan Board of Works on the subject, and they propose to address the President of the Local Government Board, in reference both to the metropolis and to localities in other parts of the kingdom. The Council have sought for information and suggestions from the various metropolitan authorities having such matters in charge. They appreciate the valuable labours of these bodies, but they desire to draw public attention to what, it appears to the Council, needs further action on their parts, and they suggest that Parliament should be moved, if need be, to confer additional powers and responsibility on local authorities.

Under these circumstances the Council invite communications both as to cases of evil arising under the present state of things in the metropolis and in the country generally, as well as any suggestions for remedy, and they will be glad to receive any such communications before the 20th October next.—I am, &c.,

P. LE NEVE FOSTER, Secretary.

Society of Arts, Adelphi, London, W.C.
September, 1876.

The Kensington Vestry have forwarded the following letter to the Secretary, with a request for its insertion in the Society's *Journal*. It was addressed to the *Times* by the Medical Officer of Health for Kensington, in reply to Sir Henry Cole's letter to that paper:—

"TYPHOID FEVER IN KENSINGTON.

"SIR,—The Kensington Vestry being in vacation, it behoves me to take some notice of Sir Henry Cole's letter, published in the *Times* of the 14th inst., under the above heading. It will be remembered that Sir Henry Cole's original statement was to the effect that 'typhoid fever is chronic in South Kensington.' This statement, unsupported by a single fact, was met by the Vestry by an explicit denial, not one death from typhoid fever having occurred in South Kensington this year, and no cases of the disease being known to me, although, I may add, the records of poor-law and charitable dispensary practice are open to my inspection, and notwithstanding direct application to medical practitioners for immediate information respecting the occurrence of cases of infectious disease. Sir Henry Cole now affirms that the Vestry 'had no authority for their statement, that no death had occurred from typhoid fever in South Kensington during the present year;' and he endeavours to prove his case by figures, which I shall show to be incorrect, and by inferences that are transparently erroneous. Sir Henry Cole states that 'upwards of 24 deaths from fever, of which 16 were certified as typhoid, were registered during the 26 weeks ending the 1st July, 1876,' in the 'sub-districts of Kensington Town and Brompton, including South Kensington.' To this I reply that only 19 deaths from 'fever,' of which 13 were typhoid, were registered in the 32 weeks ended on the 12th August, in the 'sub-districts of Kensington Town and Brompton,' which include the entire parish, extending from Kensal-green in the north to the Fulham-road in the south, an area of 2,200 acres, and an estimated population of 150,000; and that only one of these deaths occurred in the Brompton registration sub-district (population 37,000) which includes the locality perfectly well known as South Kensington. Sir Henry Cole correctly states that 21 deaths from typhoid occurred in Kensington during the year 1875, but he is evidently unaware that this represents a low rate of mortality. It is equivalent to 1·4 deaths per 10,000 persons living, and to 7·5 deaths per 1,000 deaths. The rate of mortality from the same cause in the entire metropolis was 2·4 per 10,000 persons living, and 10·3 per 1,000 deaths. Thirteen deaths from typhoid fever in 32 weeks are equivalent to a mortality of only 21 deaths per annum, and thus Sir Henry Cole's statement, that the 'average death-rate from this disease is increasing,' is inaccurate. The mortality is, in fact, decreasing, the deaths in the five years 1870-4 averaging 26·6 per annum in an average population about 25,000 less than the present. It will not be out of place to state here that the general death-rate in Kensington last year was

19·4 per 1,000 persons living (18·5, after deducting the deaths of non-parishioners in the Brompton Consumption Hospital), the rate in the 'Brompton' registration sub-district heing only 16·6 per 1,000, while the rate in the metropolis as a whole was 22·5 per 1,000. The only other part of Sir Henry Cole's letter I shall notice is that in which he states that 'deaths (*i.e.*, from typhoid fever) have been occurring without the knowledge of the Vestry, or its Medical Officer,' a statement on faith of which the Vestry have been charged, nay 'convicted of shameful ignorance,' and 'indifference to the welfare of the parishioners.' On this I will only remark that the Kensington Vestry was, perhaps, the first in London to enter into an arrangement with the sub-district registrars for immediate information of deaths from infectious diseases; that all the deaths above referred to were known to me within a few hours after registration, duly reported by me to the Vestry, and published in my monthly reports, which are circulated among the Vestry, the local and the medical press.—I am, Sir, your obedient servant,

"T. Orme Dudfield, M.D.
"Medical Officer of Health to the Vestry of the
"Parish of St. Mary Abbotts, Kensington.
"Vestry-hall, Kensington, August 16th, 1876."

MISCELLANEOUS.

THE TRADE OF TRIESTE.

By Captain R. F. Burton.
H.B.M. Consul at Trieste.

(*Concluded from page* 941.)

Section 3.—*Of Trieste and her connection with the Austrian Railways.*

The following two tables show clearly the importance of the chief port of the empire:—

Table 4.

Year.	Total Length of Rail.	Exports and Imports, *via* Trieste.	Trade of Trieste per kilomètre.
	Kilometres.	Florins.	Florins.
1861..	5,626	80,202,000	14,260
1862..	5,864	86,054,000	14,670
1863..	6,003	48.274,000	14,030
1864..	6,041	91,199,000	15,100
1865..	6,397	96,898,000	15,140
1866..	63,20	96,596,000	15,210
1867..	6,602	105,256,000	15,940
1868..	7,345	132,016,000	17,980
1869..	8,234	136,372,000	16.560
1870..	9,781	156,247,000	15,980
1871..	12,099	178,893,000	14,780

Table 5.

Year.	Receipts of the Austrian Lloyd's.	Total Length of Rail.	Proportion of Lloyd's Receipts.
	Florins.	Kilomètres.	Kilomètres.
1860	6,833,513	5,161	1,324
1861	7,384,343	5,626	1,313
1862	7,870,331	5,864	1,359
1863	7,729,372	6,003	1,287
1864	8,408,853	6,041	1,392
1865	7,446,791	6,397	1,164
1866	7,535,107	6,320	1,192
1867	8,921,135	6,602	1,351
1868	9,043,971	7,345	1,231
1869	9,497,985	8,234	1,153
1870	10,401,321	9,781	1,063

Hence the intimate connection of Trieste with the railways of the empire is proved by the fact that her commerce and the receipts of the Austro-Hungarian Lloyd's vary in proportion with the extent of railways. Moreover we see that both the commerce of Trieste and the receipts of Lloyd's remain on the whole nearly equal every year, assuming as our unit of comparison the kilomètre of the existing lines. And recognising the important truth that the commercial movement practically depends, as theory suggests, upon the development of the railways in general, I would offer the following deductions:—

Table 1. (colonial produce, &c.) shows a rapid decay of this branch through its transfer to Germany. The fact is the more regretable from the port being nearer the shipping places in Italy, Turkey, Greece, Africa, Asia or South America than any German harbour. Moreover, it may easily be proved that the increase of Germany is directly *en rapport* with her lines connecting with the Austrian railways.

Table 6.

Year.	Germany Imported through Austria.	German Railways measured.	Proportion of these Imports per Kilomètre.
	Florins.	Kilomètres.	
1852	4,941,410	6,606	748
1857	7,442,144	8,991	828
1862	12,641,101	12,048	1,049
1867	15,943,783	15,679	1,016
1871	21,734,493	20,980	1,035

Here we see that every kilomètre of rail opened in Germany was an increase of competition with Austria, and served to carry off a portion of her gains in ever increasing quantities. The following table, on the other hand, shows the condition of the Austrian railways:—

Table 7.

Year.	Imports *via* Trieste.	Austrian Railways Numbered.	Imports *via* Trieste.	
			Per League.	Per Kilomètre.
	Florins.	Kilomètres.	Florins.	Florins.
1852	11,158,288	216·9	51,444	6,778
1857	6,569,716	366·3	17,932	2,363
1862	5,438,711	683·7	7,955	1,048
1867	4,499,371	825·9	5,448	717
1871	6,629,747	1533·0	4,325	569

This statement proves that the Austrian railways not only have not cultivated the field; they have also, contrary to every principle of political economy, neglected it more and more every year. Yet this trade, which includes spices, is diffused throughout the country, and enters into the national life.

To illustrate this truth I may further point out that the rapid transfer to Germany (as shown by Table 1.) took place exactly at the epochs (1852-3 and 1861-2) when the Bodenbach-Prague line was opened (1851); and it was followed in 1861 by the West Bohemian and the Elizabethan, in fact when the influences of Germano-Austrian connection began. Table 3. announces tidings equally sad to Austria, and joyful to Germany, in the coffee trade, which deals with another article entering into general use, and conduces to territorial prosperity by feeding the railways.

The coffee trade at Trieste during the last 20 years has stagnated at an average import of 2,000,000 florins; whereas, during the same period, its transit through Austria has greatly increased. For instance—

via South Germany	it has risen from	1,000,000 to	6,000,000 florins.
,, Saxony	,, ,,	2,000,000 ,,	8,500,000 ,,
,, Prussia	,, ,,	700,000 ,,	4,300,000 ,,

It is notorious that the German ports, Hamburg, Bremen, and Stettin, have ousted Austria from this trade, to the damage of Trieste; and that all the merchants in Bohemia, for instance, import coffee from the south as they did twenty years ago. Moreover, the general view of Austro-Hungarian exports between 1856-1871, disposed according to the imperial frontiers from South Germany to Trieste, shows clearly the victory of the former over the latter, and the decadence of commerce *viâ* Switzerland. On this side tho trade passes through Italy and Venice, not through Trieste; on the other, the colonial commerce and that in southern fruits, as well as certain products of maritime commerce, instead of passing through our principal port, enter Austria *viâ* South Germany. This fact is shown by the following table:—

Imported via South Germany.

	Representing in 1861. Florins.		1871. Florins.	
Common silks......	85,000	..	2,378,000	
Fine ditto	1,179,000	..	8,280,000	*
Coloured ditto	128,000	..	2,839,000	
Indigo............	1,785,000	..	2,617,000	
Raw hides	454,000	..	2,462,000	
Unworked tobacco	78,000	..	1,601,000	
Petroleum	2,000	..	1,340,000	
Extract of madder, &c.	30,000	..	578,000	
Fine drugs	45,000	..	608,000	
Cochineal	102,000	..	206,000	
Fine southern fruits	3,000	..	184,000	
Fish oil	36,000	..	140,000	
Coral	..	..	119,000	
Olive oil	..	..	106,000	
Colouring earths ..	..	..	78,000	
Oil of cocoa-nut and palm...........	22,000	..	54,000	

Imported via Saxony.

	Representing in 1861. Florins.		1871. Florins.	
Petroleum and stone oils	18,000	..	6,318,000	
Common silks......	281,000	..	2,921,000	*
Dyed silks	205,000	..	1,836,000	
Raw skins and hides	537,000	..	1,860,000	
Rice	315,000	..	1,257,000	
Dye woods and their extracts	577,000	..	636,000	
Chili saltpetre	382,000	..	578,000	
Oil of cocoa-nut and palm (in casks) ..	248,000	..	475,000	
Dye-woods	350,000	..	358,000	
Cochineal	313,000	..	349,000	
Fine drugs	240,000	..	333,000	
Teas (China)	107,000	..	221,000	
Horns	..	..	124,000	
Unworked ivory ..	31,000	..	112,000	
Cocoa (chocolate) ..	61,000	..	95,000	

Imported via Prussia.

	Representing in 1861. Florins.		1871. Florins.
Petroleum	..	..	1,453,000
Raw skins and hides	405,000	..	908,000
Indigo............	252,000	..	563,000
Oil of cocoa-nuts and palm...........	347,000	..	497,000
Rice..............	55,000	..	352,000
Common drugs	87,000	..	180,000
Cochineal	57,000	..	167,000
Fine drugs	86,000	..	111,000
	84,000	..	102,000

* Under these are included articles imported by sea.

Imported via Trieste.

	Representing in 1861. Florins.		1871. Florins.
Olive oil	1,717,000	..	3,747,000
Raw skins and hides	2,460,000	..	3,240,000
Olive oil in casks	2,178,000	..	3,035,000
Petroleum, &c.	1,000	..	2,808,000
Southern fruits (fine)	1,034,000	..	1,585,000
Ditto (middling)	417,000	..	1,348,000
Indigo	48,000	..	422,000
Dyewoods	275,000	..	263,000
Extract of madder........	57,000	..	248,000
Rice	27,000	..	242,000
Common drugs	160,000	..	153,000
fine ditto	32,000	..	116,000
Madder (ground and unground), wood, and saffron	180,000	..	68,000
Precious stones	138,000	..	48,000
Chile saltpetre	43,000	..	10,000

During this period, cochineal, horns, oil (cocoa and palm), unworked ivory and coral, were either not imported at all *via* Trieste, or in such small quantities that they are omitted by official reports.

A falling off also took place in dyewoods, common drugs, madder, precious stones, and oils (rape, flax, and linseed), the latter from 258,000 to 111,000. Petroleum (1871) was imported into Austria *via* Trieste, to the value of 2,800,000 florins, and *via* Germany, 9,100,000. Indigo, *via* Trieste, represented 422,000 florins, *via* Germany, 5,200,000. Raw skins and hides, *via* Trieste, 263,000; *via* Germany, 460,000. Comparing these movements between Trieste and Germany, we must bear in mind that the former, during the Franco-Prussian war of 1871, became a highly favoured market.

From this general consideration of the commerce of Trieste, result the following special deductions:—1. The imports have materially remained behind the exports. The two together, more than trebled in 15 years (from 55,100,000 in 1856, becoming 178,900,000 florins in 1871). But the imports, which were 27,500,000 in 1856, rose only to 81,400,000 in 1871.

2. The importation of colonial goods and southern fruits, *via* Trieste, fell to one-half in twenty years, whilst *via* Germany into Austria, during the same period, they increased six fold.

3. Between 1852 and 1871, while the coffee import remained stagnant at Trieste, it quintupled *via* Germany; viz., six-fold *via* South Germany, four-fold *via* Saxony, and seven-fold *via* Prussia.

4. Between 1856 and 1871 the trade of Trieste rose only from 1·000 to 3·243, whilst the imports and exports over the whole Austrian frontier, *via* Southern Germany, from 1·000 became 5·873.

5. The imports and exports from and to Switzerland fell, during the same time, to one-tenth, that is from 1·000 to 0·106.

6. Similarly, in Fiume and other Austro-Hungarian ports, imports and exports were reduced during those years from 1·000 to 0·500.

7. The cotton importation, *via* Trieste, rose from 6,400,000 florins in 1856 to 15,000,000 florins in 1870, and to 27,750,000 florins in 1871.

8. These figures prove the intimate connection between the commerce of Trieste and the network of Austrian railways.

9. The colonial imports into Austria, *via* Germany, increase in greater ratio than tho railways, and in a lesser ratio than the growth of Austrian lines; thus the former gain ground from the latter. Let us now see how these losses, which are proved by the incontestable testimony of statistical tables, can be redeemed, and first of what has caused the evil.

A.—Defects in our Commercial Relations.

The first is carelessness in nursing the Eastern and the

inter-oceanic trade, which has never been sufficiently appreciated. Geography shows it standing before our doors, yet amidst our fancied security, we have indolently allowed others to carry off the prize. Thus we have made over our birthright to Germany, and consoling ourselves with the absolute increase, the inevitable result of economico-national life, we have forgotten that in human affairs to stand still is to retrogade.

Under this head what we have to do is clear. Persuaded that the neglect of maritime commerce must end in loss of power and influence, we are bound to cultivate direct relations with trans-oceanic markets, to watch the policy of our rivals, and seriously and industriously to extend the area of our commercial conquests. Of this necessity our merchants are not yet, it would appear, sufficiently persuaded.

B.—The Loss of Venice.

We learn from statistics far better than from political disquisitions what the lagoons of Venice were to the Empire. She was the key of West Austrian commerce, the key that opened the gate from the Adriatic to Germany, and the key of the Brenner Pass, beyond which the City of the Doges connected herself with upper Europe. And how did we cultivate in its day the commerce with Venice? We allowed the opening of the Kufstein-Innsbruck Railway (November 24, 1858), of the Verona-Bolzano (May 16, 1859), of the Brenner Pass (August 24, 1867), whilst we permitted the Piedmontese statesman, Cavour, to begin the Mont Cenis Tunnel in order to restore the greatness of Italy, which had been ruined by want of communications. Those measures were taken some 30 years before we perceived their importance. We lost Venice, in fact, by isolating her; the tie of material interests is far stronger than those of loyalty or of affection.

The lesson, then, taught by our sad experience is this. Let us do for Trieste what we neglected in the case of Venice; let us strive to recover her commercial importance, and let us determine to open the lines which she absolutely requires. These are the Predil Pass*, the Spital-Salzburg, and the Arlberg railways, to which we shall presently return.

C.—Isolation of Fiume and other Dalmatian Ports.

Here we decline entering into the private history of Austria which has led to these painful results. But we may assert that our commerce has suffered immense damage by want of that inland communication, without which the best ports are simply useless. Austria should extend, even by artificial means, the scanty litoral still remaining to her. What we require in the supreme interest of the State are railways through Istria and Dalmatia, a line from Trieste to Fiume, and from both these cities to our naval arsenal, Pola. We want Dalmatian lines directly subtending the sea-board and connecting it with the interior, with Trieste, Fiume, and Pola, and with the various railways and principal commercial centres around our neglected Adriatic province.† The locomotive, that plough of civilisation, will then clear the waste, where men now pass their time in cutting off noses and in barbarous political feuds. When Dalmatia flourishes, Austria will exercise her legitimate influence upon the conterminous peoples now demanding their independence, upon Bosnia, the Herzegovina, Servia, Turco-Croatia, and Montenegro—provinces, still trampled under the heel of the barbarous Ottoman.* This communication will be determined by the line of the Narenta river, whose mouth is now in our possession.

* This has been a disputed point for the last few years. On some future occasion further details may be given. Suffice it here to say that the Tedeschi (German party) prefer the Predil line, whilst the Italianissimi, their Italian opponents, advocate that of Laack, further East. The effect is to prevent anything being done, the great aim of the powerful Süd-bahn, which has monopolised the transit of Istria.

† The railway connection between Trieste and Fiume is a mere branch of the Süd-bahn, which sets off at St. Peter and describes an immense round. After years of struggle between Hungarian Fiume and Austrian Trieste, it was opened in June, 1873. The transit occupies six instead of two hours, and everything is done to render it uncomfortable. Until lately the one daily train left Trieste at 8 p.m., and reached Fiume at six a.m. on the following day. Another branch of the Süd-bahn has also been made to connect Divazza (Ital., Divaccia) and Pola, *via* the Carso, with an offset from Canfanaro to Rovigno. The length is 16·238 leagues (128 kilometres and 182 metres), there is 12 intermediate stations, and the cost will be 11,497,029 florins. For the Canfanaro-Rovigno branch of 2·993 leagues (= 32 kilometres, 705 metres) is appropriated the sum of 2,039,120 florins. It was opened on the Imperial birthday, August 18th, 1876.

D.—Insufficient Communication between Trieste and the Empire.

Trieste, the main lever of maritime Austria, owes her want of development chiefly to this cause, and the insufficiency manifests itself in various relations, which may be here briefly set forth.

1. The want of concurrence where a single line, the Süd-bahn, connects our port with the inner empire. That great company, whose head is a Rothschild at Vienna, and whose members extend far and wide through Europe, absolutely rules the only thread passing through the centre of Western Austria from the chief port to the capital. It can thus oppose, instead of fostering, the new lines required. It determines its own hours and prices for transit and transport; it refuses the simplest favours in the shape of excursion trains;† it beats down all opposition with its powerful interest; it is rich enough not to trouble itself with improvements, or with seeking new markets. It has, in fact, every evil of a monopoly, and the public can only complain of such *imperium in imperio;* the highest officials are in its favour, and the country suffers, under a liberal constitution, far more than it did in the pre-constitutional days. What would be said of a main-trunk line in England or France which, during the 24 hours, has only 1 express and 2 ordinary (postal) trains for passengers, the former taking $13\frac{3}{4}$ and the latter $21\frac{1}{2}$ hours (exclusive of stoppages) to cover some 595 kilometres?

The action of the Süd-bahn upon the port of Trieste has been noticed at length in another paper.‡

The Süd-bahn, in an opuscule entitled "La Concorrenza in argomento Ferroviario" (pp. 6-12), declares that, "the project of a rival line would do much harm to the country." But the injury would be only to its own tariffs. The energetic rivalry of adjoining nations, Germany and Italy, has carried off the prosperity of Trieste; the opening of the Suez Canal is again offering an opportunity of recovering her position, and finally, the competition of Austrian internal lines is the only remedy for the present state of things.

The value of competing lines is shown by the passage of colonial goods and southern fruits into the hands of Germany. The rails connecting Bremen, Hamburg, and Stettin with Austria, not only rivalled one another, but also had to contend against those of Havre, Amsterdam, Rotterdam, and Trieste. Hence the differential tariffs which acted so efficaciously. Breslau, for instance, was called upon to pay for wool and coffee (*sic !*) 23 s. gr. 8·9 pf. per centner; for grain, 2 rix-dollars 2 s. gr. and 10 pf. per Wispel§; and normal goods, 19 s. gr. 4·4 pf. per centner dearer than Vienna, from Stettin, and *viá* Breslau. Breslau received from Hamburg, wool and coffee at 14 s. gr. 8·4 pf. per centner; grain, at 8 s. gr. 11 pf. per centner; common goods at 10 s. gr. 14 pf. per centner; goods of Class A. at 2 s. gr. 11·4 pf. per centner; and goods of Class B. at 2 s. gr. 3·4 pf. per centner,

* Written in 1873.

† This has been improved in 1876.

‡ See the *Journal of the Society of Arts*, Nos. 1,197 and 1,198, for October 29th and November 5th, 1875.

§ 12 Pfennig = 1 Silbergroschen.
30 Silbergroschen = 1 Thaler.
The Wispel is = 28·9694 English bushels.

dearer than what was paid by Vienna from Hamburg. All the ingenuity of "Meister Michaelis" was required to stay the storm aroused by neglecting the intermediate German places, such as Magdeburg, Berlin, Breslau, Dresden, and Cologne. These assertions are luminously proved by the statistics of commercial development *viâ* Germany, and the same figures furnish a sufficient answer to pp. 14 and 15 of the Süd-bahn's opuscule.

2. The want of railroads to the north and west of of Austria. The network of the Austro-Hungarian lines shows that the country, lying left of an imaginary connection between Trieste and Linz, cannot be reached from the former except by long and vicious arcs of circles; hence the direct result that trade has passed, to our loss, into the hands of Italy and Germany, whereas it was in ours during the days of transporting merchandise by the rolling roads common to the three nations. In order to recover for Austria the maritime commerce with Bohemia, South Germany, the Lake of Constance, and North-eastern Switzerland we require the following three lines:—

(*a*.) The Predil or northern line, which shortens the Trieste-Villach section by 13½ leagues; this railway is absolutely necessary, whereas that of Laack should be positively rejected. The latter would be a mere parallel running alongside of the Süd-bahn, and serving only local interests.

(*b*.) The Salzburg "Tauern" (Tauri) line, now in course of construction, will continue the Predil, and place Salzburg, *via* the Brenner (which has been opened for the benefit of Italy), at 56½ leagues from Trieste instead of 70 leagues *via* Vienna.

(*c*.) The Arlberg, or north-western, is the shortest from Trieste to Northern Switzerland, the Rhine, and Southern Germany. Moreover it places the "Vorarlberg," an important and distant part of the empire, in direct communication with Vienna and the sea. Thus Trieste-Bregenz will be able to contend against Genoa-Schaffhausen. The Arlberg line will claim from that of the St. Gothard the maritime commerce of Bavaria and a part of Wurtemberg. The tunnel beyond the Arlberg will form the equivalent offered by the spirit of the age for the loss of Lombardy, and will restore the economico-political preponderance which was forfeited with Venice. The piercing of the St. Gothard, so much in favour of Genoa, also concerns Austria. And, finally, the connection of the Empire with the Vorarlberg is politically of the highest importance. This district of 45 square leagues and 100,000 souls, has been subject, since the 15th century, to the Austrian reigning house.

Every delay in opening these three lines is to us a loss of imports, wealth, and political weight. Commerce has ever guided invading armies into the interior as well as to the exterior of nations. The subjects of a State have equal rights in not being left isolated and unprotected. It is incredible, especially in an age depending solely on communications, that a nation, which lavishes millions upon its armies, should not see the necessity of being able to throw them, in case of need, upon the parts where they are mostly wanted. As regards the funds required, a difficulty which we are far from undervaluing, they would be distributed over the number of years occupied by the works, and the outlay of capital would eventually bring the highest interest. In war, financial questions are subordinate to the principle of union; and this, even in peace, must at most times be held paramount.

It is to be considered, then, that these primary lines are of the first importance, and it is lamentable to see them neglected when the secondaries are taken in hand. This proceeding, if persisted in, will prove highly injurious to the national wealth and ability of paying taxes, to the development of the coasts, to the political weight, to civilisation and progress, and finally, to the integrity of the Empire.

Section 9.—Economical Value of Railways.

It is too often asserted that Austria is sufficiently rich in railways—even too rich—for her financial condition; consequently that expensive additions like those advocated above would not advance her interests.

This fallacy is refuted not only by the indispensable want of the lines in question, but also by general considerations by comparisons with other States *(a)* and *(b)* by absolute figures.

(a).—Comparative Extent of Railways in 1871.

	Kilomètres of railways per million souls.	Kilomètres per square league.
England	800	4·29
Belgium	621	5·69
Switzerland	588	1·95
Germany	522	2·12
Denmark	486	1·26
France	485	1·84
The Netherlands	425	2·51
Sweden and Norway	383	0·16
Austria	330	1·05
Spain and Portugal	295	0·56
Italy	240	1·19
Russia	205	0·14
Turkey and Greece	60	0·10

Thus considered, Austria ranks ninth in the list, both as regards number of inhabitants and territorial area. The comparison proves that her people will have hard work, distributed over many years, before they can arrive at the development of their neighbours which has proved so injurious to them.

(b).—Figures showing the Economical Value of Railways.

We may say of railways what has been said of war, namely, that they should be self-nourishing and self-supporting. Hence, the statician Baxter showed that the influence upon all the fields of human industry can be established by figures, the latter expressing the relations that exist, in the respective years of the same country, between the annual labour-production and commerce of a country and the length of its iron lines. This connection of work and transit, though, in a multitude of exceptions, not to be verified with exactitude, still shows itself sufficiently clearly to form a general rule. The following figures, it must be noted, reproduce only the final results and the most striking aspects of commerce.

The value of imports and exports per English league, in pounds sterling, represents the following comparison, with existing railways and canals.

In France.

1840	£9,985
1845	11,358
1850	10,750
1855	15,712
1860	17,476
1865	18,518

In England.

1833	£21,375
1840	22,884
1845	20,959
1850	16,006
1855	21,098
1860	25,985
1865	28,341

In the United States (Railways only).

1830	£5,310
1844	4,437
1850	5,102
1855	4,778
1860	4,568

The value of imports and exports to and from Austria-Hungary, per kilometre of railway, was, in

	Florins (Austrian currency).
1861	103,278
1863	101,038
1865	100,687
1867	116,149
1869	112,185
1871	92,834

The production of coal and lignite in Prussia, per kilomètre of railway, was, in—

	Centners.
1848	39,007
1852	44,091
1856	56,593
1860	51,064
1864	71,848
1868	59,390
1871	55,487

The production of coal in France per kilomètre of railways, was in—

	Metrical centners.
1859	8·238
1861	9·306
1863	8·898
1865	8·323
1867	7·861
1869	7·652

The production of coal in Austria per mile (league) of the existing railways, was in—

	Centners.
1860	91·852
1862	104·714
1864	103·731
1866	102·938
1868	127·066
1870	131·327

The production of coal in England per English league of railways, was in—

	Customs Zoll.-centners.
1854	160·200
1856	152·718
1858	136·004
1865	148·560
1867	147·508
1869	144·602
1870	148·164

The transport of coal in Zollverein centners was as follows:—

In	Per square league.	Per kilomètre of railway.	Per head of population.
England (1870)	394,000	92,600	70·5
Prussia (1871)	103,900	55,500	26·6
France (1869)	27,000	15,300	7·2
Austria - Hungary (1870)	12,800	14,700	4·0
Bohemia only (1870)	78,800	50,100	14·5

The production of salt in the Zollverein per kilomètre of railways, was in—

	Zoll-centners.
1863	654
1864	744
1865	656
1866	704
1867	706
1868	718
1869	739

The cotton imports of England per English league of railways, was in—

	Bales.
1863	49·3
1864	54·0
1865	53·6
1866	58·6
1867	56·2
1868	60·1

The importation of eggs in England per English league was in—

1850	25,400
1855	17,600
1861	18,700
1862	20,110
1863	21,660
1864	26,150
1865	27,400
1866	31,600

The importation of eggs from France to England per kilomètre of French railway was in—

1862	16,200
1863	18,600
1864	21,980
1865	24,700
1866	24,000

The imports and exports of swine in Austro-Hungary, according to kilomètres of railway was, in—

	Head.
1867	99
1868	115
1869	112
1870	90
1871	69

The production of raw iron in France, per kilomètre of railways was, in—

	Zoll-centners.
1867	1,450
1868	1,480
1869	1,580

The export of raw iron from Scotland, per English league throughout Great Britain, was, in—

	Tons.
1861	24·5
1865	27·4
1870	27·8

The production of beet sugar in the Zollverein, per kilomètre of German railways, was, in—

	Zoll-centners.
1860	3,102
1862	2,630
1864	3,043
1866	2,938
1868	2,488
1870	2,760

The importation of distilled liquids into Austria, per kilomètre of railways was, in—

1867	1·88
1868	1·87
1868	1·72
1870	1·64
1871	1·66

The number of spindles employed in the linen trade, per kilomètre of railways, are as follows:—

In	1862.	1866.
England	65·3	67·1
Belgium	114·1	116·9
The Zollverein	11·4	11·6
France	40·6	41·2

The number of spindles employed in the American (U.S.) cotton trade, per kilometre of railways, were, in—

1860	106·3
1869	85·2

The export and import of made clothes in the Zolverein, per kilometre of railways, were in—

1850	80·1
1865	86·9
1866	88·3

The import and export of cotton manufactures in Austria-Hungary, per kilomètre of railways, were, in—

	Florins (Austrian currency.)
1861	9,825
1867	12,363
1868	13,169
1869	13,347
1870	10,244
1871	10,029

The importation of raw industrial minerals into Austria-Hungary per kilomètre of railways, was, in—

	Florins (Austro currency.)
1867	22·0
1868	24·5
1869	24·1
1870	24·1
1871	20·6

The value of raw minerals subsidiary to industry exported by Austria-Hungary per kilomètre of railways was in—

	Florins (Austro currency).
1864	659
1865	575
1866	635
1867	839
1868	829
1869	847
1870	715
1871	630

The exports of Italy, per kilomètre of railways, was in—

	Francs.
1865	149,434
1866	128,151
1867	149,158
1868	146,710
1869	142,449
1870	122,474
1871	170,203

Furthermore, the influence of railway development upon that of the traffic transported, and upon the cheapening of freights is shown by the following table, taken from the statistics of Prussian railways:—

Year.	The receipt in pfennigen per league		Per league of railways.	
	Per person	Per cent. per goods	Persons.	Goods.
				centners.
1844	40·7	6·8	34,470	68,618
1850	41·0	4·3	24,460	119,397
1856	41·3	3·3	28,939	398,547
1859	37·1	3·3	30,358	363,759
1862	37·8	2·9	32,417	508,670
1865	34·9	2·5	39,553	693,638
1868	33·6	2·3	42,095	686,586
1871	29·2	2·2	46,443	758,381

And the influence of railway development upon transit and traffic per every opened kilomètre was—

	Year.	Souls.	Tons of Goods.
England,	1860 =	9,737	4,893
„	1865 =	11,781	5,444
France,	1860 =	5,726	2,333
„	1865 =	6,189	2,506
Germany,	1860 =	4,331	2,171
„	1865 =	5,714	3,518
Austria,	1860 =	2,395	1,389
„	1865 =	1,195	1,645
Italy,	1860 =	——	614
„	1865 =	——	614
Belgium,	1860 =	9,832	4,917
„	1865 =	14,005	7,745
Sweden,	1860 =	1,368	364
„	1865 =	1,233	328
Norway,	1860 =	——	1,176
„	1865 =	——	1,174

The harbour trade of Great Britain per kilomètre was in—

	Tons.
1859	1,200
1860	1,239
1861	1,253
1869	1,264
1870	1,297
1871	1,443

The harbour trade of France per kilomètre was in—

	Tons.
1860	727
1862	683
1864	740
1867	667
1868	640
1869	652

Letter transit in England per English league of railways, numbered in—

	Letters.
1850	54,735
1860	54,059
1865	54,215
1870	57,096

Letter transit in Cis-Leithania per Austrian league, numbered in—

	Letters.
1869	184,002
1870	187,973
1871	177,185

Bavaria shows transport of in—

	Letters.
1855	18,170
1865	16,272
1869	18,920

Wurtemberg sent in—

	Letters.
1855	21,970
1860	28,972
1865	32,933

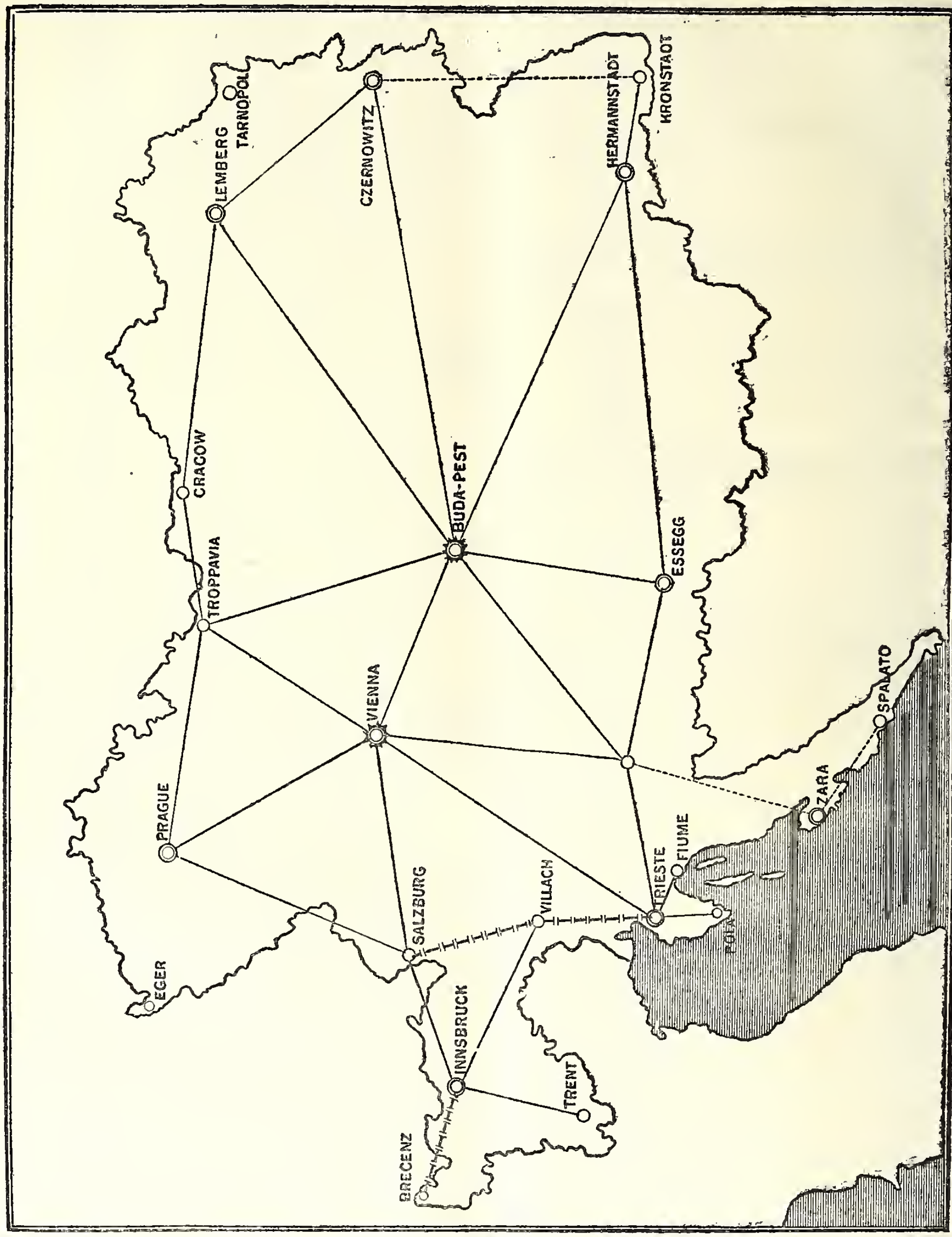
France sent in—

	Letters.
1860	28.130
1861	27,120
1865	23,380
1866	22,820
1868	21,640
1869	21,630

Despatches in Wurtemberg per kilomètre of the railways, were in—

1863	437
1865	644
1867	676
1869	569

Despatches in Cis-Leithania, per kilomètre of the railways, were in—



The Land Communications of Trieste.

1869	4,449
1870	4,537
1871	4,193

The number of members belonging to agricultural associations in Germany, per kilomètre of its railways, was in—

	Souls.
1864	4·1
1865	6·7

The rate of fire insurance, in Germany per kilomètre of railways, was in—

	Dollars.
1860	311,000
1865	349,000
1869	355,000

These figures establish in the moral, as well as the material world, the regular and proportionate working of a supreme economico-national principle; all progress being based, to use the words of Michaelis, upon "hard work full of privations." They also proclaim that labour itself is facilitated by mechanical facility of transport. The exchange of ideas and the freedom of intercourse correct the inherent defects of individuals, of families, of communities, and even of States. Inequalities are levelled by dispersing local accumulations. The fervid rivalry, and the creation of new wants, force progress on mankind; hence the growth of productions, of manufactures, of industries, of arts, of sciences—in a word, of civilisation.

Materially considered, the necessity of transit is best proved by the social state of British India, which can be

saved from her periodical desolating famines only by improved transit and transport, by canals, roads and railways.

The same figures, showing progress sometimes in lesser, but more often in equal proportions with the prolongation of the rail, assure us that railways support themselves by conferring abundant benefits upon the States who know how to foster them. After this it would be lost time to answer the assertion that Austria has done enough for the present, and may defer to future time the construction of lines, upon which her activity, intellectual and economic, depends for development.

Only when the triad of Predil, of Arlberg, and of the Tauern (Tauri) shall have restored the lost commerce of Switzerland and South Germany, and shall be followed by the Istro-Dalmatian lines; only when our main branches shall connect with those of the Principalities of Turkey—if Turkey is to be—and of Russia; then, and then only we may consider the great tracery of the Austria-Hungarian railways as progressing towards a satisfactory state. Till then we must decline to "rest and be thankful."

The sketch given on p. 952 shows the commercial and strategic connection of the three centres of the empire, Vienna, Pest, and Trieste, with the principal cities and markets. The following are the directions to which activity will extend itself:—Vienna—Trieste; Vienna—Agram (Zagabria) Novi; Vienna—Pest—Kronstadt; Vienna—Lemberg (Leopoli); Vienna—Brünn—Prague; Vienna—Innsbruck—Bregenz; Vienna—Laybach—Fiume; Vienna—Pest—Bazias; Vienna—Pest—Czernowitz; Vienna—Cracow (Krakau); Vienna—Linz—Salzburg; Vienna—Innsbruck—Trent.

Pest will have lines as follows:—Pest—Trieste; Pest—Trent; Pest—Bazias; Pest—Czernowitz; Pest—Cracow; Pest—Salzburg; Pest—Agram, Fiume; Pest—Ersegg; Pest—Kronstadt; Pest—Lemberg; Pest—Prague; Pest—Bregenz.

And finally Trieste, the important harbour for whose benefit these pages are written, will have the following lines radiating from her:—Trieste—Innsbruck—Bregenz; Trieste—Villach—Salzburg; Trieste—Linz—Prague; Trieste—Vienna—Cracow; Trieste—Pest—Lemberg; Trieste—Agram—Czernowitz; Trieste—Essegg—Kronstadt; Trieste—Pola—Fiume.

The latter prolonged to Ogulin, Zara, and Spalato.

P.S.—Nearly three years have elapsed since these lines were written; something has been done to foster the trade of Trieste, but much more remains undone. The year 1875 is an improvement upon that preceding it, but the results do not equal those of former years, and it would appear that the retrograde movement which has continued, almost without interruption, since early in 1870, is likely to become chronic. The usual phrases about the "effects of the crisis" do not apply to Trieste. Long before the "krach" of 1873 her business began to decline, and the monetary panic has left no traces to explain the manifest and continuous falling-off of her commerce even in 1875, which passed without any particular disturbing influences. The chief port of Austria is not a great industrial centre, and the general increase of business in the Austria-Hungarian empire, contrasting with the decline of Trieste, can be explained only by the causes adduced in this paper.

Thus, while Trieste is declining, Fiume, the Hungarian port to the south-east, and Venice, on the west, show improvements, resulting in both cases from increased facility of transit and traffic. Fiume is now connected with the rest of the empire by two distinct lines, the Fiume—S. Peter and the Fiume—Carlstadt, which, however, are entirely at its service. Venice, already united to South Germany by the Brenner line, is now constructing the Ponteba Railway, and its completion next year will doubtless absorb much of the commerce that now passes through Trieste. Briefly, this emporium of the Austria-Hungarian Empire, one of the first commercial ports on the Mediterranean, is the victim of a monopoly, the Süd-bahn, which represents her only communication with the interior. As is shown in preceding pages, had a second line of railway, either *via* Predil, as proposed by the Chamber of Commerce and the so-called "retrogrades," or *via* Laack, as supported by the municipality and the self-termed "Liberals," been at once laid down after the cession of Venice, Trieste would have preserved the greater part of her trade with Switzerland and South Germany. Unfortunately, personal influence and considerations of party and politics have prevailed, and hence the injury of commercial interests in a port whose accessibility and whose central position entitle her to expect the highest degree of prosperity.

These remarks are borrowed from the "Trade Report of Trieste" for the year 1875, by Mr. Vice-Consul Brock, and the reader is referred to that able paper for the figures which form the facts stated above.

Trieste, August 5, 1876.

PATENT-LAW REFORM.

At the recent meeting of the British Association at Glasgow, a paper was read "On Recent Attempts at Patent Legislation," by Mr. St. John Vincent Day. In the discussion which followed, Mr. F. J. Bramwell spoke at some length. He began by saying the Lord Chancellor himself, in bringing forward his Bill, had assured the House that he was not a strenuous advocate of Patent-law. It appeared in the highest degree undesirable a Bill should be brought forward for the amendment of a law by an officer of the Crown who, at the very time of bringing it forward, expressed his indifference to the existence of any such law at all; and it was not to be wondered at if the Bill, produced under such auspices, was, in the opinion of those who are earnestly desiring the maintenance of a Patent-law, a Bill calculated to defeat rather than to promote that object. Not only was it the opinion of those who were in favour of a Patent-law that the Lord Chancellor's Bill of last Session, and still more the Chancellor's Bill of the previous Sessions, was calculated to destroy patents, but that was the opinion likewise of those who were avowed opponents of a Patent-law. In the 1875 Bill of the Lord Chancellor, there was a provision which showed conclusively that the framer of the Bill had either framed it without employing due consideration, or, if he had employed due consideration, had, as a result of that employment, come to one of the most extraordinary conclusions ever arrived at in a Bill treating of patents for inventions. That was the clause which directs the examiners to consider and report whether the invention in respect of which protection was sought was one entirely new, or whether it was made up wholly or in part of known arrangements or contrivances, and if it appeared that the invention was made up in part of old arrangements or contrivances, then a shorter term was granted for the existence of the patent. Now, every invention, no matter how important or how novel, is made up of old things, and it appears as unreasonable to refuse a patent to an inventor of a new and useful combination of old things, or to reduce the period of protection afforded by that patent, as it would be to refuse a copyright because the work proposed to be protected by that right was made up of the old letters of the alphabet. This particular clause was expunged from the Bill of 1876; but it showed the mind of the framer of the Bill of 1875, and also the framer of the Bill of 1876—the Lord Chancellor. If further legislation was to be attempted in respect to patents, it ought to be taken out of the hands of the lawyers. As a rule, the lawyer is not acquainted with manufacturing processes. It seems to be thought that lawyers have a special claim to dominate in patent legislation, perhaps on account of the great gravity of the legislation which arises out of patents. This notion

of excessive litigation in reference to patent matters is absolutely unfounded. An eminent barrister connected with patent litigation, when it does arise, had assured Mr. Bramwell that on an average of many years only nine patent actions or suits go to the stage of a primary decision in each year, and an examination of files of *The Times* for the year ending November, 1874, showed the accuracy of the statement which had been made. Within the last ten years there have sat a Royal Commission and a Parliamentary Committee of Inquiry upon Patent-law. That Commission and that Committee, after taking evidence from competent persons, evidence of persons of varying views, reported, and it did seem the duty of an officer of the Crown who brings forward a Bill to improve patent legislation to frame that Bill upon the basis of such reports, and not upon his mere inner consciousness, disregarding the labours and advice of others, who certainty are, in the judgment of inventors and manufacturers, more competent to deal with the subject than a lawyer, however eminent that lawyer may be. Mr. Bramwell then proceeded to the question of the examinations into novelty and frivolity. He had long had very great doubts whether it is desirable to make an examination even into novelty; but if such an examination be made, the very first care must be to appoint a sufficient number of men of scientific attainments or of good experience. This is a difficult task in itself; even when the greatest care has been taken it is certain that some mistakes will be made, and some hardships will be suffered, and we have to consider whether the advantages to be attained are sufficient to justify the risk. After all, what is the benefit to be derived from an examination into the novelty of an invention? Sometimes, it is said, it is to protect the inventor. Tho answer to that is, if you make the inventors into classes separate from the community at large, the inventor says, "For heaven's sake leave us alone; we do not need to be protected against ourselves." But others put the desirability of the examination into novelty on broader grounds. They say it is undesirable a patent should be granted for a thing which is not new, because the public may thereby be prohibited from using something which the patentee claims as his invention. The answer to this is, a patent granted for a thing which is not new is, if not void, voidable, and then in truth a very small amount of harm results. Mr. Bramwell then went on to illustrate his meaning by reference to the inventions of James Watt, Dr. Potts (the inventor of the method of driving piles by exhaustion of the air), and Dr. Siemens, all of whom he urged would, probably, have been refused a patent by the examining body. It appeared certain that we should not have an examination as to frivolity; and if we were to have examination as to novelty, that examination should be fenced with precautions to prevent an inventor being injured by a wrongful decision. It was recommended by the committee of the Society for the Amendment of the Law that a patentee should have, notwithstanding the adverse report of the examiner, a right to demand his patent if he still so pleased, but that the specification should have appended to it the decision of the examiner, and that any person bringing an action under such a patent should be compelled to give security for the costs; and that in the event of his failing, and failing on the grounds put forward by the report of the examiner, he should pay the whole costs of his opponent as between solicitor and client, and not the mere taxed costs. Some protection such as this against the mistake of novelty examiners was absolutely necessary. There were two other provisions in last year's Bill which were absolutely and obviously unnecessary in one and the same Bill. The one provision was that a patentee should be compelled to give licences to others; the other that if he did not put his invention to work within two years he should lose his patent. With respect to tho obligatory granting of licences, in the various discussions which there have been from time to time, he had reluctantly acceded to this, because he thought it would do away with the last objection of the objectors; but there must be precautions adopted here, and very serious precautions. Unless great care is taken the very object of the provision may be frustrated. Imagine the case of a person who had made an invention by which he is enabled to utilise that which had been previously a waste product; that waste product may be very small in quantity, it may only be commercially possible to utilise it as long as its price remains low. Its price would remain comparatively low if the only customer were the one patentee; but if he were compelled to licence his competitors, the price would rise, and the very industry come to an end. But in a Patent Bill containing a provision for obligatory licences it manifestly is not needed that there should be a deprivation of the patent if the invention be not put to work at all; because, when a patentee is bound to grant licences he cannot vexatiously employ a patent for purposes of obstruction; and, on the other hand, such is the very natural objection of manufacturers to adopt new processes which may render existing machinery valueless, that a patentee is not, as is ordinarily supposed, besieged by manufacturers eager to put his invention into practice; but he has to seek after the manufacturers, and then entreat that his invention may be practically worked, and the more important and widespread would be the result of the practice of the invention, the greater is his difficulty in getting into use. Take, for instance, an invention applicable to blast furnaces—a furnace costing, say, £20,000. Blast furnaces are easily put out of order by any error in management, and it is extremely difficult for the inventor of an improvement in such furnace, or in the operations connected therewith, to obtain permission, even at his own expense, to make a trial. Similarly imagine a substantive invention in connexion with ocean steamers. The proprietor of one of these steamers naturally hesitates before he will allow an experiment to be made; as, in addition to the danger to the ship, worth perhaps £100,000, failure may imperil the lives of the crew and passengers, and may involve the proprietor who had given his sanction to the experiment in loss of reputation and in ruin. It is on grounds such as these that he urged the unfairness of deprivation of a patent if not put to work within two years, even if there were not the obligatory licence clause; but with such a clause, it is manifest thero is no need whatever for the revocation clause for non-working, and no such clause would be suggested if the true object of the Bill were to encourage invention and to stimulate industry.

In conclusion, the Chairman proposed, and Mr. Bramwell seconded, the following resolution, which was put to the meeting and unanimously adopted:—"That a Committee of the Association be appointed to watch legislation with reference to patents, and to take such steps as may be deemed expedient to promote an efficient Patent-law."

The National Training School for Cookery re-opened its classes on the 18th September for the winter session.

A mineral congress has lately been concluded at Douai. The president of the congress was M. Gruner, who reviewed the future possible coal extraction of Europe. The maximum coal production of Great Britain was estimated by M. Gruner at 250,000,000 tons per annum; that of France at 30,000,000 tons per annum.

The law for the International French Exhibition for 1878 has been voted by the Senate. M. Krantz, the director, as engineer, has established his offices at the Palais de l'Industrie, and sixteen pupils of the School of Beaux Arts are executing building plans under his direction. The work of construction in the Champ de Mars is expected to begin almost immediately.

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FRIDAY, SEPTEMBER 29, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

PROGRAMME OF EXAMINATIONS FOR 1877.

The Programme for 1877 is ready, and can be had on application to the Secretary. The Society's Examinations now comprise the following divisions:—

1. Commercial Knowledge.
2. Domestic Economy.
3. Fine Arts applied to Industry.
4. Music.
5. Technology of Arts and Manufactures.
6. Elementary.

PRIZE IN INDUSTRIAL HYGIENE.

An offer of a medal in connection with this subject has been made by Mr. Benjamin Shaw, and has been accepted by the Council.

The medal will be of the value of £20, and will be awarded every fifth year. Mr. Shaw has transferred into the name of the Society a sufficient amount of Consols for the purpose.

The terms of the offer are as follows:—"For any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means."

The first award will be made in May, 1877.

Parties desiring to compete for the above prize should communicate with the Secretary of the Society of Arts. A full description of the invention or process must be given, illustrated, if necessary, by models, drawings, specimens, &c. When the invention or process is in actual work, it is desirable that this should be stated, so that the Committee may, if they think proper, have the opportunity of examining it.

The Council reserve to themselves the right of withholding the prize, in the event of nothing of sufficient merit being sent in for competition.

The latest date for receiving communications will be March 31, 1877.

In case a sufficient number of objects are sent in for competition, the Council will make arrangements to exhibit them, or a selection from them, to the public.

CANTOR LECTURES.

The first lecture of the third course of Cantor Lectures for the past Session, on "Wool Dyeing," by Mr. George Jarmain, was delivered on Monday evening, March 6th, as follows:—

Lecture I.

I have been instructed by the Council of the Society of Arts to give the present course of lectures on "Wool-dyeing," in order that students preparing for examination in this subject may have indicated to them the course of study which it is desirable for them to follow.

During the last twenty years, that is since Mr. Perkin patented the process for the production of a mauve dye from aniline, in the year 1856, the woollen-dyeing trade has experienced great changes in the modes of performing many of its operations. The introduction of a large number of new dyes, through the discoveries of chemists, has necessitated these changes.

The dyer of the present day has, therefore, been educated to the fact that he owes a considerable number of his most beautiful colours to the chemist, and he has even received lessons in dyeing from him, for Schutzenberger and Lalande have taught the indigo dyer that he can dye a piece of cloth by other processes besides that of the woad vat.

The dyer has, in fact, received so many helps from the hands of the chemist, that it is difficult to understand why he does not more frequently endeavour to make himself acquainted with the principles of the science, which he must see is more competent than any other kind of knowledge to enable him to excel in his art.

Oftentimes, when I see the skill which, with long practice and observation, enables our working dyers to produce the excellent work which they turn out, I feel persuaded that, were his practice and observation combined with correct scientific knowledge, the British working dyer need fear no rival which any country could produce. He would do well, however, to take to heart the fact that, however much practice he may have as a dyer, and however close his observation may have been, if he does not use the means to enable him fully to comprehend the nature of the operations which he is performing, he will, in the long run, be outstripped by those who have the good sense to combine theory and knowledge with practice.

On the other hand, the chemist is not always competent to give a satisfactory account of some of the ordinary processes of the dye-house, processes which seem to him but ill-adapted to accomplish the objects which the dyer has in view, but which, nevertheless, the dyer does accomplish.

Such being the case, it is very desirable that the chemist and the dyer should work hand in hand, and thus each in turn benefit the other.

Water.

This indispensable article claims our first atten-

tion. I may say that the success of the operations performed upon wool in the various processes of scouring, rinsing, bleaching, and dyeing will depend very much upon the character of the water employed. It is, therefore, of prime importance that the quality and suitability of the water for the operations intended to be carried on should be ascertained, before establishing new works or removing to others already in operation.

Having had a large number and great variety of waters to examine from time to time, in order that their suitability for woollen manufacturing purposes might be ascertained, I have arrived at the following results, which I may term limits of impurity in water suitable for wool scouring and dyeing. The water must fulfil the following conditions:—

1. It must not exceed 7 degrees of hardness by Clark's soap test, of which it should lose not more than 2 degrees by boiling for an hour, and returning the water evaporated.

2. It must not deposit a brown sediment of oxide of iron when exposed freely to the air for some hours, nor must it give a blue colouration when a few drops of a solution of red prussiate of potash are added to a portion of it.

3. A portion of the water contained in a white glass bottle, to which a few drops of a solution of logwood are added, should be coloured of a sherry colour, which may be compared with a portion of distilled water treated in the same way.

4. The water should be clear, and must not throw up a brown scum of oxide of iron or organic matter when heated up to the boil.

5. Samples of wool or woollen fabric mordanted and dyed with the colours required, should compare well with similar samples mordanted and dyed with distilled water, or any other water known to be good.

A water which fulfils the above conditions is suitable for scouring and for the dyeing of woollen colours. Any considerable departure from these conditions will be attended with unsatisfactory results, unless the water be submitted to some treatment or purification.

The actual examination of the water is performed in the following manner:—

1.—*Clark's Soap Test.*

This test gives such abundant and important information to the scourer, dyer, and steam-user, that I venture to repeat such details of it that any intelligent operative may apply it to the examination of the waters in which he is most interested. The following are the apparatus and materials employed:—

One burette divided into 50 cubic centimetres, in $\frac{1}{5}$ or $\frac{1}{10}$ cubic centimetres, stoppered.

One stand and clamp to hold ditto.

One 100 cubic centimetre measure.

One stoppered bottle, about 16 ounces capacity.

One pint of soap test.

One 16-ounce flask, fitted with a perforated cork, through which passes a glass tube $\frac{1}{4}$-inch bore, and about 4 feet long.

One 3 in. funnel and filter paper.

One retort stand, with Bunsen burner or spirit lamp.

The soap test should be bought of any operative chemist, for it is somewhat troublesome to make. Directions for preparing it, however, may be found in many of our standard text-books of chemistry. The soap test consists of a solution of soap in dilute methylated spirit, of such a strength that, when shaken up with a definite quantity of the water, it will indicate the amount of soap-destroying materials or hardening matters contained in the water. The operation is performed in this way:—

Measure out 100 cubic centimetres of the water to be tested, and pour it into the clean and empty stoppered bottle.

Fix the burette in the clamp, and pour into it the soap test up to the top mark.

Run out the soap test through the glass stopper of the burette into the bottle containing the water, in small portions at a time, shaking the bottle vigorously after each addition; continue this operation until a full lather is formed on the surface of the water, which remains covered with the lather for five minutes.

When this point has been arrived at, read off the number of cubic centimetres which have been run out of the burette, and look for the degree of hardness in the table furnished by Dr. Clarke, and which is here appended:—

Table showing the Degree of Hardness.

Degree of hardness.	Soap-test measures.	Differences as for the next degree of hardness.
0	1·4	
1	3·2	1·8
2	5·4	2·2
3	7·6	2·2
4	9·6	2·0
5	11·6	2·0
6	13·6	2·0
7	15·6	2·0
8	17·5	1·9
9	19·4	1·9
10	21·3	1·9
11	23·1	1·8
12	24·9	1·8
13	26·7	1·8
14	28·5	1·8
15	30·3	1·7
16	32·	

The first column gives the degree of hardness, the second the number of soap test measures, and the third is a useful number for determining the fractional part of the next degree—it is the denominator of a fraction of which the excess above the number indicating the nearest whole degree is the numerator.

If, as sometimes happens, 32 measures of the soap test are insufficient to produce a lather, 50 cubic centimetres of the water are taken, and 50 cubic centimetres of distilled water added, and the hardness of the mixture is determined, the double of which is the true hardness of the water.

The hardness of the water, as determined above, represents the absolute or total hardness caused by the soap destroying ingredients contained in it, which may consist of—bicarbonate of lime, bicarbonate of magnesia, bicarbonate of iron; sulphate of lime, sulphate of magnesia, sulphate of iron; chloride of calcium, chloride of magnesium; free acids, and acid salts.

The degrees of hardness are determined in terms of carbonate of lime or chalk, each degree representing one grain of carbonate of lime per gallon.

If hardening matters other than carbonate of lime are the cause of the hardness, then they are present in the following approximative relative proportions, if the whole hardness be due to these bodies respectively:—

	Equivalents.
Carbonate of lime	100 parts.
„ magnesia	84 „
„ iron	116 „
Sulphate of lime (dry)	136 „
„ magnesia (dry)	120 „
„ iron „	152 „
Chloride of calcium	111 „
„ magnesium	95 „

That is to say, 100 lbs. of chalk dissolved in a certain bulk of water will make the water as hard as if it had dissolved in it 84 lbs. carbonate of magnesia, 116 lbs. of carbonate of iron, and so on with the rest.

When water containing the bicarbonates in solution is boiled they are decomposed, carbonic acid being expelled, and they are converted into insoluble carbonates, which precipitate or form an incrustation on the vessel in which they are boiled.

It is often of great importance to the dyer and steam-user to know how much of the hardness of of the water is due to the presence of these bicarbonates.

Proceed in this way:—Pour 100 cubic centimetres of the water into a clean flask fitted with a cork and a long straight tube. Boil gently for an hour, taking care that little or no steam escapes from the top of the tube, filter back into the measure, making the bulk up to 100 cubic centimetres with distilled water if necessary, then take the hardness with the soap test, with the precautions given above. The hardness thus obtained is due to the presence of bodies other than bicarbonates, and is called its permanent hardness, and the loss of hardness by the boiling is due to the removal of bicarbonates; the hardness so lost is called "temporary."

The following example will show how the results of an examination of water by the soap test should be calculated:—

A sample of water took 29·6 cubic centimetres to produce a persistent lather, and after boiling one hour and filtering it took only 7 cubic centimetres.

Therefore—

Total hardness	=	28·5	=	14	degrees.
	=	1·1	=	$\frac{11}{18}$	$= 14\frac{11}{18}$
Permanent do.	=	5·4	=	2	
	=	1·6	=	$\frac{16}{22}$	$= 2\frac{8}{11}$
Temporary do. The difference or loss.	=		=		12 nearly.

2.—*Examination for Iron Compounds.*

These form a very objectionable impurity; for many colours cannot be dyed satisfactorily if iron be contained in the water, even in small quantity. The iron is usually present in the water in the form of bicarbonate or sulphate of the protoxide (ferrous bicarbonate or sulphate), the former being the more frequent form. When the iron is present in appreciable quantity, its presence betrays itself by the water becoming turbid when exposed to the air in an open vessel, and, after a few hours, a reddish brown sediment is found at the bottom of the vessel, the water having more or less regained its clearness. The deposit consists of the iron converted into the condition of insoluble hydrated peroxide (ferric hydrate) by the oxidising action of the air.

The iron may also be detected by adding a few drops of a solution of red prussiate of potash, which will give a blue colouration in such water. When present in small quantity, the iron may be found by boiling a portion of the water down to about one-tenth its bulk in a dish or flask; the iron, as peroxide, will then be found as a brown sediment, which may be dissolved in a little hydrochloric acid, and the above test applied to the solution.

3.—*Examination with a Decoction of Logwood.*

A decoction of logwood is an extremely delicate re-agent, showing by the various tints which it assumes the impurities contained in the water. The decoction is made by boiling about 1 ounce of logwood chips in 4 ounces of distilled water for a few minutes, allowing it to stand till quite cold, and then filtering it.

The water to be tested should be poured into the 100 cubic centimetres measure, or into a tall white glass bottle; a few drops of the infusion are then dropped into the water, and the colouration observed without stirring up the water.

The following reactions will be observed:—

Distilled water	A brown amber or sherry colour.
Water containing only—	
Calcic sulphate or chloride	Red amber becoming red brown.
Magnesic do.	Amber becoming more brown.
Calcic bicarbonate	Red claret passing to a bluer shade.
Magnesic do	Red claret becoming more blue.
Ferrous bicarbonate or sulphate	Olive black becoming blue black.
Alkaline carbonates, carbonate of potash or soda	Dark cherry.
Free acids	Light amber.

The depth of colouration is in each case in proportion to the amount of the special impurity in solution. When there is a mixture of impurities the colouration partakes also of a mixed character, but a departure from the standard of distilled water is readily recognised, and should not be considerable.

4.—*Organic Matter.*

The presence of organic matter, in quantity which would prove injurious in the woollen industry, generally betrays itself by the brown colouration which it gives to the water, or by separating as a brown scum when the water is raised to the boil. This brown substance may, however, readily be mistaken for oxide of iron, which it frequently resembles very closely in colour; a portion of it should be removed, dried, and burnt. If it be organic matter it will burn almost completely away; if it be oxide of iron, a red powder will be left.

5.—*The Dyeing Test.*

To test the water, in order to ascertain whether it may be suitable for use for obtaining any particular colours, it is advisable to dye with it in

a small way samples of the wool; at the same time, for comparison, samples should also be dyed, using distilled water, or water known to be good for dyeing, taking every precaution to use in each case the same weight of materials and dyes, and the same temperature and time; and particular notice should be taken whether any marked change of colour takes place when the goods are finally rinsed or washed off in the same water.

The particular colours to be tried will readily suggest themselves to the dyer.

These small operations are best performed in an enamelled iron pan heated over a powerful gas burner.

Having examined the water by the five operations described above, a good knowledge will have been obtained of its capabilities to fulfil the conditions required of it, and any obnoxious substances will have been detected.

Influence of the Impurities Contained in Water on the Operations of Scouring, Rinsing, and Dyeing.

1.—*Calcareous and Magnesic Impurities.*

Influence on Scouring with Soap.—These impurities, in whatever form they may be present in the water, decompose and destroy as a detergent their equivalent quantities of soap, by converting it into a lime or magnesia soap, which is insoluble and greasy, and not only non-detergent, but it adds to the difficulty of the subsequent thorough cleansing. Every pound of chalk or carbonate of lime dissolved in water destroys 10 lbs. of soap. The insoluble soap so formed cannot be washed out from the wool or fabric, to which it attaches itself with great tenacity, and is frequently very mischievous in the dye bath, producing irregularity in the reception of both mordant and dye. I have therefore mentioned 7 degrees of hardness as the furthest limit at which it will be found advisable to employ water for scouring purposes when soap has to be used.

Even during the rinsing or washing off the wool or fabric where soap has been used, the mischief is increased by the fresh water acting upon the excess of soap which has to be used to obtain a scour; this excess is also converted into insoluble soap, and is added to that already formed.

Influence on Scouring with Alkaline Carbonates and Urine. — Calcareous and magnesic salts, when heated up with alkaline carbonates, precipitate their carbonates in a powdery condition which may readily be removed by washing, but as wool generally contains a portion of natural fatty matter which forms a soapy emulsion with the alkaline carbonate, the presence of calcic and magnesic compounds interferes with the detergent action of the alkalies. The bad effects, however, are not so great as when soap has to be employed for scouring.

Influence on Mordanting and Dyeing.—Calcic and magnesic salts, when in the condition of sulphates or chlorides, appear to have no influence over the reception of either mordant or dye; waters containing them act, so far as woollen dyeing is concerned, as pure water.

When the salts are in the condition of carbonates, held in solution by carbonic acid (so-called bicarbonates), they are often exceedingly troublesome.

1. They diminish the effect of the mordant, and necessitate great care in counteracting this evil tendency by the use of an acid of tartar.

2. They produce a different shade of colour in most cases in the dye bath, and require great skill and experience to obtain uniform results.

In fact, the dyer has a host of complaints to make against these earthy carbonates, for they blue his cochineal scarlets and purples; they blue the reds of his red woods; they strengthen the colours of logwood, fustic, and bark, but at the same time, the colours lose their brightness, and the strength of colour is not permanent; they destroy his tartar, which expends itself in converting the earthy carbonates into tartrates; they act generally as a diminution of mordant.

2.—*Impurities in the form of Iron Salts (Ferruginous Waters).*

Their influence on Scouring.—With soap they act like the calcic and magnesic salts, producing an iron soap which adheres to the wool, and is more mischievous than even the lime and magnesia soaps, for it seriously affects the colours afterwards dyed upon the wool. With alkaline carbonates (soda ash, urine) the oxide or hydrate of iron is precipitated, which adheres more or less to the wool or fabric, and is a constant source of anxiety and annoyance to the dyer.

Their influence on Dyeing.—As iron compounds always have the effect of saddening colours, it is hopeless to expect to obtain any bright shades of colour when a ferruginous water is used. Even with the dark and sad shades, and blacks, the use of this description of water frequently produces unsatisfactory colours. I have often seen cloudy and rusty spots on pieces which have been dyed with such water.

3.—*Impurities in the form of Alkaline Carbonates.*

Influence on Scouring.—When the water is not also charged with earthy carbonates, the presence of these carbonates is beneficial rather than otherwise in scouring with either soap or alkaline carbonates.

Influence on Dyeing.—I know of no condition of water which is more troublesome to the dyer than this alkaline condition. In the mordanting they precipitate the bases of iron, tin, and copper salts, and of alum, and reduce bichromate of potash to the condition of yellow chromate, a much less effective mordant. They act on mordants in a similar manner to what the earthy carbonates do, but the action is sharper and more decided. Their evil influence can only be prevented by the use of an acid to neutralise the alkalinity of the water.

In the dyeing with this alkaline water the greatest care and skill are required, otherwise the colours will be affected, and in the rinsing or washing off, the colours, which may have been set right in the dye bath, will be thrown altogether wrong again by the alkalinity of the wash-water.

I repeat, I know of no condition of water which is more perplexing to the dyer than this alkalinity; and, unfortunately, it is of too common occurrence in some of the woollen districts of Yorkshire, where the dyer derives his supply from wells, or by boring into the lower beds of the coal measures, which appear to be charged with carbonate of soda.

4.—*Organic Impurities.*

Waters charged with organic matters, in sufficient quantity to give them a colour, are not suitable for bleaching wool, as they tend to stain it; but I have not met with any cases in which they have proved prejudicial for scouring or dyeing, except the organic matter be in the form of dye-waters from other works. Even the peaty waters from our Yorkshire moorlands do not seem to have any prejudicial influence on the dyeing of wool or woollen fabric; at any rate, no cases have come under my notice.

5.—*Impurities in the form of Free Acids or Acid Salts.*

I have met with two classes of these waters:—(*a*) Waters containing peaty acids. (*b*) Water running from pyritic shales near the surface, which by oxidation charge the water with sulphate of iron. On exposure, much of the iron deposits leave the water acid with free sulphuric acid. Both these waters are exceedingly injurious to steam boilers. The acids become concentrated by evaporation in the steam boiler and attack the iron plates.

A new boiler, for which the first class of water was used, had its half-inch plates perforated after three months use, and the tubes of a multitubular boiler had to be removed after using the second description of water for a few months. Both waters were entirely corrected by the addition of a little lime. They neither of them contained a trace of lime.

These waters are unsuitable for the treatment of wool. The second one decomposes soap, and liberates the fatty acids contained in it, which attach themselves to the wool in the same manner as the lime and magnesia soaps which I have already described.

PURIFICATION AND CORRECTION OF WATERS WHICH ARE TO BE USED IN THE TREATMENT OF WOOL.

The treatment of water which is required in such large quantities for the scouring and dyeing of wool and woollen cloths is always troublesome, costly, and unsatisfactory at the best, and it is advisable to avoid all such treatment when possible, by obtaining the water from another source, or even by removing to new premises where suitable water is obtainable.

In case, however, no such course is practicable, the following processes may be employed, in order that the evil effects of unsuitable water may be mitigated:—

1.—*Exposure to Air, Subsidence, and Filtration.*

When the impurities consist of matters in suspension or of bicarbonate of iron, exposure to air in a shallow reservoir, and subsequent filtration through a bed of sand, will generally be found sufficient. The iron will be oxidised and rendered insoluble, and is then capable of removal by filtration. I have seen its removal effected satisfactorily by passing the water through a bed of shoddy, which acts as a very good filter.

2.—*Treatment with Lime and Subsequent Subsidence (Clark's Softening Process).*

This treatment is only applicable to water that contains chalk, carbonate of magnesia, or iron salts in solution. The lime combines with the carbonic acid, which holds the carbonates of lime and magnesia in solution, which are thus rendered insoluble, and precipitate along with the lime added. This mode of treatment is theoretically very perfect, but there are practical difficulties in the way of treating large masses of water which render it very difficult to manage. If too little or too much lime be added, the water is often made worse, and the point at which sufficient lime has been added is not very easy to determine. If a day's consumption can be treated at one time, the proper quantity of lime to use can be determined by treating separate small quantities of the water with known but varying weights of lime, and after allowing it to subside overnight, that proportion which has softened the water most can be determined by the soap test. The quantity of water for a day's consumption should be treated with the calculated weight of lime, which should be mixed with water, and run into the reservoir, and the whole must then be agitated. This should be done at the close of the day. The carbonates will have subsided before morning. Water thus treated is very bright and clear, and if managed successfully will be found to be moderately well adapted for the treatment of wool.

3.—*Treatment with a Ferric Salt, and then with Carbonate of Soda.*

This method is well adapted for the removal of soluble organic impurities and suspended fine clay. It has been applied by Dr. Gunning with great success to the turbid waters of the River Meuse. For the treatment of 3,000 gallons, 1 lb. dry perchloride of iron is dissolved in water, and then thoroughly mixed with the bulk; 1 lb. of soda ash of 52 per cent. is then dissolved, run in, and tho whole again agitated. The hydrated peroxide of iron deposits, carrying down with it the organic impurities, common salt being the only substance left in solution.

4.—*Treatment of Permanently Hard Waters (Wanklyn's Method).*

As has already been explained, these waters contain the sulphates of lime and magnesia, which have always proved to be the most difficult of removal. Mr. Wanklyn has recently proposed to soften waters of this class by first adding bi-carbonate of soda and then lime. The bicarbonate of soda first converts the sulphate of lime into bi-carbonate of lime, and the subsequent addition of lime precipitates the bicarbonate so formed. Sulphate of soda remains in solution in the water.

I have not had an opportunity of seeing this process tried on a large scale, but I consider it likely to accomplish the end in view, if its cost should not prove to be a bar to its use.

5.—*Treatment of Hard Waters with Soap.*

If hard water must of necessity be employed for scouring with soap, it is advisable to separate the hardening matter, by mixing a sufficient quantity of a hot solution of soap with it, and then causing it to run through a filter-bed before use. The insoluble soaps will thus be separated without attaching themselves to the wool or fabric, and they may be

collected and treated with hydrochloric acid, to decompose them and separate the fatty acids, which may then be collected and reconverted into soap, by boiling them up with caustic or even carbonate of soda, and the soap thus obtained may be used again for the same purpose. Water thus treated is well adapted for the scouring of wool and woollen goods.

6.—*Treatment and Correction of Waters in the Dye-bath.*

Organic matter, oxide of iron, and often a considerable proportion of the hardening matter, may be caused to rise to the top, and may then be skimmed off, by dissolving alum in the water in the proportion of about 4 oz. per 1,000 gallons, and then raising it to near its boiling point.

In preparing waters which contain alkaline or earthy carbonates or bicarbonates, as a bath for either mordanting or dyeing, they should be treated with sufficient sulphuric acid to expel all the carbonic acid, and to neutralise any alkali which may have escaped washing out from the scour.

The use of bran is frequently serviceable in removing impurities from water in the bath.

Purification of the Refuse Waters from Woollen Mills.

In concluding my remarks on the subject of water, I beg to draw attention to the fact that the refuse-waters from a woollen manufactory contain, within themselves the elements of their own purification. At the present time, the practice is to turn these refuse-waters into the river-courses as they are done with. Sometimes mordant-baths are run out; at other times the spent dye-baths, and soap, or alkaline fluids. These mingle in the common receptacle, the river, and precipitate each other there, thus producing those black deposits which give to our streams in the woollen districts such an inky and foul appearance. I have mixed together solutions of all the substances used in our woollen industries, and find that they precipitate one another, and leave the supernatant water in a tolerably clear condition. The remedy seems to be, so far as the woollen trade affects the purity of the rivers, to run all the liquids into one common reservoir, and, after subsidence, to pass, if necessary, the supernatant water through a filter-bed into the river. The utilisation of the black muddy deposit would, I believe, speedily follow.

Scouring.

I have now to draw your attention to the cleansing of wool and woollen fabric, in preparation for its subsequent treatment in the dye-house.

Raw wools always contain a considerable amount of organic and earthy impurities. The most abundant of these is suint, a peculiar organic body containing potash. M. Chevreul gives the following as the composition of merino wool:—

Earthy matter	26·06
Suint	32·74
Greasy matter	8·57
Earthy matter fixed by the grease	1·40
Clean wool	31·23
	100·00

I am not aware that any attempt has been made in England to utilise the wool impurities. A very pure potash salt is, however, manufactured from them in France.

Scouring Materials.

The following are the detergents in use in the woollen industry:—Urine, ammonia, soda ash, soda crystals, soap (hard and soft) silicate of soda, and various compositions containing carbonate of soda.

Many manufacturers prefer to use stale urine, which contains a considerable quantity of carbonate of ammonia, a particularly mild alkali. The organic matter in the urine appears also to assist in cleansing, and it protects the woollen fibre from injurious action by alkalies.

Ammonia is also a mild alkali, and for the treatment of wool, that distilled from urine is preferred to all other kinds. The strength of ammonia is determined by taking its specific gravity by means of a hydrometer, called an ammoniameter. The one in common use in Yorkshire and Lancashire has an arbitrary scale, each degree equalling 3, water being taken at 1·000. Thus, the specific gravity of ammonia at 20 degrees equals $1·000 - (20 \times 3) = ·940$. The crude ammonia distilled directly from gas liquor frequently contains hydrocarbons and sulphide of ammonium. The former can easily be recognised by pouring some of the ammonia on a plate; after a few hours, when the ammonia has passed away, the tarry smell of the hydrocarbons will be perceptible. Sulphide of ammonium is readily distinguished by the dark colour which the ammonia gives when treated with a solution of acetate of lead, or by the blackening of a silver coin when dipped into it; the black sulphides of lead and silver being formed respectively.

The hydrocarbons act strongly on the skin of the workman, and the sulphides act injuriously on the wool.

Carbonate of soda is the most extensively used scouring agent; it enters largely into the composition of many detergents bearing fancy names. The following are the principal forms in which it is employed in the woollen manufactory:—Soda ash, containing from 30 to 52 per cent. available alkali; (oxide of sodium) soda crystals, containing 21·7 per cent. available alkali; soap ash, containing 21·7 per cent. available alkali, and a small quantity of soap, or palm oil; dry soap (good), containing $\frac{2}{3}$ carbonate of soda and $\frac{1}{3}$ soap; urine substitute, melted soda crystals.

The value of these substances as detergents is in proportion to the available alkali (oxide of sodium combined as carbonate) which they contain. Dry soap, however, contains in addition a considerable quantity of soap.

I have occasionally seen the workman gauging the strength of his soda ash liquors by means of a hydrometer; this is a foolish plan, because the salt and other impurities contained in weak soda ash add to the density of its solution, and give to it a fictitious strength.

It is important that the foreman should know what is the available strength of the soda ash he employs. I have found the following plan to give sufficiently accurate results in the hands of an intelligent workman:—

Apparatus Required. — One burette, 50 cubic centimetres in $\frac{1}{5}$; one holder for ditto; one 100 cubic centimetres graduated measure; one litre measure; one box, scales and weights to weigh to $\frac{1}{10}$ of a grain; one boiling flask; one filtering funnel and filter paper; one spirit lamp, or Bunsen burner where gas is in use; one retort or tripod stand, and a piece of wire gauze; infusion of litmus; one $\frac{1}{2}$-oz. porcelain crucible; one 4-oz. beaker glass. Most of these are included in the soap test apparatus.

Two standard solutions are required, viz., standard sulphuric acid, and a solution of caustic soda which exactly neutralises an equal volume of the standard sulphuric acid.

The acid is made of such a strength that 1 cubic centimetre of it neutralises $\frac{1}{2}$ grain of oxide of sodium (soda).

The preparation is as follows:—About 200 grains of pure carbonate of soda, or, failing that, Howard's bicarbonate, are heated to redness for an hour in the porcelain crucible over the lamp, to expel moisture, &c. When cold, weigh out carefully 171 grains of it, dissolve it in a little distilled water in the beaker, pour it into the 100 cubic centimetres measure, rinsings as well, and make up to 100 cubic centimetres with distilled water; pour into a bottle and add to it another 100 cubic centimetres of distilled water.

Every cubic centimetre of this solution contains $\frac{1}{2}$ grain of oxide of sodium, and is used to prepare an acid solution of equal strength—the standard sulphuric acid.

The acid is prepared in the following manner:—About half fill the litre measure with distilled water, pour into it 31 cubic centimetres of strong sulphuric acid, D. O. V. 170° Tw., fill up to the litre mark with distilled water, then pour into a bottle to mix it. This acid will be too strong, and will require an additional quantity of water; its actual strength, as compared with the prepared solution of carbonate of soda, must now be ascertained. Pour 100 cubic centimetres of the standard carbonate of soda solution into the boiling flask, add another 100 cubic centimetres of distilled water and a few drops of the litmus; fill the burette up to the top mark with the diluted sulphuric acid, and run it into the flask until the litmus begins to redden, then boil to expel carbonic acid; run in more of the sulphuric acid in repeated small quantities until the blue colour begins to permanently redden, boiling after each addition. When the exact point has been reached, read off the number of cubic centimetres which have been used; if, say, 94 cubic centimetres of the diluted acid have been used, then the acid of the proper strength will be made by adding 6 of water to 94 of the trial acid; in order that this mixture may be made, pour 60 cubic centimetres of distilled water into the litre measure, fill up to the mark with the trial acid, and mix as before by pouring it into a bottle. This is the standard sulphuric acid, every cubic centimetre of which neutralises half a grain of oxide of sodium, and which alone will enable the workman to test his soda ash and other materials depending for their value upon the available oxide of sodium they contain.

The process is as follows:—Weigh out 50 grains of the ash, put it into the flask with 100 cubic centimetres of distilled water, and heat until dissolved; filter; if any portion remains undissolved, wash the filter, add a few drops of litmus liquid, run in the standard sulphuric acid from the burette, and find the neutral point as before, boiling between each addition of acid until the litmus shows signs of reddening. Read off the acid taken; the number of cubic centimetres of acid required is the per-centage of available alkali contained in the soda ash examined, no calculation being required, for each cubic centimetre of the acid neutralises half a grain of oxide of sodium, and 50 grains were taken.

The operation may be shortened, and made more exact, by using a second standard solution, viz., one of caustic soda, which contains half a grain of oxide of sodium per cubic centimetre. This solution is prepared by testing with the standard acid a solution of caustic soda made a little too strong, and then diluting it to standard strength in the same manner as was done with the sulphuric acid.

To test a sample with the two solutions, weigh out 50 grains, and dissolve, with the precautions given above; measure into it an excess of standard acid, say 60 cubic centimetres, if a strong soda ash be under examination; boil until all carbonic acid is expelled, add a few drops of litmus, which will redden if the proper amount of acid has been added, then neutralise the excess of acid by running into it from the burette the standard solution of caustic soda until the red colour begins to change to blue. The number of cubic centimetres of caustic soda required to do this is a measure of the excess of acid used; the per-centage of available alkali is, therefore, ascertained by deducting the cubic centimetres of caustic soda from the cubic centimetres of standard acid used; the remainder represents the available alkali.

The following is an example:—50 grains of soda ash were dissolved in hot water and filtered into a flask, and 60 cubic centimetres of standard acid were added, and the whole boiled for ten minutes. Litmus was then added, and it was found that it required 8 cubic centimetres of standard caustic soda before the blue colour of the litmus was restored. The per-centage of available alkali was, therefore, 60 — 8 = 52 per cent.

The process given above determines the true per-centage of available alkali, and does not take account of the absurd standards which trade customs sanction in Liverpool and Newcastle.

The advantages derived from being able to ascertain the amount of alkali in a detergent are—

1. The manufacturer knows when he gets his money's value.

2. The workman knows when he is using the right quantity of materials.

Soap.—Soap consists of a fatty acid in combination with potash or soda, water, and impurities of no detergent value, or positively injurious. The value of a soap depends upon the amount and correct proportions of fatty acid and alkali. The former is determined by weighing out 50 grains of the soap, and boiling it in a beaker glass in distilled water till dissolved, adding 10 grains of solid paraffin, and then about 10 cubic centimetres of sulphuric acid, diluted in a little water; the whole is then boiled gently until the liquid clears, and the oily matter completely rises; it is then set aside till

quite cold, when the fatty acid can be removed in a cake, dried upon blotting-paper, and weighed. The weight, from which the paraffin added must be deducted, gives the fatty acid, the double of which, if 50 grains have been taken, is the per-centage.

The per-centage of soda can be obtained in the same manner as is used for soda ash. In soft soaps, which contain potash instead of soda, the potash (oxide of potassium) is obtained by multiplying what is obtained by the soda process by 1·516, or roughly calculating for potash half as much more as the soda indication. The equivalent of potash is 94, and that of soda is 62.

Silicate of Soda.—This material is coming into favour as a detergent; it cleanses wool very satisfactorily, and leaves it in a suitable condition for the reception of dyes, particularly those of the aniline colours.

Wool Scouring.

The detergents used are, soft soap for fine long wools; and for short wools, both coarse and fine, urine alone, or urine and soda ash, or soda ash alone, silicate of soda, and various mixtures of alkaline carbonates and soaps.

The best temperature for the scouring of loose wool is from 125° to 135° F.

The old-fashioned mode of scouring wool, and which gives fair results, is to work it about in a kettle or tub containing the scouring liquid, with a stick or stang, for five or ten minutes, and then lift it out upon a scray, with the stang or a fork, by small portions at a time. When it has drained upon the scray, it is then thrown into a cistern called a "wash-off," the bottom of which is fitted with perforated iron plates. Water is then run into the cistern by a five or six inch pipe entering horizontally, and when full the wool is stirred up well in it. The water is then let out from under the perforated plates by means of a clack. The washing with water is repeated two or three times. This method requires an abundant supply of water, but is in other respects economical. An improvement upon this process, very often resorted to, is to have a perforated sheet iron shell swung on a trunnion, and fixed to a crane. The shell is lowered down into the scouring pan, and the wool scoured in it; when ready it is drawn out by the crane and the wool thrown out into the wash-off cistern by tilting the shell over. The wool is washed two or three times as before. One man can scour from 500 lbs. to 600 lbs. per day by the first mode; it requires two men to scour by the perforated shell, but more work can be got through.

For certain classes of wool, in which soap is employed as the detergent, the scoured wool is passed between rollers instead of washing it.

Long stapled wools are manipulated with forks by hand in the scouring fluid.

In most large factories, however, the above processes for cleansing wool from their natural impurities have been superseded by the introduction of wool scouring machines, the first of which was invented in 1851, by Mr. John Petrie, jun., of Rochdale, who has since that time very greatly improved the machine; in fact, the latest form of it, the "Paragon," as he calls it, leaves little to be desired.

A complete machine consists of three boxes or bowls. The wool is fed into the first by a boy. In this bowl a strong scour is placed, through which the wool is forked by forks ingeniously fixed to cranks; from this bowl it is passed through rollers into the second, which contains a weaker scour; it then passes through rollers to the third, in which it is forked through running water; and lastly passes between heavy squeezing rollers and is thrown forward by a powerful fan which leaves it light and open. The wool is turned out very clean and half dry. In fact the machine performs a large amount of work in a very satisfactory manner, and the manufacturers who use them tell me that they are very much pleased with them. McNaught's and Leech's machines, each possessing special features of their own, are also spoken well of by those who use them.

Yarn Scouring.

The impurities to be removed by scouring from woollen yarns are, oil which has been used to enable the wool to be scribbled and spun, and accumulated dirt. The detergent used is a mixture of soap and ammonia, but for some descriptions of yarns cheaper alkaline liquids may be used.

It is important that the felting of the yarn should be avoided as much as possible. This may be accomplished by steeping the yarn in hot water and leaving it to cool before scouring.

The scouring is done in a wood cistern filled with the scouring fluid; the yarn is hung on sticks placed across the cistern, it is turned over frequently, and worked about in the scour, and finally wrung out. The best temperature for the yarn scour is from 140° to 150° F.

Cloth Scouring.

This is always done in a machine consisting of a bowl or cistern, and squeezing rollers placed above. The scouring materials vary with the description of cloth, soda ash, soda crystals, and soap ash being usually employed for woollen cloths. The cloth passes through the scouring liquid heated to from 150° to 160° F., and then between the rollers for some time, whereby the oil contained in the cloth is removed in the form of an emulsion by the detergent. The scour is frequently used again, after being strengthened by the addition of more alkali. The cloth is finally washed in clean running water on the machine for a considerable time. The thorough removal of all oil, soap, and grease from the cloth is very important for the subsequent dyeing, for if any remain in it, the action of the mordant is seriously interfered with.

Wool bleaching.

The mode of bleaching woollen goods in general use at the present day is of a very primitive character, there having been but little improvement in the process since the days of Pompeii, in the ruins of which, Pliny tells us, there were found traces of the art. As in those days, so now, a closed chamber, in which the goods to be bleached are hung up, is filled with the fumes of burning sulphur, and the goods left exposed to the action of these sulphurous fumes for some hours, during which time the yellow colouring matter of the wool is more or less affected, probably by the reducing action of the sulphurous acid, whereby

the colouring matter is transformed into a colourless substance. The bleaching, however, is not of a very permanent character, the colour being liable to return, especially if the goods are treated with alkaline solutions, which frequently favour oxidation. The bleaching of wool with sulphurous acid is, therefore, not so satisfactory as the bleaching of cotton with chlorine.

Chlorine is not suitable for the bleaching of wool, for it attacks and damages the fibre without bleaching it. Sulphurous acid is the only bleaching agent which has proved effective for wool. The operation is called sulphuring, or stoving. The sulphur stove is built of brick or stone, and often lined with wood, as few nails as possible being used to prevent damage from sulphate of iron, which is formed by the sulphurous acid, combined with air, acting upon the nails. The goods to be bleached are well soaped and washed, and while in a moist condition are hung up in the room. A quantity of sulphur is placed in an iron dish in the room, and a red-hot piece of iron is dropped among it; the door is then closed, and the room left undisturbed for some hours. The door is then thrown open, and the sulphurous acid gas escapes; the goods are then removed, and washed, to free them from the sulphurous acid which, if left in contact with the fibre, would become sulphuric acid by the oxidising action of the air.

Certain improvements have been suggested in the management of these sulphur chambers, having for their object economy in the use of sulphur; the more equal diffusion of sulphurous acid in the chamber, and, consequently, more regularity in its action; and, lastly, prevention of the destructive action on vegetation arising from the escape of the sulphurous acid on opening the door. In the "Moniteur de la Teinture," for 1872, an arrangement is described which is likely to accomplish this object. Sulphurous acid, produced in a sulphur burner, is forced into the chamber by means of a small steam jet, and when the goods have been exposed in the room for the proper time, the sulphurous acid is drawn out by an aspirator, and is absorbed by carbonate of soda, which it converts into sulphate of soda. An additional improvement consists of an arrangement for passing the goods through the chamber by means of rollers. The bleaching of cloth can thus be made continuous.

MISCELLANEOUS.

HEALTH AND SEWAGE OF TOWNS.

The following appeared in the *Times* of Friday last:—

A letter we published yesterday, from the Secretary to the Society of Arts, calls attention to a very important, though comparatively neglected, question in relation to public health. We have expended enormous sums of money, of late years, on the efficient drainage of towns and the proper construction of public sewers, and, no doubt, our efforts have resulted in incalculable benefit to the community at large. But while we have been directing all our energies to the task of carrying off the refuse matter which reaches our sewers, and disposing of it in a harmless, if not in a profitable, manner, we have as yet taken little thought of the means whereby the matters we want to get rid of are to be conveyed innocuously from our houses to the sewers. It is much easier to reform town drains than house drains; the former are made to be got at easily, and at the worst can always be reached at the cost of a temporary suspension of traffic. But house drains, especially in old houses, are to be found no one knows where, and even in new houses the perversity or ignorance of builders often places them where they are practically inaccessible. Out of sight out of mind is too often the easy-going maxim of builder and tenant alike, and it is frequently not till another sense is forcibly called to take cognisance of what the sight has neglected that the householder finds, to his cost, that the drains are out of order. Few builders can be trusted to make the connexions between the house drains and the public sewers satisfactorily, and, unfortunately, it is a matter which most architects seem to think beneath their notice. But even if that particular matter has been thoroughly attended to, the danger is by no means at an end. All house drains need to be ventilated, and, wherever it is possible, their connexion with the external sewer should be broken by a simple expedient, known to all builders, but, unhappily, adopted until quite recently by few or none. Thus, in too many cases, the improvement in public sewers has as yet been a bane as well as a benefit, because it has not been accompanied by corresponding attention to sanitary precautions within the house.

It cannot be too strongly insisted on that the universal extension of a general and public system of drainage in large towns calls more imperatively than ever for vigilant attention to domestic sanitary arrangements. Formerly, when every house more or less disposed of its own drainage, though matters were bad enough, yet the extent of the mischief could generally be measured. Now, however, each house, unless specially protected, is exposed to the attacks of the sewage of the whole town, and yet, as a rule, no greater precautions are taken than heretofore to keep the enemy at bay. The evils to which the unwary householder is exposed are neither few nor easy to guard against. If his house is an old one, drains are hidden away in a manner which conclusively proves that malice is no match in ingenuity for ignorance. Some of them are sure to be found with all connexions closed save that which furnishes them with a constant supply of noisome and fetid matter. Sometimes the outlet of the old cesspool is closed when the house is connected with the public sewers, but the builder has carelessly left open to the house all the old drains which formerly fed the cesspool; or the new drain is laid with a broken pipe or a defective joint, and fills the house with stench and poison. Indeed, where a house has exchanged the old system of drainage for the new, it needs an almost superhuman vigilance to guard against the various and subtle sources of future mischief; yet the task is generally left to a careless builder and to blundering workmen. In a new house the dangers are not, perhaps, so numerous nor so difficult of detection, but they are real and serious enough. The great object of builders seems to be to get the drainage out of the house in as closely-sealed channels as possible. This is a good thing with proper precautions, but they forget or refuse to acknowledge that where water can pass gas can pass too, and that while the natural flow of water is downwards, that of this particular gas is upwards. Consequently, the drains, unless ventilated as well as trapped, are so many channels whereby sewer gas is laid on to the interior of the house. Now, sewer gas has a very bad character, and for all we know its character may be worse than it deserves; that, however, is not a question for us, and the connexion of sewer gas with specific disease we are content to leave to professional experts. At any rate, all will admit that sewer gas is a very unpleasant companion in a house, more especially when a good deal of money has been paid to keep it out. Yet, with all our efforts at sanitary improvements, there are still very few houses in towns where it is not at least an occasional visitor. Builders

will insist on the efficacy of water traps and cemented pipes, and, no doubt, such expedients are good as far as they go. But, of course, gas will pass through water under sufficient pressure, and, not to speak of the pressure which the unaided gas often exerts on the outside of the trap, it is often powerfully aided from within by the difference of temperature which exists between the house and the external drains. In fact, we not only lay on the gas from the large reservoirs we have constructed in every street, but we often turn our houses into ingenious pumps to suck it in. The remedy for this is not only to trap all drains, but to ventilate them as well. If from below the trap a pipe rises to a convenient distance in the open air, the gas is forced through it whenever the pressure becomes excessive, and the trap, relieved from this pressure, becomes a protection, and not a snare. This remedy is as simple as it is effective; yet it would be interesting to know the per-centage of houses in any large town whose most noxious drain pipes are ventilated as well as trapped. Another frequent source of mischief is to be found in the arrangement of cisterns. Frequently the drinking supply of the house is furnished from the cistern, which also supplies the water-closet, and, what is still worse, the waste-pipe of the cistern is often conducted, entirely without trapping, into the nearest drain. We need not dwell on the consequences; they are unsavoury enough, even if they are not, as most sanitary authorities are agreed that they are, positively dangerous.

These are a few of the defects of domestic sanitary arrangements. We do not mean to say that they are universal, but they are at least so frequent that few householders find themselves free of them without much personal effort and worry. They spring from the fact that in old houses we have a system on hand which is obsolete, but extremely difficult to get rid of; while as to new houses, few architects or builders will give themselves the trouble to understand the subject, or intelligently to carry out the really very simple measures that are necessary to avert the evil. We wish Mr. Le Neve Foster and the Society of Arts all success in their benevolent endeavours to remedy a state of things of which all must acknowledge the evil, and many feel the inconvenience. It is obvious, however, as Mr. Foster seems to acknowledge, that the matter is one rather for private effort than for public legislation. Even the submission of plans for the drainage of new houses to competent inspection, though it might remedy some of the more obvious defects, and put a stop to a few mischievous arrangements, would have little positive result where so much depends less on skilful planning than on effective execution. What is wanted is what it is very difficult to accomplish—namely, to engage the personal attention of every householder to the sanitary arrangements of his own house. The matter is really not very difficult to understand, nor are the more immediate and necessary precautions difficult or expensive to take. We are all the victims of architects, and builders, and workmen, and we suppose we must remain so until we can all dwell in "Hygeiopolis." But if professional men will not help us, we can do a great deal to help ourselves, and it is astonishing how much can be done, with a few yards of piping and the aid of a common plumber, to render a house sweet and healthy. Mr. Foster is, no doubt, quite right in saying that good public sewers lose a great deal of their practical benefit without an efficient system of house drainage; indeed he might have gone further, and said that they are in some respects, as we have endeavoured to point out, a positive evil. But the evil may be speedily and effectively checked by a little common sanitary knowledge and a little determined effort, which, though a public benefit, is not disinterested, for it brings its immediate reward in increased comfort and security. The Society of Arts would do a great public service if, in addition to inviting public discussion of the evil and its remedy, it would lend its powerful aid in diffusing the necessary sanitary knowledge in a popular and accessible form. The great drainage question is one which is as yet far from being settled, and this particular aspect of it is one in which every householder has a direct and personal interest. Even if all new houses could be effectively drained, the danger would still beset us in our present habitations. We cordially sympathise, therefore, with the efforts of the Society of Arts, for nothing but benefit can come from a public discussion of the question, from the interest it will arouse and from the knowledge it will diffuse. We do not, however, think that the matter as yet calls for further legislative interference, and such, we gather, is also the opinion of Mr. Foster and the Society of Arts. "Every Englishman's house is his castle," as we know, and the principle is doubtless, in most respects, a good one; but if the Englishman would keep the sanitary inspector from his door, he must take his own measures, and that speedily, to drive away from his dwelling disease that can be prevented.

CORRESPONDENCE.

THE TRADE OF TRIESTE.

Sir,—In the communication on "The Trade of Trieste," in your last number, I notice what I imagine to be mistakes of a very serious character.

I suppose that England buys a larger weight of cereals than any other country, but I see it set down that England takes 80 and France 340 millions of centners of cereals. Germany and Spain are both renowned wine-growing countries, but the wines of Austria, though well known, I believe to be less important in both quantity and value. Yet I see it stated that the produce of Austria is much more than double that of Spain and Germany taken together. This may be true, but if so, it deserves to be prominently brought out.

I supposed that silk was more costly, weight for weight, than either wool or cotton, yet I see in the paper in question that cotton is three times as valuable as silk.

The "credit" of Europe and North America, whatever that expression may really signify, is stated to be represented by 177 millions sterling of deposits (1,771 million florins) and by some other heterogeneous items. I believe that in this United Kingdom alone the deposits lying in the hands of bankers exceed 500 millions sterling.

The sketch of ancient trade routes, which mentions a line "through the wastes east of Syria to the Levant," it is not said from whence; and "along the Mesopotamian streams," not to the Gulf of Persia, but "to the Indus," is necessarily so imperfect, that I doubt the utility of inserting it. I see Marseilles mentioned, but Rhodes and Corinth disregarded.

Then, on page 940, and after, we have statements showing the growth of Austrian trade *viâ* South Germany, without an indication, so far, that the alterations in the frontier might influence the matter. The utility of showing ancient trade routes is trifling in comparison with that of indicating what routes come under the titles of South Germany, Saxony, &c., if the main object be that your readers should grasp effectually the facts concerning the trade of the empire of Austria, and especially of Trieste.—I am, &c.,

Thomas A. Welton.

3, Moorgate-street, London, E.C., September 19th, 1876.

M. Meissonier, the Inspector-General of Mines to the French Government, has called the attention of the *Academie* to the existence in Spain of a nickel ore similar to that of New Caledonia. The deposit is situate in the province of Malaga, and has already produced some hundred tons of ore. Analyses made at the School of Mines proved that it contains from 8 to 10 per cent. of metal; that is to say, a little less than the samples from New Caledonia. It contains, however, no trace of cobalt.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The Michaelmas Term commenced on Thursday, the 28th ult., with seventy-one scholars.

The Nottingham Sacred Harmonic Society's Scholarship was competed for on September 26th, and has been awarded to Miss Ada Thacker.

Mr. Ernst Pauer's Lectures on the "Æsthetics of Music" will commence on the 11th inst., in the West Theatre of the Albert-hall. These lectures will be delivered to the whole body of students.

The Duke of Westminster, K.G., will preside at a meeting to be held at Rhyl, North Wales, on the 18th October, to promote the foundation of scholarships in the northern counties of the Principality. The meeting will be addressed by representatives of the Society of Arts, and the Committee of Management of the School.

CANTOR LECTURES.

The second lecture of the third course of Cantor Lectures for the past Session, on "Wool Dyeing," by Mr. George Jarmain, was delivered on Monday evening, March 13th, as follows:—

Lecture II.

One or two processes stand over from the last lecture for consideration now.

During the last few years a solution of sulphurous acid has been employed, to a considerable extent, for the bleaching of wool. Liquid bleaching presents many advantages over gas bleaching for loose wool, which is much more easily manipulated in a liquid than it can be in the sulphur chamber. On the other hand, sulphurous acid in solution is not as effective a bleacher as it is when in the gaseous state, and the solutions are troublesome to make, or more expensive to purchase, than the sulphur, which is the only article required in the gas bleaching process.

The solution of sulphurous acid used for bleaching purposes is one of the following:—

1. A solution of the gas in water.
2. A solution containing from 3 to 5 per cent. of bisulphite of soda, to which an equal volume of hydrochloric acid is added.
3. A solution, containing from 3 to 5 per cent. of the bisulphite, from which the sulphurous acid is set free in a subsequent operation.

The wool to be bleached should be well scoured with soap, washed, and steeped in one of the above solutions for some hours. If the first or second solution be employed, it will only require to be washed to free it from the acid; it may then be placed in a coach, and covered up with a sheet for some time, under which circumstances th bleaching action will be continued by the sulphurous acid remaining adhering to the wool.

If the third solution be employed, the wool, after draining, should be passed into water containing from 3 to 5 per cent. of hydrochloric acid, which will liberate the sulphurous acid from the bisulphite of soda with which the wool is soaked, and the sulphurous acid being liberated in contact with the fibre, and probably within the fibre itself, the colouring matter of the wool is acted upon more powerfully by this nascent condition of the bleaching agent than it is by free sulphurous acid. This method resembles the bleaching of cotton by bleaching powder, in the liberation of the bleaching agent by an acid.

Solutions Nos. 1 and 2 rapidly lose strength by the escape of the sulphurous acid, or by its conversion into sulphuric acid by oxidation. Some loss is, therefore, experienced when the bleaching is only required to be done occasionally. The sulphurous acid may be preserved in them to a considerable extent by neutralising it with carbonate of soda; when required again it can be set free by the addition of hydrochloric acid. No. 3 solution holds its strength much longer than Nos. 1 and 2, and, although it requires a little more labour, the bleaching by it is more effective.

The following equation explains the action of the hydrochloric acid upon the bisulphite:—

$$\underset{\text{Bisulphite of soda.}}{H\,Na\,SO_3} + \underset{\text{Hydrochloric acid.}}{HCl} = \underset{\text{Common salt.}}{Na\,Cl} + \underset{\text{Sulphurous acid.}}{H_2\,SO_3}$$

The colour of the wool is often improved by tinting it with a little blue; this may be done in the acid bleaching bath, or, better still, in a bath specially made up for the purpose after the bleaching has been done. I have found a solution of indigo carmine to be best adapted for the tinting, but where the wool is very yellow it is necessary to use a red colour in addition. The colour may be given in the cold.

Bisulphite of soda solution of 45° Tw. is sold at the present time at 9s. per cwt.

When required in large quantities for bleaching purposes, or for the preparation of reduced indigo by Schutzenberger and Lalande's method, it may be made by absorbing in a solution of carbonate of soda the sulphurous acid gas produced by burning sulphur. The absorption may be made in a coffee still, or in a tower made of sanitary pipes filled with coke, or, finally, the gas may be absorbed by aspirating it, or by forcing it through the alkaline solution. The gas should be passed till after all effervescence has ceased, and until it is no longer absorbed.

The solution of bisulphite may also be prepared, if required in smaller quantities, by heating crushed charcoal soaked in strong sulphuric acid in an iron vessel, and conducting the gases evolved into a solution of carbonate of soda till saturated. And for small experimental purposes it may be made

by heating in a flask strong sulphuric acid, to which is added either copper turnings or crushed charcoal, and conducting the sulphurous acid gas produced into a bottle containing solution of carbonate of soda, and shaking it up from time to time until no more gas is absorbed.

The following equations explain the reactions involved in the above operations:—

$$\underset{\substack{\text{Sulphurous}\\\text{acid gas.}}}{2\,SO_2} + \underset{\text{Water.}}{OH_2} + \underset{\substack{\text{Carbonate}\\\text{of soda.}}}{Na_2CO_3} = \underset{\substack{\text{Bisulphite of}\\\text{soda.}}}{2\,HNaSO_3} + \underset{\substack{\text{Carbonic}\\\text{acid gas.}}}{CO_2}$$

$$\underset{\text{Sulphuric acid.}}{2\,H_2SO_4} + \underset{\text{Charcoal.}}{C} = \underset{\substack{\text{Sulphurous}\\\text{acid gas.}}}{2\,SO_2} + \underset{\substack{\text{Carbonic}\\\text{acid gas.}}}{CO_2} + \underset{\text{Water.}}{2\,OH_2}$$

$$\underset{\text{Sulphuric acid.}}{2\,H_2SO_4} + \underset{\text{Copper.}}{Cu} = \underset{\substack{\text{Cupric}\\\text{sulphate.}}}{CuSO_4} + \underset{\substack{\text{Sulphurous}\\\text{acid gas.}}}{SO_2} + \underset{\text{Water.}}{2\,OH_2}$$

Tinting or Dyeing White.

There are some descriptions of wool and woollen waste, the yellow colour of which is but little affected by the action of sulphurous acid, but which may be very greatly improved in tone by tinting with the complementary colours, blue and red. The wool, waste, or cloth is well scoured in soap; the tinting bath is made by heating up water to about 120° and adding the tinting colours. Good proportions and colours for 250 lbs. yellow material I find to be—three tablespoonsful of Brook, Simpson, and Spiller's Humboldt; two tablespoonsfull of Brook, Simpson, and Spiller's No. 1 B blue. Work in the bath for 40 minutes.

For some descriptions of goods other colours and proportions may be found to be better adapted; the above directions are merely intended to indicate the course to be adopted.

Indigo.

The importance of this colouring agent in the woollen trade cannot be over-estimated; our finest and most expensive cloths are dyed with it, often with it alone, and frequently it forms the base upon which other colours are dyed.

Indigo has been known and used as a dye from the earliest times of cloth manufacture. It was employed by the Egyptians at a very early period, for it is found on mummy cloths; and the ancient Hindoos, Chinese, Greeks, and Romans were known to use it.

Indigo is a product of the vegetable kingdom, and is sometimes found in small quantities in animal secretions. Many attempts have been made to produce it artificially for industrial purposes, but as yet without result. The success which has attended the preparation of artificial alizarine, however, encourages the hope that at no distant day the production of artificial indigo for the use of the dyer will be added to the triumphs achieved by chemists in the production of tinctorial substances.

The plants from which indigo is derived belong chiefly to the family Leguminosæ and genus Indigofera. The species most cultivated and esteemed are—*I. tinctoria*, *I. disperma*, *I. anil*, *I. argentea*. The production of indigo is not confined to the Indigofera, for it is furnished also by the woad plant, *Isatis tinctoria*, belonging to the Compositæ family, and by other plants.

Indigo does not appear to exist in the plant in either of its well-known conditions, but is a product of a species of fermentation, to which the leaves are subjected during its preparation, the details of which I will not enter upon.

Asiatic indigos are produced in Bengal, Oude, Coromandel, Manilla, Madras, and Java.

African, in Egypt, Mauritius, and Senegal.

American, in Guatemala, Caraccas, Mexico, Brazil, and Carolina.

The Bengal, Java, and Guatemala varieties are most esteemed. The Java is preferred for the manufacture of indigo carmine, on account of its purity of colour. Its per-centage of colouring matter is not very high, and the woollen dyer consequently prefers varieties richer in colour.

The best varieties of Bengal indigo have a deep blue violet colour. They are fine grained, and adhere to the tongue. They easily pulverised, and have a coppery hue when rubbed with the nail. Sp. gr. an average of ·769. The colouring principle upon which the value of indigos mainly depends ranges from 12 to 72 per cent.

The examination of indigo, so far as it concerns the dyer, includes:—

1. The determination of the per-centage of mineral matter.

2. Its tinctorial power, compared with a standard sample of good indigo, or with indigotin, the pure colouring matter of indigo.

3. The amount of indigotin it contains as compared with a standard sample.

4. Its physical characters, such as its specific gravity, colour, ease with which it powders, appearance when rubbed with the nail, action on the tongue, fracture.

1. The mineral matter is determined by burning in a platinum capsule, over a spirit lamp or Bunsen flame, a known weight, say 20 grains, of the powdered indigo, until all carbonaceous matter disappears, and weighing the ash. If 20 grains have been taken five times, the weight of the ash will give the per-centage of mineral matter. The combustion will be complete in about an hour, but will be much facilitated by breaking the coke, and stirring it up at intervals with a platinum wire. Good indigo does not leave more than 10 per cent. of ash, and the best Bengal seldom more than 7 per cent.

2. Its tinctorial power is found, as compared with the standard sample, by placing 5 grains of each in a 2-oz. porcelain dish, pouring on each 5 cubic centimetres of strong sulphuric acid, or, better still, of fuming sulphuric acid, and digesting them for an hour or two at a gentle heat. Water is then added, and they are run into the 100 cubic centimetre measure, and then emptied into a beaker or flask to mix the solution. Five cubic centimetres of the sample under examination are then taken up with a pipette, and run into 100 cubic centimetres of water placed in a glass cylinder, or tall white glass bottle, and the solution of the standard sample is run into another 100 cubic centimetres of water, from a graduated pipette or from the burette, until a colour is obtained equal to that of the sample under examination. The relative amounts of solution required to produce the same depth of colour give the relative tinctorial values of the indigos. Fifty cubic centimetres of the remainder of each solution are placed in a small pan, dish, or beaker, along with 50 cubic centimetres of water, and swatches of woollen cloth of equal weight are dyed in them, the heat being raised nearly to the

boil. The depth of colour obtained in each case will give the relative tinctorial values of the indigos.

3. To obtain the amount of indigotin, as compared with a standard sample, pour 10 cubic centimetres of the solution (as obtained in 2) into a pint of water contained in a flask or beaker, and run in from the burette a solution of permanganate of potash, until the blue colour disappears and the solution becomes golden yellow. Treat 10 cubic centimetres of the standard solution in the same way. The number of cubic centimetres of permanganate required in each case gives the relative amount of pure indigotin in each sample. A convenient strength of solution of permanganate is made by dissolving five grains of the crystals in one litre of water.

Solutions of bichromate of potash or of bleaching powder may also be used for destroying the colour of the indigo solutions, and the per-centage of indigotin calculated from the amount of solution required in each case.

4. The examination of the physical characters of the indigo needs no comment.

Indigo, as met with in commerce, is insoluble in water, alkali, and dilute acids, and its treatment for bringing it into solution, in order that it may be used as a tinctorial agent, depends upon the fact that it is rendered soluble by the action of nascent hydrogen, whereby it is converted into white, or so called reduced indigo, which is then soluble in alkaline fluids, such as lime, soda, or potash. This is effected by various means, according to the class of goods which are required to be dyed with it. The vessels in which the goods are to be dyed are called vats, and the substances used to reduce or hydrogenise the indigo give the name to the vat. These vats may conveniently be divided into —1. Cold vats; 2. Warm vats.

The cold vats are used for dyeing cotton or other vegetable substances; warm vats are invariably used for wool and woollen goods.

The following equation will explain the conversion of insoluble blue indigo into soluble white or reduced indigo:—

$$\underset{\text{Indigo blue.}}{2\ C_8H_5NO} + H_2 = \underset{\text{Indigo white.}}{C_{16}H_{12}N_2O_2}.$$

Two molecules of the former being converted into one of the latter by the nascent hydrogen.

The following table exhibits the various materials and means employed to bring about the conversion and the name of the vat:—

Indigo Vats.

Copperas vat	Cold	Copperas, lime, and soda or potash	..	Cotton and vegetable substances.
Woad vat	Warm	Woad, madder, bran, and lime	By fermentation, 140° F.	Wool and woollen goods.
Pastel vat	Ditto	Pastel, madder, bran, lime	By fermentation, not beyond 158° F.	Ditto ditto.
Pastel potash vat	Ditto	Pastel, madder, bran, lime, potash; and, for some classes of goods, molasses	By fermentation, 120° F.	Ditto. ditto.
Urine vat	Ditto	Urine, salt, madder	..	Useful for small dyers.
The German soda vat	Ditto	Bran, carbonate of soda, lime, molasses	By fermentation, 120° F.	Wool and woollen fabrics.
Schutzenberger and Lalande's vat	Warm or cold	Zinc dust, bisulphite of soda, lime	By simple admixture	Wool and woollen in warm vat; cotton in cold.

In the copperas vat, in which a mixture of copperas and lime is employed, the nascent hydrogen is produced as follows:—The lime precipitates ferrous hydrate (hydrate protoxide of iron) from the copperas thus—

$$\underset{\text{Copperas.}}{FeSO_4} + \underset{\text{Slaked lime.}}{CaH_2O_2} = \underset{\text{Sulphate of lime.}}{CaSO_4} + \underset{\text{Ferrous hydrate.}}{FeH_2O_2}$$

The ferrous hydrate then takes up oxygen from water—

$$\underset{\text{Ferrous hydrate.}}{2Fe_2H_2O_2} + \underset{\text{Water.}}{2OH_2} = \underset{\text{Ferric hydrate.}}{Fe_2H_6O_6} + \underset{\text{Nascent hydrogen.}}{H_2}$$

Soda and potash, which are sometimes used in place of lime, act in the same manner.

In the fermentation processes, the woad, pastel, bran, and madder act as the ferments, by virtue of the nitrogenous matter which they contain; the sugar of the madder and the farina of the bran pass successively into grape sugar, lactic acid, and finally into butyric acid, the production of the latter being accompanied by the evolution of hydrogen and carbonic acid, the following equation representing the change:—

$$\underset{\text{Lactic acid.}}{2\ HC_3H_5O_2} = \underset{\text{Butyric.}}{HC_4H_7O_2} + \underset{\text{Carbonic acid gas.}}{2\ CO_2} + \underset{\text{Hydrogen.}}{2H_2}$$

The nascent hydrogen thus produced is the reducing or hydrogenising agent.

In Schutzenberger and Lalande's vat, the hydrosulphite, formed by the zinc acting on bisulphite of soda, decomposes water, taking up oxygen from it and liberating the hydrogen, itself passing into a higher state of oxidation. These changes are at present not very well understood.

The only vats employed in England for the dyeing of wool, so far as I can learn, are the woad vat, and that of Schutzenberger and Lalande. There seems to be a strong objection amongst English dyers to the employment of soda or potash, in consequence of vats being made caustic by the use of these alkaline carbonates along with lime. Caustic potash or soda is exceedingly prejudicial to the soundness and handle of the wool, especially when

it is heated along with it; and Schutzenberger and Lalande's vat was not at first well received, because soda was used as the solvent of the reduced indigo, and many complaints were made that it rendered the pieces rotten. This is, however, now avoided by the use of lime only as the solvent, too great an excess of lime being carefully avoided.

Utensils.

The indigo mill is a very important apparatus. Unless the indigo is thoroughly ground great loss of that material will take place. Indigo can only be reduced when brought into the condition of an impalpable powder. The mill is either constructed of stones, somewhat like those for grinding corn, and worked by a perpendicular shaft, or it consists of four iron rollers, which are rolled backwards and forwards in a trough by a cradle motion. The indigo is ground with water to a pulp, the operation being continued for several days. The pulp must feel perfectly smooth, and contain no gritty particles.

The vat is a cylindrical iron vessel, having a diameter and depth of 6 ft. 6 in. by 6 ft. 6 in. to 7 ft. 6 in. by 7 ft. 6 in. It is encased by an iron jacket or by brick work, and heated by steam, the steam space in the jacket being about 2 in. wide, and extending from the bottom to within 4 ft. of the top. Sometimes the vats are heated by a coil of copper pipe placed inside the vat, which is an economical arrangement. Direct fire heat is now but seldom employed.

Rakes are used to stir up the contents of the vats. The rake head is about 15 in. long by 5 in. wide, and the handle is 10 or 12 ft. long. The rake is lowered down to the bottom of the vat, and a portion of the sediment is drawn up with a jerking motion, when the head approaches the surface. Three or four men work up the vat in this manner vigorously for about ten minutes.

When not in use the vats are covered by a cover, in three pieces, made of battened three-quarter inch boards. This keeps in the heat, and prevents oxidation of the vat liquor to a great extent.

A net of half-inch meshes is lowered down into the vat when wool has to be dyed. The wool is gently moved about in the net by means of a "stang," care being taken that it is not lifted out of the fluid.

When the wool has been in the vat a sufficient length of time, it is lifted out of the net, and placed in a bag made of strong net. The wool is then wrung in the bag, and the liquid returned to the vat.

Pieces, when placed in the vat, are moved about by means of an instrument called a "hawk," one of which is held in each hand, and the piece is pulled towards the operator. It must not be raised above the liquor. In order to prevent the piece from sinking down into the sediment at the bottom of the vat, an iron hoop of the same diameter as the vat, covered with a net having 4 or 5 in. meshes, is lowered down about a yard below the surface of the liquid, and suspended there.

A moveable squeezing machine, consisting of two iron rollers 6 in. in diameter, fixed in a frame work, serves the purpose of removing pieces from the vat. One or both rollers may be covered with vulcanised india-rubber.

Materials used in the Woad Vat—Woad, Madder, Bran, Lime, Indigo.

Woad consists of the fermented leaves of the woad plant, *Isatis tinctoria.* This article is grown and manufactured largely in Lincolnshire. The seeds are sown in early spring, and when the plants are large enough they are transplanted in rows. When the plants are from 3 to 6 inches high, the outer leaves are twisted off by children, and then placed under a shed. Usually three crops are thus gathered during the season. The manufacture of the woad is carried on in the winter. The leaves are mixed with lime and urine, and thrown in a heap to ferment. The heap is repeatedly turned over with shovels, to prevent excessive fermentation; this turning of the heap is continued until fermentation ceases. The woad is then packed in barrels and sent to the market. The present price of woad is from £26 to £30 per ton. (Sample exhibited.)

Madder contains sugar and nitrogenous matter in addition to its colouring matters. The sugar passes into the butyric fermentation, and furnishes part of the nascent hydrogen; the nitrogenous matter acts as a ferment. The ordinary crop madder is employed. The use of madder in the fermentation vats is not essential, and in many establishments it is not employed. The colouring matter of the madder gives a special shade to the indigo which some manufacturers like.

The bran used is the ordinary bran obtained in grinding wheat. It contains nitrogenous matters and starch; the former assists as a ferment, and the latter passes during the fermentation through the various stages of glucose, lactic acid, and butyric acid, nascent hydrogen being produced at the latter stage.

Newly burnt lime slaked and riddled is thrown into the vat in the powdering condition. Its employment serves the purpose of neutralising the butyric acid as fast as it is formed. When the addition of lime is neglected too long, the butyric acid and other matters pass into the putrid fermentation, which acts destructively upon the indigo.

The indigos found to be the most economical and effective for woollen dyeing, are the medium qualities of Bengal, ranging, at the present time, from 4s. to 5s. per lb. The violet copper-coloured varieties, having a low specific gravity, are prepared. (Samples exhibited.)

Preliminary Operations.

When the indigo-dyed goods are required to have a special "bloom," the wool or woollen fabric has a "bottom" put on it. Camwood, barwood, Saunders'-wood, cudbear, archil, or archil paste, are the colouring matters which are employed for this purpose. Camwood is the best for wool. The woods give a much more permanent bloom than the weed colours, cudbear and archil, which are somewhat fugitive.

The goods are boiled with the colour for an hour or an hour and a-half, no mordant being used. The quantity of ware is varied according to the depth of shade of bottom required. 16 lbs. of camwood or 12 lbs. of cudbear for 100 lbs. of of wool are good proportions for a full bottom.

Of course the blooming is not the only object which the dyer has in view; economy of indigo is an important matter to him.

It is important that the goods to be dyed should be thoroughly cleansed from all dirt, grease, and soap, or otherwise the dye will be taken up unequally.

Setting the Woad Vat.

The following is the method adopted in the woollen districts of the West Riding:—

Dimensions of Vat, 7 ft. diameter by 7 ft. deep.—Materials.

	£.	s.	d.
5 cwt. Lincolnshire madder, at 26s...	6	10	0
3 pails of bran, weight 18 lbs.	0	1	1
22 lbs. slaked lime in dry powder	0	0	$2\frac{1}{2}$
$2\frac{1}{2}$lbs. madder	0	0	$10\frac{1}{2}$
24 lbs. of indigo, at 5s...............	6	0	0
	£12	12	2

The woad is chopped and pounded with a spade until the pieces are no larger than a hen's egg. It is thrown into the vat, which is then nearly filled with water. The contents are now heated by turning on the steam, until a temperature of 140° to 150° F. is obtained. The vat is stirred up three or four times at intervals of 15 minutes, and then left overnight. The woad will now be soft and pulpy. Next morning put in the bran, madder, indigo reduced to a smooth paste by grinding, and half the lime, rake up, cover over, and leave till next morning. If the fermentation has commenced, the vat will present the following appearances. A slight froth will rise to the surface when the bottom is slightly stirred with one rake. The liquid, when stirred, will appear green yellow with blue veins or streaks, the green colour predominating. A coppery blue scum called "flurry" will appear on the surface of the vat. A portion of the bottom drawn up with a rake will show signs of fermentation, and will smell slightly sour. A piece of wool put into the liquid for a short time will be dyed. If these appearances present themselves the vat is progressing favourably, and about a quart more lime may be added, and the whole well raked up. If no signs of fermentation appear, more time must be given before adding the lime, which in this case would only have the effect of retarding the fermentation. If the vat matures satisfactorily, a quart more lime may be added every two or three hours, stirring up well after each addition. The coppery blue flurry will increase in quantity, and the liquid, when stirred, will be green yellow with blue streaks. Then heat up to 140°, cover, and leave overnight. Next morning (the third morning), if the fermentation has proceeded satisfactorily, the vat may be used for dyeing. It is very important that great caution should be exercised in the addition of lime, for if the vat be overdosed fermentation will be arrested, and there will be considerable difficulty in re-establishing it. The vat will then have to be left probably for several days before the fermentation re-appears. On the other hand, if the addition of lime be neglected too long, and the fermentation passes to the putrid stage unchecked, the indigo will be lost, or, as the dyers say, it will "run away." The liquid exhales an agreeable odour when the progress of the setting is proceeding satisfactorily, but the odour changes when too much or too little lime is present. Much depends on the care and skill of the dyer, for no description of the process can accurately convey to the mind of the uninitiated the mode to be adopted, in the varying conditions to which the fermenting indigo vat is subject. An experienced indigo dyer can exercise perfect control over the condition of his vat.

The following account of the setting of two indigo vats last week, of which I took notes, may be useful.

The vats were intended for the dyeing of broad cloths and wool of a full blue.

Dimensions of vats 6 ft. 6 in. by 6 ft. 6 in.—On Wednesday at noon the vats were filled with water, and $4\frac{1}{2}$ cwt. of crushed woad were put into each vat; the liquid was heated to 140° F., and stirred up once. On Thursday morning they were heated up again to 140° and kept at that temperature all day. During the day they were raked up vigorously by four men four times. At five o'clock p.m., 25 lbs. of indigo, well ground to a smooth paste, 14 lbs. madder, 5 quarts of lime, and 4 pails of bran (2 gallons each), were added, and the whole well stirred up and left overnight. On Friday morning at nine o'clock a light froth rose on the surface, when the vat was gently stirred up with one rake. The bottom was in a slight state of ferment and smelt rather sour. The liquid appeared green yellow on the surface with blue streaks when it was stirred by the hand. (Sample of wool dyed in it exhibited.) One quart of lime was added to each vat, and the contents well stirred for ten minutes as before. It was then covered up. At 11 a.m. and at 1 p.m. another quart of lime was given, and the contents raked up as before. A considerable quantity of coppery blue flurry had now accumulated on the surface, and the liquid appeared of a dark greenish yellow with blue streaks when disturbed by the hand. The odour was favourable and the fermentation steady, being kept under by the lime. At 3 p.m. the vats were warmed to 135° and another quart of lime added and again well stirred up, appearances and odour favourable as before. At 5.30 the vats were in a condition fit to use for dyeing. (Sample dyed exhibited.) Three pints of lime were given to each vat and 5 lbs. more indigo; they were well stirred up; temperature 130°. They were covered up and left over-night. At 9 a.m. on Saturday 2 sixty-yard pieces of narrow doeskins were put into each vat, and after they had been worked for $1\frac{1}{4}$ hours I took off a sample and left them. (Sample exhibited.)

The Dyeing Operations.

Pieces to be dyed a full blue are hawked in a strong vat from 20 minutes to 2 hours, according to the class of goods, heavy and closely woven fabric requiring more time for the colour to penetrate into the centre than lighter and more open goods. The material is then drawn out of the vat, and after exposure to the air for some time, in order that the reduced indigo may become oxidised and pass into the blue and insoluble condition, the goods are passed into a weaker bath, to dye up to the shade required. For light-blue colours, such as are given for woading for blacks, a single working through a moderately weak bath for about 20 minutes will be sufficient.

For dyeing wool, a vat which shows the fermentation to be in a moderately active state is found to be the best, but pieces are dyed more perfectly in a vat in which the fermentation is kept under.

When the goods are withdrawn from the vat, they are of a fine green colour which rapidly passes to blue. The green colour is due to tho instant oxidation of a portion of the yellow coloured reduced indigo, which thus produces a mixture of blue and yellow.

The formation of indigo blue from the reduced indigo is explained by the following equation :—

$$\underset{\text{Indigo white.}}{C_{16}H_{12}N_2O_2} + \underset{\substack{\text{Oxygen}\\\text{from the air.}}}{O} = \underset{\text{Indigo blue.}}{2\,C_8H_5NO} + \underset{\text{Water.}}{OH_2}$$

For keeping up the strength of the vat, about 15 lbs. of indigo are added every other day, more lime and bran being added every day. After finishing the day's working of the vats the necessary addition of bran, lime, and indigo is made, and the vats well raked up and heated up to 140° F.

The following table gives the quantities and cost of materials used in a large dye-house, for the woad vat for dyeing dark indigo blues on cloth (sample exhibited):—

	£	s.	d.
6,533 lbs. indigo, at 5s. 6d. per lb.	1,796	11	6
68 cwts. lime, at 1s. per cwt. ..	3	8	0
19¾ packs bran, at 14s. 6d.....	14	6	4
142½ lbs. madder, at 4¼d.......	2	10	6
56½ cwts. woad, at 30s.......	84	15	0
12 cwts. fuller's earth	1	16	0
	1,903	7	4

Per-centages of total cost:—

Indigo	94·37
Fuller's earth	·10
Woad	4·45
Madder	·13
Bran	·76
Lime	.18
	99·99

Cloth dyed wth the above materials, 159,180 lbs. Cost per pound, 3·67 pence.

It is noteworthy that the materials required to reduce the indigo only cost 5·52 per cent. of the whole.

Schutzenberger and Lalande Vat.

This vat stands in marked contrast to the woad vat already described, as regards time and the number of vats required. The reduction of the indigo is almost instantaneous ; in fact, the reduced indigo may be prepared beforehand, and then it is only necessary to add it to the vat, and proceed with the dyeing in the manner already described. The reduction is performed in the following manner:—

Materials required.—Bisulphite of soda, at 45° Tw., costing 9s. per cwt. Zinc dust, at 23s. per cwt. Slaked lime in powder, sifted, or in the form of cream of lime. Indigo, ground in water, in the form of pulpy paste, without any gritty particles.

Utensils for the preparation of the reduced Indigo.—A small tub, or pail, in which to prepare the hydrosulphite. A cask in which the indigo is reduced. Barrels in which to store the reduced indigo. The same vats and utensils which are employed with the woad vat.

To prepare the reduced indigo proceed as follows:—

Pour bisulphite of soda solution into a pail or small tub, and add zinc dust until the smell of sulphurous acid disappears, stirring up well until this takes place. The zinc dust required will be be from one-fifteenth to one-tenth of the weight of the bisulphite of soda. The solution so produced is called hydrosulphite.

Place your indigo paste in a cask or tub ; add a little cream of lime, and heat to 120° F. Run in sufficient hydrosulphite to reduce the indigo, which may be known when the surface of the mixture assumes a dark green appearance ; then add more cream of lime to dissolve the reduced indigo, when the mixture then becomes yellow. It may be known when sufficient lime has been added by taking out the stirring rod, which will quickly assume a bronzed, coppery appearance. If too much lime has been added, the indigo becomes brown, and is partly destroyed, a smell of ammonia being given off.

The creamy fluid is then run into barrels for use.

The principle on which the indigo is reduced has already been given. (A small sample of indigo was reduced.)

The Dyeing Operations.

The vat is filled up with water, which is heated up to from 130° to 140° F., and the necessary quantity of reduced indigo run in from the store casks. The dyeing may be carried out exactly on the same plan as with the woad vat; the vat may, however, be used continuously, as it may be fortified at any moment by the addition of reduced indigo. If the indigo in the vat should become oxidised by exposure to the air, and by the air which the goods carry in with them mechanically, it may be reduced by adding hydrosulphite, and also lime if necessary, to the vat. As there is not such an accumulation of solid matter at the bottom of the vat as there is in the woad vat, vessels having a much less depth may be employed.

The dyer very quickly learns how to manage this vat. The operations are simple and perfectly under control, and they do not, therefore, require an apprenticeship to learn how to manage them, as is the case with the fermentation process.

Opinions of Dyers on the Hydrosulphite Vat.

Since the year 1873, when it began to be used in Yorkshire, the experiences of woollen dyers with this vat have been very varied. It has been abandoned by some and continued by others.

The advantages claimed for it are—that it is easy to manage ; that it dyes worsted goods clean ; that it can be used either for light or dark blues ; that the services of an experienced blue dyer at high wages can be dispensed with ; that it is rapid.

The disadvantages attributed to it by those who have abandoned it are—that it is much more expensive than the woad vat, on account of loss of indigo in washing ; that the goods handle thinner when of the same weight and texture, although the strength of the goods is not impaired, as tested by Hebden's machine ; that the colour is not quite so good, being somewhat green ; that it requires one-third more red bottom than the woad vat ; that is spoils the face of goods.

The heaviest charge against it, however, seems to be the cost, but this may be very greatly lessened by recovering the indigo which washes off, by passing the goods through milk of lime before

the washing. The lime dissolves the reduced indigo which has not become fixed to the fibre. The green colour can be removed by passing the goods through very dilute sulphuric acid in the washing machine.

The following table gives the cost of dyeing dark blues by the hydrosulphite vat, by a dyer who wished to use it, but was deterred by the cost. It bears unfavourable comparison with the cost of materials by the woad vat. The cost of labour in working the two vats may be assumed to be about the same :—

	£	s.	d.
240 lbs. Indigo at 5s. 6d.	66	0	0
1,978 lbs. Bisulphite of soda at 1d.	8	4	10
195 lbs. Zinc dust at 23s. per cwt.	2	0	1
30 lbs. Fuller's earth	0	1	0
Lime	not given		
	76	5	11

Per-centages of total cost :—

Indigo	86·84
Bisulphite soda	10·62
Zinc dust	2·63
Fuller's earth	nil.
Lime	not given
	100·09

Cloth dyed with above materials, 3,420 lbs. Cost per lb., 5¾d.

The materials required to reduce the indigo cost 13·25 per cent. of the whole.

(Wool and swatches of cloth were then dyed with the hydrosulphite vat.)

Extracts of Indigo (Indigo Carmine).

These are sulphuric acid derivatives of indigo obtained by dissolving indigo in strong, or even fuming, sulphuric acid. The extract having a purple colour, contains chiefly sulphopurpuric acid, $C_{16}H_{10}N_2O_2,SO_3$, the blue extract contains sulphindigotic acid, C_8H_5NO,SO_3. The production of these two varieties depends upon the strength of the acid used, and the temperature and time of contact.

The acid, or "sour extract," may be made by gradually adding 1 lb. of well-powdered indigo to 12 lbs. of the strongest commercial sulphuric acid, stirring well during the addition. The mixture is then kept for two days, at a temperature of about 140° F. A little of the mixture dropped into water should completely dissolve. The mixture is poured into water, and is then ready for use. The best qualities of indigo and the refined article should be used in these preparations.

The sweet extract is made by neutralising an acid extract with carbonate of soda and chalk, adding also salt. The sulphopurpuric and sulphindigotic acids form soda salts, which are insoluble in solutions of alkaline salts; the colouring matter can therefore be precipitated, filtered off, and washed. The following process gives a good sweet extract:—Add gradually 9 lbs. of the strongest sulphuric acid to 1 lb. of the finest quality of indigo finely ground and sifted, stirring well all the time; set aside for a week at from 60° to 70° F.; then add a solution of 10 lbs. of common salt and 15 lbs. of soda crystals, then ½ lb. of powdered chalk may be added, and the whole well stirred up and thrown upon a filter, and washed with a solution of salt, till the washings run through colourless.

The purple extract is made by using one-third as much acid and leaving them in contact only a short time.

These dyes require no mordant for wool; they dye best in an acid bath, and the addition of sulphate of soda is found to be beneficial in clearing the liquid and producing evenness of shade.

They are not used as self colours on woollen goods, but enter largely into the composite colours of goods which do not require to be scoured afterwards.

They are not therefore fast colours, and cannot be compared with indigo colours dyed by vat processes, which possess a degree of permanence which has long given them a deserved popularity, as they remain unaffected alike by heat and cold, sunshine and rain, acid and alkali.

MISCELLANEOUS.

HYGIENIC AND LIFE-SAVING CONGRESS, BRUSSELS.

(FROM A CORRESPONDENT.)

The congress was opened on Wednesday, September 27th, in the Palais Ducale, in the presence of his Majesty the King of the Belgians. M. Vervoort, in his opening address, gave a warm welcome to the representatives of the various countries. M. Ferréol Fourcault, secretary, then read the names of the presidents-elect of the foreign committees, whose election was confirmed by acclamation. M. Aug. Couvreur, secretary-general, gave an outline of the work before the congress. The labours of the congress are divided under three sections:—(1), hygiene; (2), saving of life; (3), social economy; the first being subdivided into general and medical hygiene, and the second into the saving of life (*a*) in mines and factories, and (*b*) in war. All these sections held preliminary meetings; and, in the evening, M. Anspach, the Burgomaster of Brussels, received all the members of the congress at the Hôtel de Ville. The committee for Great Britain is constituted as follows:—

President of the English Committee, Capt. Douglas Galton, C.B.

Hygiene.—Presidents, Mr. Edwin Chadwick, C.B., and Dr. Richardson, F.R.S.; Vice-Presidents, Dr. Hardwicke and Mr. H. H. Collins; Secretaries, Mr. J. S. Phené and Mr. J. W. Pearse.

Saving of Life.—Presidents, Sir Henry Verney, Bart., and Mr. W. Crookes, F.R.S.; Vice-Presidents, Surgeon-Major Pater and Mr. G. M. Cooke; Secretary, Major Burgess.

Social Economy.—President, Mr. John Siltzer; Vice-President, Mr. Willis Bund; Secretary, Mr. John Russell, M.B.

The real work of the Congress did not begin before Thursday, 28th September, when the various sections held separate meetings at 9 a.m.

Section I.—Division A.—General Hygiene.—Under the presidence of M. Bergé. M. Herpin read his report on the seventh question, as to the conditions of salubrity to be maintained in (*a*) hospitals and (*b*) temporary erections for hospital purposes and ambulances. Captain Douglas Galton pointed out the necessity of frequently renewing the plaster on the walls of hospitals. The question was adjourned to the following day.

Section I.—Division B.—Medical Hygiene.—Doctor Croeq presiding.—M.M. Charbonnier and Hymans

brought up the fifth question, "How to reconcile the interests of individual liberty with those of public health (*a*) in quarantine and lazarettos, (*b*) in infectious diseases, and (*c*) in the prophylactic measures to be adopted?" M. Dally proposed, as a practical conclusion to the report, that a legislative measure should render obligatory the feeding, during transport, of animals intended for food. Captain Douglas Galton gave some details as to cholera in India, and pointed out the excellent results which followed the energy of the authorities, especially as regards a pure water supply. Signor Guido Suzani called attention to the efficacious prophylactic measures that exist against the silkworm disease, and proposed that the various Governments should be called upon to concur in measures against the return of the disease. Dr. Crocq added to his observations the example of Belgium, where the Government vigorously enforced prophylactic measures, at the same time indemnifying the owner of the animal destroyed. M. Pagny would have less destruction of diseased animals and more chemical study upon them; he hoped that in future a portion of the animal would bo kept for study. Discussion adjourned.

Seetion II.—Division A.—General Sauvetage.—Presidents, MM. Andersen, de Kislanski, Dumoustier de Frédilly, and Janssens.—The question relating to collisions by sea, and shipwrecks generally, was discussed, the members present agreeing to the following propositions:—(1) That maritime powers should concur in measures for the amelioration and general application of an international regulation, determining the lights which shall be carried by vessels and the course to steer in case of *rencontre*, and that this regulation have the force of law; (2) tbat a tribunal, composed of men specially qualified, should be constituted, to try and pass judgment upon the conduct of every captain who should have lost or abandoned his vessel.

Section III.—Social Economy.—Capt. Docx read his report on instruction in gymnastics in elementary and middle schools for boys and girls in town and country. M. Boens read the conclusions in his report as to the fifth question, the work of women and children in manufactures. Dr. Marjolin spoke against the work of women and children in mines, and the discussion was adjourned.

At the afternoon sitting of the united sections, the first question, as to workmen's dwellings, was taken. After Dr. Paul had given a *résumé* of his report, Captain Galton gave some information as to the operation of the various Acts of Parliament in England bearing on the subject. Professor Andréeff described the educational and refectory establishments which in Russia form a complement to institutions of this kind. Professor Gneist, of Berlin, insisted on the necessity of bearing in mind varying conditions of climate, &c., in workmen's dwellings, and contended that building societies had rendered good service. Dr. Kaan (Austria) advocated the system of life assurance and annuities, for enabling a workman to leave his house to his family, on decease, free from debt. M. Vander Linden (Brussels) supported the advisability of the acquisition by workmen of their houses; but M. Rolin-Jacquemeyns objected that, in certain branches of industry subject to fluctuations, it is unwise to saddle a workman with an investment which may turn out unproductive on his having to seek work elsewhere, or which he might be obliged to dispose of at a loss.

FRIDAY, 29TH SEPTEMBER.

Section I.—Division A.—General Hygiene.—President, M. Bergé. In continuation of the discussion of the preceding day, Mr. Edwin Chadwick observed, that the mortality in hospitals is always greater than in the town generally, especially when they are large.

With regard to the sixth question, warming and ventilation, M. Somasco read an interesting paper, regarding the subject from a hygienic point of view.

Herr Zimmer then read his report on the first question, water supply. M. Bergé (giving up the chair to Herr Strohm) disputed certain assertions of MM. Gérardin and Vandenschrieck: (1) The city of Brussels had a water supply dating from Joseph II.; (2) it has been decided that organic matters alone are dangerous in water, and we know that water charged with lime and chloride of calcium kill fish; chemical analysis is necessary for determining the quality of water; (3) the fact of tbe deterioration by mixing of two qualities of water, both good, is not yet determined by science.

Section I.—Division B.—Medical Hygiene.—M. Manouvriez, jun., read a communication on the maladies and hygiene of men engaged in making patent fuel, to which M. Proust added that the pulmonary affection mentioned should be known by the name of *brachiosic pneumonogoniosis.*

With regard to the subject of cattle disease, on M. Charbonnier insisting on the utility of incineration of the carcases, Herr Kuborn explained that the gases disengaged were, by his method, collected and burnt, so that only carbonic acid was evolved from the apparatus, the residue being phosphate of lime and animal charcoal. Mr. Edwin Chadwick was not favourable to human cremation, and quoted the conclusion arrived at by the commission appointed to inquire into the matter.

Herr Kuborn put in the report on the fourth question, as to the excessive mortality of newly-born infants and young children, legitimate and illegitimate, but the discussion was adjourned.

Section II. — Division A. — Civil Sauvetage. — M. Habets gave an analysis of a paper as to the use of the electric light on board steamers, and Mr. Barrow described a new system of signal light, devised by Capt. Jacob Holm, Denmark. M. Alvin gave a description of the system invented by Capt. F. F. Lemoine, of the Messageries Maritimes, for ensuring the safety of crew, passengers, and cargo, in case of shipwreck; and M. Geelhand read a communication from M. Challès as to his method and the apparatus in the Exhibition. A report by Dr. Iseux was put in as to the new floating *brise-lames* (breakwaters) invented by Major Cambrelin, who gave some supplementary explanations. M. Tromp spoke as to spontaneous combustion on board vessels, and its prevention by special measures taken in loading. M. Lyth, engineer, Sweden, described a new system, invented by Baron von Otter, of lighthouses, which gave a sure indication of the locality every minute by means of flashes in accordance with the Morse alphabet.

Seetion II.—Division B.—Military Sauvetage.—Prince Caraman Chimay presided. Sig. Appia gave a *résumé* of the three first paragrapbs of his report on the 7th question, "How should committees of succour be organised before and during war?" and recommended: (1) that the system of committees should be extended over all countries, and that a central authority should be constituted; (2) that in each country the society should act in concert with the Government, and obtain (*a*) permission to act in case of war, and (*b*) a kind of convention establishing beforehand what, in case of war, shall be the respective duties of the official service and the society; (3) the creation of a medium between the army and the civil aid; (4) a mention of the special services to be created during war. Capt. Galton explained the working of the English Red Cross Society. With regard to the second portion of the subject, that part to taken by the civil contingent, Sig. Appia proposed the preference of the members of the *Croix Rouge*; to separate the tactic elements of the service of the societies from that of the army; to leave the military authority the control of and the admission to certain long established orders of chivalry. Madame Behrens showed that a proper organisation was frequently wanting. As to the third point, staff to be organised and *matériel* to be prepared, the members were agreed that it is advisable to organise in time of peace the plant and transport to be employed during war.

Section III.—Social Eeonomy.—M. Alb. Picard presiding.—M. Vander Linden read the report by M. Daubrey

on the sixth question, organisation of register offices for masters and workmen, results obtained, and improvements to be introduced.

As to the work of women and children in mines and factories, M. Havard detailed the provisions of the French law. Mr. Willis Bund would express some of the views of the workers themselves; to absolutely limit the hours of work was entrenching on individual liberty, and might prevent a widow from supporting her family. Mr. Boens, in reply, contended that both from a hygienic and moral point of view the work of women in mines should be forbidden.

At the afternoon meeting of the united sections, under the presidency of M. Janssens, of the general *sauvetage* section, M. Emilie de Mot spoke as to his paper on the second question of the second section (emigration), contending that the transport of emigrants should be regulated in a uniform manner by means of international conventions between all the maritime nations.

In the evening the members were invited to a grand representation of the opera *Carmen*, by G. Bizet, at the Theatre Royal de la Monnaie, which their Majesties the King and Queen of the Belgians and the Archduke Charles Louis of Austria honoured with their presence.

Saturday, September 30.

Section I.—Division A.—General Hygiene.—M. Bergé having taken the chair, Capt. Galton said that hitherto only the composition of the water had been dealt with; but an important point remained, viz., its distribution. Between the cistern and direct supply, he was greatly in favour of the latter, because the water became decomposed in reservoirs. He strongly advocated a gratuitous supply of water. Sig. Mariani put in a communication from Mr. Edwin Chadwick, as to the supply of water in England to all the floors of a house. M. Nyssers read a report on the subject; and Mr. Thibault read a paper on the tinning of lead pipes.

Section I.—Division B.—Medical Hygiene.—Under the presidency of Dr. Crocq, the fourth question, as to the excessive mortality of newly-born infants and children, came on for discussion. M. Bodart made a communication as to the mortality of infants in the Indre-et-Loire, and the society established in that department of France for protecting infant life, and M. Despaulx-Ader added a note on other societies of a similar nature. MM. Roeck, Broch, and Durant gave some statistics as to the mortality of infants in Berlin, Switzerland, Norway, and Sweden.

At the afternoon meeting of the United Sections (Dr. Crocq presiding), M. Bergé read a report on the third question, "Determination of the signs of death, cemeteries, cremation," and spoke in favour of cremation, instead of inhumation. After a valuable speech from M. Bouchut, as to the signs of death, mortuaries, and cemeteries, MM. de Paepe and Charbonnier spoke in favour of cremation, and M. Vanderstraeten-Ponthoz against it, with a reply from M. Bergé; the President closed the discussion by observing that it should not leave the field of pure science, which only elevates, while it purified sentiment.

Section II.—Division A.—Civil Sauvetage.—Mr. Barrow gave a translation of the conclusions arrived at by the Royal Commission appointed to inquire into the spontaneous combustion of coal in ships, as contained in their report, dated 18th July last. M. Fontaine described a new safety raft, depending on compressed air. M. Van Peborg presented his report on the third question, as to the abuses arising from maritime insurance and the means of remedying them, concluding with the adoption of an idea put forth by M. de Courcy, of a conference between the representatives of maritime nations, for seeking together means of protecting the life of sailors, and enumerated the basis on which such a discussion might be conducted. M. Seve proposed that the conclusions arrived at in the report should form the subject of an international convention.

Section II.—Division B.—Military Sauvetage.—Prince Caraman-Chimay presiding.—Reports on the following questions were put in:—11th, measures with regard to corpses on the battle field; (*a*) for preventing spoliation and other abuses, (*b*) for preventing or arresting putrefaction (the provisional inhumation), (*c*) final inhumation, (*d*) incineration, (*e*) establishment of an auxiliary corps, the black cross. 12th, as to wounded and stray animals on the battle field. 15th, as to prisoners of war; (*a*) succour, (*b*) transport and interment, and (*c*) exchange. M. Hermaut, military physician, Ghent, gave a *résumé* of his report on the organisation of the means of transport for the wounded; and M. Dauvé read a paper on the same subject, passing in review the various systems represented at the exhibition. M. Furley observed that at the time of the Exhibition of 1873 a special commission determined the best arrangements to be adopted, and therefore it was superfluous to recommence the discussion unless any more perfect system had subsequently been invented, a proposition which the President supported; and the meeting proceeded to discuss the best system of ventilating ambulances. M. Bougard then gave a *résumé* of his report as to the best mode of construction and arrangement of tents and huts; the former should be double, and the latter arranged in line with the predominant winds of the country. M. Francisque Michel gave information as to a new system of ventilation applied to the schools of Paris, and which might be useful in the huts. MM. Bougard and Peltzer also mentioned various systems of ventilation, while M. Vandervyvere contended for simplicity in huts erected on the battle-field.

Section III.—Social Economy.—The Secretary read a list of a large number of treatises placed at the disposition of the section. M. L. d'Andrimont spoke to the seventh question, a means of developing in the working classes a habit of saving. M. L. D'Andrimont, the reporter, detailed the various systems of the establishments for receiving the savings of workers, such as savings banks, co-operative supply associations, benefit societies, and life assurance societies; the conclusion arrived at was that all institutions which favour provident habits should be promoted in every way. M. A. De Malarme, secretary to the *Société des Institutions de Prévoyance*, Paris, after stating that Belgium was in the front rank in this respect, traced the history of the provident institutions in different countries. Herr Engel-Groote then read a paper by his father, Herr Engel-Dolfus, as to the organisation of and results achieved by provident institutions at Mulhouse. M. L. D'Andrimont mentioned that he had omitted to mention in his report the Danish provident institutions, which were most flourishing; he then gave an account of them, and concluded by expressing his opinion that the workman should save and raise his condition by his own unaided efforts. M. Lombaer contributed some details as to what was passing in Switzerland on the subject, and the debate was adjourned.

In the evening the members assembled at the Place des Congrès, to witness the experiments made by M. Lyth in signalling from a distance, by the apparatus of Baron von Otter, referred to the previous day, and a model of which is in the Swedish Department of the Exhibition. The appliance is provided with blinds, or shutters, moved by clockwork, which cause flashes to be given in accordance with the Morse alphabet. The signals were very distinct, and were recorded by a pocket appliance, in which the pressure of the thumb on a button, following the flashes, prints the signs on a paper ribbon.

M. Vervoort, president of the Chamber of Deputies, and also president of the congress, afterwards gave a *soirée musicale* at the Cercle Artistique, the famous band of *artisans réunis* singing several *morceaux*, which were loudly applauded. His Majesty the King of the Belgians honoured the *fête* with his presence, and conversed freely with many of those present.

Visit to Antwerp.

On the 1st October, the members proceeded by special

train to Antwerp, where they were received by M. L. de Wael, the Burgomaster, and a contingent of the *Société Royale des Sauveteurs*. A visit was made to the Musée Plantin, founded by the celebrated family of that name, where were to be seen the old printing presses and founts of type with which were printed works, still preserved, dating as far back as the year 1500. The Salle de Balthazar Moretus, with a cabinet enriched with paintings made in 1510, also excited much interest. At the *déjeûner*, in the arsenal, which followed after the speeches of representatives of the different nations, the national air of each country was played by the band of the Garde Civique; Mr. Willis Bund's speech was followed by "God save the Queen," which was loudly joined in by those present. Some experiments were then made on the Schelt with life-saving appliances, including life-buoys, belts and costumes, and rocket apparatus; and the demonstrations concluded with the extinction of conflagrations and a contest between some German and Spanish *extincteurs*, in which the latter, with the *matafuegos* of Señor Banolas, came off victorious.

SMALL ARMS.

Under this generic term are classed muskets, rifles, carbines, revolvers, pistols, and sword and other bayonets, most of which, being of exceedingly complex manufacture, require many different processes in most ingeniously designed machines, as well as some small amount of hand labour, before being handed over to the inspector for viewing and testing. This branch of industry is extensively carried on at the Small Arms Factory, Smallheath, near Birmingham, under the management of Major-General Dixon, which finds employment in busy times for about 1,500 men, and is capable of turning out complete as many as 2,000 rifles a-week. This production can, if necessary, be increased to 3,000, if what is called "double shift," or a relay of men, be employed in some of the departments.

At this establishment none but walnut-wood, chiefly obtained from Italy, is used for the stocks of firearms, though inferior stocks are made of beech. The block of wood, rough-sawn out of a $2\frac{1}{2}$ in. plank, is made to revolve in a kind of lathe called a rough-stocking machine, the tool of which advances and recedes, so as to give the required shape, in accordance with the contour of a "former" or cast iron counterpart of the stock. The result is that any number of stocks are identical in form, one machine alone being capable of turning 600 per week. One especial feature in the working of this machine, and all others in the same department is, that it is not only self-acting, but also stops of itself as soon as it has accomplished its task, or, to speak in more precise and technical language, the feed stops as soon as the cut is finished.

After the general external form has been given to the stock, the groove for the barrel is cut out by a machine for that purpose. It is then smooth-turned, and afterwards transferred to the lock-bedding machine, by which the recess is made for receiving the lock. In this machine there is a stationary bed-plate, on which the stock is fixed. Loose on the central spindle is a circular frame, carrying four drills, and formers in pairs; a large pulley revolves above the frame, and on the lever being depressed, a small pulley on the drill spindle is driven rapidly by friction. When the work has been performed by that pair, a catch is loosened, and the frame revolves until the next pair are brought into position, and so on. The consequence is that the stock is quite ready to receive the various parts made of iron or steel, and, after a little smoothing, and a coat of linseed oil, the stock is perfectly complete. All these machines have either been designed by the officials at the works, or have been improved by them from American models.

All the metal portions of the stock and lock are stamped out while hot, between dies, by means of "drops" and steam-hammers, the "flash," or rough part left at the joint, being afterwards removed by a trimming press after the nature of a punching machine; but, previous to this, the work is annealed and pickled, to soften the metal and remove the scale. Trigger-guards for Snider work are drawn out under a Ryder hammer, and the steel "shoes," containing the action of the Martini-Henry rifle (the stock of which is in two parts), are forged under a 15 cwt. Davey hammer. Another hammer of the same power afterwards stamps the "shoe," a mandril having been driven into the hole drifted by the first hammer.

Barrels are not at present made at the factory, although rolling mills and furnaces have been erected for the purpose, but are obtained with a hole ready drilled through them. The barrel is first rough bored, then turned or "stripped," as it is called, in three different lathes; *i.e.*, three cuts are taken off. The barrel is next polished in a vertical machine, five being worked together, up and down, like so many pump-rods, twisting at the same time between blocks of wood fed with emery and oil, and kept against the barrel by springs. Then comes the fine boring. Six barrels are laid on a machine table, while steel rimers, ground to the right size and of square section, are made to revolve in their spindles, the barrels being gradually brought up to them by means of a weight passing over a pulley. To keep the "bits" steady, strips of wood of segmental section are placed over the sides of the rimer, packed up as required with slips of paper. In the Martini-Henry rifle, the bore is 0·449 of of an inch. The rifling in the same barrel consists of seven shallow grooves, making one turn in 20 inches. This operation is performed by an ingeniously devised machine capable of rifling to any pitch; but which cannot well be described without elaborate drawings. The machines are inclined, so as to allow the soapy water forming the lubricant to run down the barrel. The breach end of the barrel is finished by milling machinery, as also are the several parts of the lock. In all cases the system of working with a former in adopted, in order to ensure the interchangeability of parts. The setting of the barrel is performed between the boring and stripping operations by blows of a hammer, before turning, and a mallet afterwards, the workmen being able to ascertain whether the barrel is straight or not by looking through it, and noting how the shadow of a horizontal line falls inside. The barrels are proved twice; 1st, after boring, with $7\frac{1}{2}$ drachms of powder, $1\frac{1}{2}$ ozs. of lead, and a cork wad; and again after rifling and the addition of the lock, this time with 5 drachms of powder. The rifle is also fired in the ordinary way when quite complete, with the usual service charge of $2\frac{1}{2}$ drachms. In the first proof, ten loaded barrels, with plugs, containing firing holes screwed into the breach, are laid with the hole downwards on a train of gunpowder.

The bayonets now being made for the Government are the Snider, of triangular section. They are forged from a $1\frac{1}{16}$ inch round steel bar, which is drawn down under a Ryder hammer, about four inches remaining untouched to form the socket. It is next bent, or "broken down," as the term is, in two places. After being cut off from the bar, sufficient metal being left for the blade, it is stamped in a pair of dies; the blade is then drawn out by the Ryder hammer. The rolling is a very interesting operation, and is performed by Barnes' patent rolling machines, in which there are two horizontal spindles, each carrying four cams, in which the dies are fixed. These cams occupy about one-third of a circle; and the dies, which are cut on the periphery, are set so as to give the required thickness to the bayonet blade. After the bayonet has been trimmed, it is hardened and ground. The socket is next drilled and milled, the slot for forming the attachment to the rifle being afterwards cut; and after the further operation of "blueing" and polishing, the bayonet is complete.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

HEALTH AND SEWAGE OF TOWNS.

A meeting of the Executive Committee has been summoned for 12 o'clock on Tuesday, the 24th inst.; and an invitation has been addressed to the Surveyors and Medical Officers of Health of the Vestries and District Boards of Works of the Metropolis, asking them to attend, to meet the Committee, and confer with them on the House Drainage of the Metropolis.

NATIONAL TRAINING SCHOOL FOR MUSIC.

The Michaelmas Term commenced on Thursday, the 28th ult., with seventy-one scholars.

Mr. Ernst Pauer's Lectures on the "Æsthetics of Music" will be continued on the 21st and 28th instant, in the West Theatre of the Albert-hall. These lectures will be delivered to the whole body of students.

The Duke of Westminster, K.G., will preside at a meeting to be held in the Town-hall, Rhyl, North Wales, on the 18th October, to promote the foundation of scholarships in the northern counties of the Principality. The meeting will be addressed by representatives of the Society of Arts and the Committee of Management of the School, also by other noblemen and gentlemen.

A pianoforte, by Messrs. John Broadwood and Sons, has been presented to the School by Sir Thomas Edwards Moss, Bart., of Itterspool, Liverpool.

CANTOR LECTURES.

The third lecture of the third course of Cantor Lectures for the past Session, on "Wool Dyeing," by Mr. GEORGE JARMAIN, was delivered on Monday evening, March 20th, as follows:—

LECTURE III.

Colour has been well described as the impression which the light, reflected from the surface of a body, makes upon the eye.

Sunlight contains seven colours, which are called the prismatic colours, because they are obtained by the aid of a prism. The surfaces of bodies have the power of reflecting these colours. When all are reflected, the body appears white; when none are reflected, the body appears black; when part are reflected and part absorbed, the reflected ones give their own impression to the eye; and thus there is produced that infinite variety in combination of colour with which we are so well acquainted.

As gaslight and most artificial lights do not contain the whole amount of the prismatic colours which are found in sunlight, those which are not present are not reflected from the surface of bodies, which often appear differently coloured by gaslight to what they do by daylight. When a body is seen under the influence of a monochromatic light, such as that of sodium, we see these effects greatly exaggerated. As there is only one of the prismatic rays in the sodium flame, namely, the yellow, only the yellow portion of the colour of bodies is seen under its influence, the other part appearing black, or very dark.

As the colour of a body depends upon the power which its surface possesses of reflecting certain prismatic rays, it is evident that the art of dyeing consists in fixing upon the fabric a substance which will enable its surface to reflect rays different from those reflected by the fibre in its natural condition.

Substances which have the power of changing the reflecting condition of the surface of a body are called colouring matters. Many of these tinctorial agents are derived from the vegetable kingdom, as the dyewoods, some from the animal, as cochineal, whilst others, and a numerous and interesting class, are artificial productions. Each colouring matter has special characteristics of its own, which require a special study, in order that they may be utilised by the dyer to the best advantage. These individual properties and peculiarities will occupy our attention during the succeeding lectures.

For dyeing purposes, only those colours can be utilised which are soluble in spirit or water, and which have an attraction or affinity for fibre —the colour imparted to the fibre having body beauty or permanency, and not being a mere irregular stain. Colours which are insoluble are pigments that can be utilised by the painter and printer, but are of no service to the dyer.

Mr. Bancroft divided colours into two classes: those which possess the power of attaching themselves to the fibre without the aid of a third body he called substantive colours, and those which require the intervention of a third body to enable them to fasten themselves upon the fibre he called adjective colours. This distinction, though not very sharp, is very convenient, and has been generally adopted.

The distinction is not sharp, because colours are frequently adjective to one fibre and substantive to another, and often a substantive colour may be very greatly improved by the aid of a third body, when it then virtually becomes an adjective colour.

The colours which are substantive to woollen tissue, are—The aniline colours, picric acid, indigo, cudbear, and archil. The red and yellow woods partially.

The colours which are adjective to wool, are —Logwood, the red and yellow woods, flavine, turmeric, madder, cochineal and lac dye, &c.

Fast and Loose Colours.

The dyer must take account of the degree of permanence which his colours will be expected to possess. If the goods, after leaving his hands, have to be scoured in soap and alkaline liquids, and to be milled under the stocks, and then, when worn, to be exposed for a prolonged period to sunlight and atmospheric influences, to sea spray and perspiration, &c., the dyer will fix upon them his fastest colours; but if they be articles of dress which have not even to be washed after leaving his hands, and have to be worn only a few times, and then probably by artificial light, he may venture to put on a loose or fugitive colour. These colours are often bright and dazzling in direct proportion to their fugitiveness.

Few colours will withstand unimpaired the direct action of sunlight, the aniline and weed colours, and delicate shades, such as lavender and peach, pinks and greens, are often injured and spoiled when exposed to bright sunlight for a few hours.

The action of light upon colour seems to be that of a reducing or deoxidising agent.

Heat, moisture, and perspiration also affect colours injuriously.

The influence of dew upon colour has long been known, and before the use of chlorine as a bleaching agent it was customary to bleach linen and calico by exposing the goods for a considerable time on grass, so that they might be submitted to the action of dew by night, and sunlight by day.

The permanency of the colour is very much affected by the mode in which the goods are dyed; the duration of the time of boiling, the temperature of the dye-bath, the mordant used, have each their influence on the stability of the dye.

The ordinary colouring matters which may be made fast upon woollen fabric by employing suitable means, are the following:—Indigo, logwood, the red woods, madder, the yellow woods, quercitron bark and flavine, cochineal and lac dye.

The colouring matters which are more or less fugitive when applied to wool are—The aniline colours, cudbear and archil, picric acid, turmeric, and Persian berries.

As a rule, colours are faster upon wool than upon cotton or silk; indigo is, however, faster upon cotton than upon wool.

Mineral colours do not answer well for wool, Prussian blue being almost the only mineral colour employed.

The difference in the tinctorial power of colour is very great; thus, one part of flavine will dye a given weight of wool which would require sixteen parts of bark to give the same shade of colour, and the depth of colour of the solution gives no indication as to its tinctorial power, for a pale yellow solution of picric acid will dye very much more material than an infusion of fustic which may appear quite dark with colour.

Fixation of Colour.

Opinions vary as to the mode in which colour becomes fixed upon fibre. Some contend that a true chemical combination takes place between the fibre and the colouring matter; others state that it is no true chemical combination, but that the colouring matter is attached to the fibre by a special force in which equivalent proportions do not obtain; others, again, say that the adhesive action is altogether mechanical, and that the colouring matters are absorbed into the pores of the fibre and held there mechanically. Some hold that the colour is fixed to the surface only of the fibre by molecular attractions; others think that the fibre is perfectly permeated by the colour. There are special reactions which lend force to each of these antagonistic opinions, but for all practical purposes they are not likely to influence the operations of the dyehouse, and they are at the present moment more interesting as theoretical considerations than useful and capable of being turned to practical account in the dyehouse.

Mordants.

A mordant is a salt or other substance, by means of which colouring matter can be fixed upon fibre which of itself has no affinity for it. A dyed fabric may, therefore, be considered to be a ternary compound of colour, tissue, and mordant.

There are but few colours which have the power of fixing themselves upon fibre permanently without the aid of a mordant; for, as a rule, without such aid, they produce a colour or stain which may for the most part be washed out by means of soap and water. And even those substantive colours which can be used without the aid of a mordant, with one notable exception, namely indigo, are rendered both brighter and faster by the use of a mordant.

In the case of indigo, the oxygen of the air, which serves to render the indigo insoluble, and thus to fix it upon the fibre, may be considered as its mordant, were it not that the term has been restricted to bodies which are capable of being applied in solution.

Mordants may be classified in two groups:—

1. Metallic salts.
2. Oils—Albumen and casein.

Metallic salts are the only mordants which are employed in the dyeing of woollen fabrics, and these are mostly confined to the salts or other compounds of tin, aluminium, chromium, copper, and iron.

These compounds fulfil certain essential conditions of a good mordant, which are the following:— The mordant must be soluble, so that it can thoroughly permeate the fibre. If the mordant be already in solution, it must not cause the water to become turbid when it is added to the bath. The mordant must leave an insoluble deposit within the pores or upon the tissue submitted to its action. The insoluble deposit must be capable of forming a combination with colouring matter, which, if it affect it in colour at all, it must brighten. The combination should take place slowly, and with regularity.

The salts in common use as mordants for wool, which are found to fulfil the above conditions, are:—Alum and alum cake, bichromate of potash, copperas or protosulphate of iron, blue vitriol or sulphate of copper, and tin solutions.

Most of these salts are of an unstable character, the acid and base being held together by weak affinities; this is notably the case with the iron and

tin compounds; alum and sulphate of alumina are more stable, but are decomposed by woollen tissue at a boiling temperature. Bichromate of potash is decomposed in a special manner, which I shall describe further on.

The insoluble matter deposited by the mordant on the fibre is either a subsalt of the metallic base, or a hydrate, or both combined.

The nature of the combination which subsists between the deposited matter and the fibre is involved in the same doubt and uncertainty as those which are encountered in studying the fixation of colour. The general opinion seems to be that the insoluble particles of the mordant are retained mechanically within the pores or in contact with the cell walls of the fibre, or that they adhere to the external walls of the cells by some attractive force. Whatever may be the mode, however, by virtue of which they are attached to the fibre, they still retain all their properties of combining with colouring matter and forming insoluble compounds with them.

Lakes.

As the insoluble matter precipitated upon the fibre is frequently a basic salt, the acid of the mordant often exerts a considerable influence upon the colours obtained. A chloride of tin gives a different shade of colour with logwood to that produced by a sulphate or sulpho-muriate of tin.

The fact that the colours obtained upon tissues are frequently different in shade, purity, and intensity to the lakes produced with the same mordant and colour, seems to give force to the theory that the affinity which holds together the mordant and tissue is of a chemical character.

These insoluble bodies are combinations of the base of mordants with colouring matters; they are obtained when a solution of the mordant is added to a decoction of a colouring matter. Frequently the lake does not precipitate until a solution of an alkali is added to withdraw the acid from the mordant salt. It would thus seem that the action of the fibre upon the mordant is somewhat analogous to that of an alkali upon it, in causing a deposit of the mordant hydrate.

Modes of Applying Mordants on Wool.

In wool-dyeing the goods are always mordanted at a boiling temperature.

Boiling seems to have the effect of opening the pores of the wool and expelling the air, thus giving passage to the mordant solution.

The mordant may be either applied before the dyeing operation, along with the colouring matter, or after the dye has been applied. Sometimes it is found advantageous to apply the mordant both before and along with the dye.

The application of too much mordant is to be avoided; this is notably the case with the iron and bichrome mordants, which produce rusty and green shades respectively, when an excess of the mordant has been used.

Utensils Employed in Mordanting.

The most convenient vessels for mordanting woollen goods are wood cisterns, 6 to 8 ft. long, 4 to 5 ft. broad, and 3 to 4 ft. deep, with a false bottom made of perforated iron plates. The water is heated by a perforated steam-pipe, 2 in. in diameter, which passes under the plates along the middle of the cistern. When scarlets, oranges, and crimsons have to be dyed with an acid tin mordant, block tin plates should be substituted for the iron plates, which would seriously affect the colours, as iron salts would be formed by the acid acting upon the iron plates. Metallic iron also decomposes tin salts, the tin being precipitated in the metallic state.

$$\underset{\text{Stannous chloride.}}{SnCl_2} + \underset{\text{Iron.}}{Fe} = \underset{\text{Ferrous chloride.}}{FeCl_2} + \underset{\text{Tin.}}{Sn}$$

Large iron pans are also frequently used in both mordanting and dyeing, the water being heated, either by a steam-pipe blowing straight down into the water, or by direct fire-heat under the pan. The steam in this case is only employed to heat up the water to the boil, the subsequent mordanting or dyeing being done by the fire-heat alone. Many experienced dyers prefer direct fire-heat, especially for the dyeing, as a temperature can be obtained which is two or three degrees higher than what can be obtained by steam alone; and fire-heat is more especially preferred for wool, which is kept in a more constant state of agitation by the ebullition of the water than can be obtained by steam-heat. The wool is also less liable to be felted or twisted into tails.

A more uniform ebullition and agitation of the liquor may, however, be obtained by passing the steam-pipe, not perforated, several times along the bottom of the cistern, and allowing the condensed steam to discharge itself into the cistern by an upright pipe, bent over above the surface of the liquid. When the steam pressure is not less than 50 lbs. per square inch, this is an excellent and economical mode of heating both the mordant and dye baths.

When pieces are mordanted or dyed, they are kept in motion by causing them to pass over a wince, placed over the dye-vessel and turned by machinery. Three or four pieces are sewed end to end, and are thus passed over the wince continuously.

Wool is kept in motion by being stirred up almost continuously during the process by long poles, called "stangs." The thorough stirring and breaking up at the commencement is of great importance, in order to prevent unequal reception of both mordant and dye.

The mordanting usually occupies from one to two hours, the liquor is then run off from wool, and water run in once or twice to wash out excess of mordant, it is then put in a coach or waggon, covered over with a sheet, and left over-night, or longer if convenient. The colour obtained after leaving it in this manner is always better than when it is passed direct into the dye-bath after mordanting.

Pieces after mordanting are drawn out of the bath, washed on the washing machine, and left over-night before dyeing.

Alum.

This was the first substance used as a mordant. It is a double sulphate of alumina and ammonia or potash. It was formerly manufactured from certain pyritic shales found on the east coast of Yorkshire, but now it is chiefly obtained by acting on burnt aluminous shales or clay, with sulphuric acid, and afterwards saturating the excess of acid by the addition of ammonia or potash, according

as ammonia or potash alum is required. The active mordant agent in alum is alumina, of which potash alum contains 10 per cent., and ammonia alum a little more. The latter is now more frequently met with in the market than the former. Ammonia alum may be recognised by stirring up a little of the powdered alum with quick lime or caustic soda, and moistening with water. The smell of ammonia will be given off from ammonia alum. The most objectionable impurity which alum contains is a ferrous salt, which may be detected by the well-known tests for iron, namely, prussiates of potash, or a solution of tannin.

Alum deposits upon wool fibre, with which it is boiled, aluminic hydrate $Al_2(HO)_6$ or subsulphate of alumina, according to the relative proportions of the alum and wool. When the hydrate only is left on the fibre, the sulphuric acid appears to have combined with ammonia formed from some gelatinous principle of the wool which is dissolved during the boiling. M. Havrez, late proprietor of the technical schools at Verviers, made before his death a long investigation into the different reactions which alum gives during the process of mordanting. The general conclusions at which he arrived were, that a weak bath of alum, that is, a bath containing less alum than $\frac{1}{15}$ of the wool, becomes alkaline, and affects colour in an alkaline manner. A larger quantity of alum than $\frac{1}{15}$ of the wool acts as a weak acid upon colours giving violets upon logwood and the red woods. Large quantities of alum upon cloth act upon colours as alum itself does, giving acid effects, whereas small quantities act as hydrates, giving alkaline effects.

The addition of an acid has the same effect as using an excess of salt, and it is found to be useful in extracting the iron from the fibre which thus becomes purified.

Alum is sometimes employed alone as a mordant, but more frequently conjointly with other mordants. Alone it gives bright colours.

During the preparation of these lectures, it occurred to me that it would be useful to know what is the action of each mordant, when fixed on wool, upon the colouring matters commonly employed in the dyehouse. I am of opinion that these effects are much more instructive to the young dyer than the examination of the precipitates which the mordants give with decoctions of the dyes. I have accordingly mordanted samples of wool with the following mordants—muriate of tin, alum, sulphate of copper, bichromate of potash, and copperas, and have dyed them with the following colouring matters—fustic, flavine, American bark, turmeric, sumach, madder, barwood, saunderswood, camwood, and cudbear; and have arranged them in this tabular form, in order that the action of any of the above mordants on the dyes may be readily seen. 50 per cent. of the weight of the wool in colour was used with the following dyes:—Fustic, bark, sumac, madder, camwood, barwood, saunderswood, and logwood; 4 per cent. with fustic, 12 per cent. with cudbear. The following quantities of mordants were employed:—2 per cent. bichrome for logwood, 1 per cent. for the other colours; 8 per cent. copperas, with 2 per cent. tartar added; 12 per cent. alum, with 2 per cent. tartar; 8 per cent. blue vitriol, 8 per cent. muriate of tin of 60° Tw. 100 grains of well-scoured and raised white wool was found to be a convenient quantity to operate upon. The mordanting and dyeing were done in an enamelled iron pan, holding about a pint, and heated over a Leoni's gas stove. The wool was boiled with the mordant for an hour, wrung out and left over-night; the dyeing, which also occupied an hour, was done next day. [These patterns were frequently referred to during the lectures as illustrations of the effects of the mordants on the dyes, and the lecturer strongly recommended the young dyer to prepare a similar table for his own use, in order that he might familiarise himself with the use of the various mordants and dyes.]

Copperas.

This is another mordant which has been used a long time. It is the crystallised protosulphate of iron, called also ferrous sulphate. It is manufactured chiefly from soft pyrites, which are met with among coals and in the coal shales. The pyrites, when exposed to air and moisture, readily oxidise, and form sulphate of iron and free sulphuric acid; the liquor is boiled with scrap iron and then crystallised.

The most serious impurity to which copperas is subject through mismanagement is alumina. To detect this, the copperas should be dissolved in water, and fully peroxidised with nitric acid, and then precipitated with excess of pure caustic soda and filtered; the alumina, if present, will be precipitated from the filtrate by the addition of a solution of chloride of ammonium.

The use of copperas has been greatly lessened by the use of bichromate of potash as a mordant for logwood colours, especially blacks on pieces. Some of the best wool dyed blacks are, however, still done with copperas.

The same explanation of the deposition of the ferrous hydrate upon wool as was given for alum will be sufficient, with this difference, that the ferrous hydrate deposited very quickly becomes partially oxidised into the form of ferric hydrate, by the oxidising action of the air; a dyer, however, tells me that he has detected iron in the ferrous condition in the wool, even months after it had been mordanted. This fact seems to prove that there is a true chemical combination between the mordant hydrate and the wool. The reducing action which wool undoubtedly possesses may also assist in restraining the oxidising action of the air.

Tartar or argol is almost invariably used along with the copperas, in order that the solution may be kept clear, and the too rapid dissociation of the copperas prevented. The tartar, in this and every case where it is used with a mordant for a similar purpose, should be added to the bath first, for it is easier to prevent a precipitation than to redissolve the precipitate after it has formed. Copperas is frequently used simply as a saddener; its effect upon colours is to produce dark shades. It is used both alone and in conjunction with alum and sulphate of copper, but not with bichromate of potash, which it reduces and renders its special properties less effective as a mordant.

Sulphate of Copper,

Called also blue stone, blue vitriol, and Roman vitriol, is not used extensively as a mordant, and never alone. It is used along with alum to obtain

logwood blues, and with copperas to produce blue blacks.

Bichromate of Potash.

This splendid salt is met with in commerce in a state of almost absolute chemical purity. I think it is more extensively used in our woollen dyeing than any other mordant. Its decomposition in the bath in contact with wool is different from that of any other mordant, for its constitution is different. The metal which is deposited as a hydrate upon the wool, is present in this salt as the acid, and not as the base, which is potash. Bichromate of potash may be represented as being neutral yellow chromate of potash, in combination with dry chromic acid; thus—

$$\underset{\text{Bichromate of potash.}}{K_2\,Cr_2\,O_7} = \underset{\text{Chromate of potash.}}{K_2\,Cr\,O_4,} \quad \underset{\text{Chromic acid.}}{Cr\,O_3}$$

To obtain the full effect of the bichromate as a mordant, sulphuric acid is usually employed along with it; the whole or major part of the chromic acid is thus set free—

$$\underset{\text{Bichromate of potash.}}{K_2\,Cr_2\,O_7} + \underset{\text{Sulphuric acid.}}{H_2\,SO_4} + \underset{\text{Water.}}{H_2\,O} = \underset{\text{Sulphate of potash.}}{K_2\,SO_4} + \underset{\text{Chromic acid.}}{2\,H_2\,Cr\,O_4}$$

Chromic acid is a most powerful oxidiser, and acts energetically upon wool, and should, therefore, be used with caution, as we shall see further on. The wool furnishes the reducing agent, probably in the form of hydrogen, which acts upon the chromic; thus—

$$\underset{\text{Chromic acid.}}{2\,H_2\,Cr\,O_4} + \underset{\text{Hydrogen.}}{3\,H_2} = \underset{\text{Water.}}{2\,H_2\,O} + \underset{\text{Chromic hydrate.}}{Cr_2\,(HO)_6}$$

The chromic hydrate thus produced is deposited upon the wool as the mordant hydrate, a portion of neutral chromate of potash is also usually present on the fibre.

I have ascertained experimentally that it is not safe to use more than three per cent. of the weight of wool of bichromate, for if four per cent. be used the colour becomes impaired, and if 12 per cent. be used the wool cannot be dyed with logwood at all, and the curious effects of over-chroming are produced. These effects are due to the destructive oxidising action of the chromic acid upon the wool. When a still larger quantity of bichrome is used along with sulphuric acid the wool is dissolved, and a solution of chrome alum is obtained, thus—

$$\underset{\text{Bichromate of potash.}}{K_2Cr_2O_7} + \underset{\text{Sulphuric acid.}}{4H_2SO_4} + \underset{\text{Hydrogen.}}{3H_2} + \underset{\text{Water.}}{18H_2O} = \underset{\text{Chromium, Potash. Alum.}}{Cr_2(SO_4)_3K_2SO_4 + 24H_2O}$$

The effects of using various proportions of bichrome upon wool, ranging from two to twenty per cent., were exhibited.

Tin Solutions.

These are generally called tin spirits. There are great numbers of them in use; every dyer and maker has his own special plan of preparing them, and generally firmly believes that his are the best in existence. I do not think it would be profitable or edifying were I to describe the mode of preparing all there are made, firstly, because I think that at least three-fourths of them are unnecessary, and secondly, because many of them are trade secrets.

The useful and only essential varieties are the following:—

The single and double muriates. These are prepared by dissolving granulated tin in commercial hydrochloric acid standing at from 33 to36 ° Tw.; diluting with water down to 60° Tw. for the single muriate, and making the double muriate up to 80° or 100° Tw. or more.

The nitrate of tin is made by dissolving tin in single nitric acid of about 33° Tw., and free from nitrous acid. The tin should be added in small portions at a time, to prevent the precipitation of the tin as the insoluble binoxide, or metastannic acid.

Scarlet spirits are made by adding oxalic or tartaric acid, or both, to the single muriate.

Blooming spirits are made by adding sulphuric acid to the muriate prepared as above.

The use of tin solution is principally for the purpose of brightening or blooming other colours, and (except in scarlet and crimson dyeing) they are not used alone.

In the remaining lectures I shall frequently have occasion to speak of the use of these spirits.

MISCELLANEOUS.

SURPLUS OF THE EXHIBITION OF 1851.

In view of collecting evidence of public wishes in the disposal of the surplus of the Exhibition of 1851, and placing it before the Commissioners for their consideration, this subject was briefly discussed at the Educational Conference at the Society of Arts in June last. (See *Journal*, pp. 763 and 794.) The newspapers of Manchester and Leeds have taken up the question, and are commenting upon a paper written by Mr. Jones, and read before a meeting of the Iron and Steel Institute. Both Leeds and Manchester put in claims on behalf of the subscriptions which they contributed to the preliminary expenses of the Great Exhibition. And Birmingham, too, is moving. At a meeting on 5th October, to hear Mr. Morley's address at the Midland Institute, Mr. Chamberlain, M.P., said when the institution was established it was intended that there should be a museum connected with it which should represent the industries of the town. That part of its work had been thrown upon the Town Council, but the Council had been unable satisfactorily to complete it. Its limited funds were taken up in the maintenance and support of the free library, whose importance might best be estimated by the fact that every year half a million of volumes were used from its shelves. The value of an industrial museum for the town would be incalculable, and he confessed he had seen with regret such a collection as that to which the President had referred buried in the recesses of the British Museum, when he knew that it would be of so much greater use if it were sent out to the provincial centres. He thought the time had come when they might ask for a share of that golden shower which had hitherto fallen exclusively on metropolitan soil, and when they might ask for some contribution towards such an institution from the national funds. That could be be done without any claim on the taxation of the country. The Commissioners of the Exhibition of 1851 had an enormous sum at their disposal, which amounted now to something like three-quarters of a million. He would suggest that they should take an early opportunity of consulting the corporations of other towns similarly situated, and that they should have a deputation to the Commissioners to represent their case, and he had reason to believe that their demands would not unwillingly be complied with.

THE LOAN COLLECTION OF SCIENTIFIC APPARATUS AT SOUTH KENSINGTON.

Botany and Vegetable Products.

In a collection like that at present on loan at South Kensington, natural history does not come prominently to the fore; the exhibition is essentially one illustrating physical science; nevertheless, in the various branches, whether it be geometry, mathematics, electricity, or chemistry, vegetable products are found to play an important part, either working hand-in-hand with some sister science, or else forming a basis indispensable for its proper development. Naturally, one would expect to find botanical science specially at home in Section 18, Biology; and here, indeed, are some splendid botanical diagrams for class teaching, as used in the Royal College of Science, Dublin. The advantage of good diagrams of a sufficiently large size to be clearly seen in the class-room is apparent, not only to those engaged in teaching, but also to the student; and it is a remarkable fact that there is no good set illustrating the science of botany published in this country. Each public botanical class is pretty much at the mercy of the lecturer or professor, to provide what he thinks best or is capable of providing; on the Continent, however, many excellent sets are published, some capital German ones being exhibited. The models prepared by Robert Brendel, of Breslau, for illustrating the structure both of monocotyledonous and dicotyledonous flowers are certainly ingenious. They are made of gutta percha, papier mache, or some such material, held together with cane, wires, &c., and painted with some approach to the natural colours of the flowers, though in most cases they have a bright and gaudy appearance. They are made on a more or less enlarged scale, with the view of facilitating the recognition of even the smallest organ, and comprehending the distinguishing characteristics of floral structures, by comparison with living plants. They are, moreover, made to take to pieces, so that as with a real flower the model can be dissected. With all these apparent advantages, and though it appears they are used in the Royal College of Science, Dublin, they can never supersede, or even be so good for teaching purposes as real flowers, with which every botanical teacher can with little difficulty supply his class during the summer season. Their value will be chiefly for winter teaching. The models, it appears, were first prepared at the suggestion, and under the guidance and superintendence of Professor F. Cohn, by M. Lohmeyer, who died in 1872, and presented his collection of over 300 models to the Institute of Vegetable Physiology in the University of Breslau. Prof. Cohn exhibits several very interesting apparatus, one of which is described as a germinating apparatus for the simultaneous germination of a large number of seeds, or for the cultivation of microscopic organisms, at a constant degree of temperature and moisture. The seeds intended for germination are soaked for twenty-four hours in water, then 200 are placed in each earthenware dish and covered over. Enclosed tin dishes are filled with water, which keeps in the porous clay dishes the amount of moisture requisite for the development of the seeds; finally, by the aid of a small gas flame, governed by a Bunsen's regulator, and placed underneath the germinating chamber, the temperature is kept very constant. The visitor is informed that this apparatus is used for the examination of the germinating power of agricultural seeds, which takes place at the seed control station, connected with the Institute of Vegetable Physiology. The Royal Botanical Garden and Museum of the University of Breslau exhibits several series of photographs, one showing various effects upon timber consequent upon external injury to the tree; a similar set is exhibited in the Kew museum, where they find a very proper position amongst injuries caused to timber, either by bad pruning or accident. The little volumes issued by Dr. H. Nördlinger, of Hohenheim, Wurtemburg, each of which contains a number of sections of different woods, should be more generally known and more frequently consulted than they are. The volumes, though made in the form of books, are in reality small cases fitted with sheets of paper, having oval shaped holes cut in their centre; over this are pasted very thin microscopical sections of the different woods, either longitudinal or transverse. For the purposes of reference and comparison these volumes are very useful, containing as they do a large number of woods in a very small compass. The volume exhibited is the seventh published, and it contains about 50 newly introduced woods from various climates.

Belonging to this section, Biology, but really placed at the end of the proceeding section, Geology, for want of room in its proper place, is a double case containing distinct collections of fruits and seeds, illustrating several important natural orders, which have been the subject of separate memoirs by eminent authors. Viewed in the light for which they are exhibited, namely, as the basis of valuable scientific papers, they are very important; but when it is borne in mind that the orders to which these fruits belong contain some plants of the greatest value to mankind, and that the proper elucidation of the genera and species of two orders, at least, were worked out for one of our colonial Floras, the value of such work will be apparent, both to the unscientific as well as to the scientific reader. The two orders alluded to are the *Myrtaceæ*, which includes the now well-known genus *Eucalyptus* and the *Proteaceæ*, a very large group of trees, limited in their geographical distribution to Australia and South Africa. Whether the *Eucalyptus globulus* will ever prove to be the beneficent plant to mankind for which it has obtained its reputation is, perhaps, doubtful; nevertheless, the trees are remarkably quick growing, and the wood is very strong and durable, and may therefore be plentifully planted in forest reserves. Other species also, which are very numerous, might prove to be equally valuable, and quite as easily acclimatised as tho blue gum, upon which so much attention has been centred. In the *Rubiaceæ*, which form a very large tropical order of trees and shrubs, are some of the most important of all economic plants, for to it belongs the Cinchona, or Peruvian bark plants, the Ipecacuanha, the Coffee, and the Terra japonica (*Uncaria gambir*), so much used in tanning. As contributions to the accurate nomenclature and botanical affinities of the plants, the papers founded on the orders represented in this case have a very high merit; embodied, as much of the matter has been, in the Floras of our different colonies, published under the authority and by the assistance of Government, it must prove indirectly, if not directly, of permanent value to the colonist and man of commerce; for by a knowledge of the affinities of newly discovered plants with those of established reputation, the value or otherwise may often be determined. The whole of these collections of fruits are exhibited by the Museum of Economic Botany, of the Royal Gardens, Kew.

Though the arrangement of the collection at South Kensington generally is very creditable to those officers upon which this difficult task has devolved, it, nevertheless, seems a pity that exhibits relating to each other should not have been brought more together; thus in Section 19, Educational Appliances, which is at the furthest extremity of the south gallery, as Biology is at the west, are numerous specimens of a similar nature to those seen in that section; in botany, for instance, are several exhibits of botanical wall charts, also dendrological collections illustrating the trees of Russia. From Hamburg we have herbaria of grasses, of forest trees, and other specimens bearing on the uses of plants. In connection with microscopy the "wool measurer" exhibited by R. Wasserlein, of Berlin, is ingenious. It is described as "affording the investigator the possibility of a complete command over stuffs composed of vegetable or animal fibres, as wool, silk, and all vegetable fabrics, so that

they can be stretched and extended under the microscope; also in case the fibre is twisted, as in wool, it may be evenly stretched and turned round itself, so that its average diameter may be estimated. The apparatus allows the object which is thus stretched to be placed on a glass slide, so that it can be treated with acids, &c., and covered with a cover glass. All this can be done without preventing the manipulation described above. Threads up to a length of one and a half inches can be moved successively across the field of the microscope."

In Section 15, Geography, is a most interesting map of the hop-growing districts of central Europe, by J. Carl and C. Homan, of Nüremberg. It contains, besides, special maps of several of the principal Continental hop-growing countries, an "agrarian, statistical, and general map of the European hop-growing districts on the Continent and in England," also "tabular and graphical representations of the cultivation of hops, and of the hop consumption of the whole world;" next a "classification of the various sorts of hops," and "comparative tables of the agrarian measures and commercial weights." All these maps are exceedingly interesting, showing as they do the extent of cultivation of a plant so important as the hop. The statistics illustrating the cultivation, production, and consumption of hops show that while in Germany 37,910 hectares of land are under hop culture, producing 477,111 cwts., England has 25,696 hectares, producing 384,090 cwts.; Austria, 7,711 hectares, producing 92,532 cwts.; Belgium, 6,500 hectares, producing 97,500 cwts.; France, 4,000 hectares, producing 48,000 cwts.; and the rest of Europe 619 hectares, producing 8,454 cwts., giving a total European surface under cultivation of 82,346 hectares, and a production of 1,107,687 cwts. It is worthy of note in connection with the extent of the liquor traffic in this country, that the English consumption of hops is by far the greatest of any other country, for while England shows a consumption of 600,000 cwts., Germany, the next largest, gives only 321,000 cwts, and Austria 100,000 cwts., the remaining countries decreasing much more rapidly. Besides the extensive European cultivation of hops, the plant is very largely grown in North America, from which country, indeed, we import considerable quantities.

Perhaps in no branch of science is so much change and so much progress constantly being made as in Chemistry (Section 13). It is a science intimately associated with plant life, and further than this by the aid of chemistry many valuable products of plants can be imitated or entirely replaced. Thus, in the artificial fruit essences now so much used for flavouring confectionary, which are solutions of various organic ethers in rectified spirit of wine, we have essences nearly identical both in flavour and chemical composition with the flavouring principles of the fruits they are intended to imitate. Amongst the essences in common use are those of strawberry, raspberry, cherry, pine apple, pear, apple, peach, &c. With regard to medical products, which chemistry has done much of late to develop, there is a very interesting series of vegetable alkaloids, obtained principally from plants that have recently come into notice as new medical agents. Thus, there is a specimen of pilocarpin, an alkaloid obtained from the now famous Jaborandi (*Pilocarpus pennatifolius*), a plant of Pernambuco, and only comparatively recently introduced into medicine; also kamalin, obtained from the glands of the fruits of *Mallotus philippinensis*, better known, perhaps, as *Rottlera tinctoria*. The principal value of kamala is for the production of a deep bright orange, or flame-coloured dye, largely used by the Hindoos for dyeing silk. Kamala has also been used in cutaneous affections, and at Aden it is used by the Arabs internally in leprosy; its principal use, however, seems to be as an anthelmintic. The tree is very widely distributed not only in India, but in the Indian Archipelago, tropical Australia, and Arabia. Another exhibit in the same series is kosin, the active principal of kousso (*Brayera anthelmintica*), another celebrated anthelmintic from Abyssinia. Kosin is stated to crystallise, partly in needles and partly in short thick prisms of the rhombic system. It is almost insoluble in water, but is easily dissolved in ether, benzol, sulphide of carbon, and chloroform, and less easily in glacial acetic acid and alcohol. These and other productions of a similar character forming this series are exhibited by Emanuel Merck, of Darmstadt.

Perhaps the most interesting of all the exhibits, in a popular or commercial point of view, is the series of "Aniline and other chemical products used for dyeing," exhibited by Brooke, Simpson, and Spiller. The numerous bright colours and delicate shades now so much used for different articles of feminine attire are all traceable to the coal-tar series of dyes, the introduction of which has driven the vegetable dyes out of the market. *Roccella tinctoria*, *Lecanora*, *Cudbear*, and other lichens, as well as madder, are names rapidly becoming less and less known, though in the case preceding that of the aniline dyes are specimens of liquid orchil from orchella weed (*Roccella tinctoria*), as well as samples of cudbear from the same. A splendid new colour, under the name of chrysoidine, applicable for dyeing silk, wool, cotton, leather, &c., is manufactured and exhibited by Messrs. Williams, Thomas, and Dower. It is described as follows by the manufacturers, "Chrysoidine is, according to quality, the sulphate or hydrochlorate of a new bi-acid base, belonging to the benzine series. It is a valuable yellow, and owing to the readiness with which it crystallises can be obtained in a state of perfect purity. Except phosphine, it is the only basic yellow known, and as it is the result of a direct process (not a secondary product), it can be obtained at a much lower price than phosphine, which it equals, and in some of its applications surpasses in strength and beauty of shade. It dyes in neutral or slightly basic baths, and has a great affinity for silk, wool, and for even unmordanted cotton. Mordanted cotton is dyed a yellow or orange shade, according to the mordant employed. It combines readily with magenta and other red colours, giving rise to very clear and beautiful scarlets." This description is quoted to show the complete revolution that chemistry is making in a most important branch of trade, that of dyeing, the basis of which at one time was almost exclusively of vegetable origin. This most recent discovery, chrysoidine, is but one example accounting for the constant diminution in the imports of madder and of other vegetable dyes, which at one time were of no mean value to the countries producing them, but which our consuls at the different ports from whence they are shipped point to as products which, in the course of a few years, will probably be known only by name.

With regard to agricultural chemistry, a subject large, important, and interesting in itself, and, moreover, one that Messrs. Lawes and Gilbert, of Rothamstead, have made their own, it will be sufficient to say that these interesting experiments are well shown and explained. The matters connected with these experiments are so extensive and varied, that it is impossible to enter upon them in this article.

In Section 10, Electricity, we have many instances of the value of a vegetable product almost as essential in submarine telegraphy as the wires themselves, namely, the gum resins, known generally under the names of gutta percha and india-rubber, but technically under various other names, as gutta taban, gutta susu, pulo percha, &c. At one time the best quality of rubber, known in commerce as Para rubber, the produce of *Hevea brasiliensis*, was used as the coating or insulating material for telegraph cables; at the present time gutta percha produced by *Dichopsis gutta* of Bentham, or *Isonandra gutta* of Hooker, is the substance chiefly if not exclusively used. It is a Malayan tree, and the gutta percha, which is the well-known milky juice solidified, is imported in very large quantities from Singapore, not exclusively, as is well known, for telegraphic purposes; a fine series of specimens, however, prepared for the above purpose, is

shown in a glass case, the labelling of which seems to have been omitted, and therefore no reference is to be found in the catalogue. The material is shown in its crude state, as imported, as well as in a prepared form, some of the sheets being very carefully manipulated, of a firm, even texture, apparently without a flaw, or so much as an air bubble. Much more care is of course taken in the preparation of gutta percha for electrical purposes than if it were intended for the many ordinary purposes to which it is so frequently applied; the quality is carefully selected and tested, it being indispensable that no foreign matter should be mixed with it. Samples of wire, covered with gutta percha, for electrical apparatus, are exhibited by Madame Bonis, of Paris, as well as by other exhibitors.

The diversified uses of wood are well shown throughout the exhibition, one of the highest applications of of which may be said to be in the formation of geometrical or arithmetical instruments as curves, slide-rules, &c.; for the former pear wood is very largely used, as it is light, even grained, and not liable to chip; for the latter boxwood (*Buxus sempervirens*) is almost exclusively selected, no other wood equalling it in point of strength, hardness, and durability; moreover, next to ivory itself, the finest lines can be cut in it; and another recommendation is that the wood is of a light uniform colour. Boxwood, however, is becoming yearly more and more scarce, the cutting of the trees in the forests of the Black Sea, from whence we obtain our supplies, being up to a certain extent prohibited by the Turkish and Russian Governments, in whose territories these forests lie. The extensive use of boxwood for weavers' shuttles, and for various other small parts of machinery where a hard wood is required, to say nothing of its consumption for wood engraving, which is now very great, points to the necessity of economising our supplies, and, where possible, to introduce other woods in its stead. On account of the scarcity and high price of box, and in view of the ultimate failure of the supplies, various other foreign and colonial hard woods have been tried for engraving purposes, none of which, however, have been found to equal box. Ebony has been, and is still, used for rules and other mathematical instruments, and there seems to be no reason why it should not be more generally used, as well as many other hard foreign woods, especially the light-coloured woods of Australia. The great thing of course is the thorough and careful drying, to prevent the possibility of the wood shrinking, expanding, or warping after manufacture.

One of the most remarkable applications of wood, perhaps, is that for the production of sound. It is well-known that only certain kinds of wood are suitable for the manufacture of wind instruments, thus the best flutes are made of Cocus wood, supposed to be the produce of *Brya ebenus*, a small West Indian tree. This wood has a peculiar metallic ring when beaten, a property not to be found in equal power in any other wood. Many savage tribes in various parts of the world appear to be well acquainted with these acoustic properties of timber, often selecting them from their indigenous trees and constructing them into rude musical instruments; an instrument called a marimba or balafo, from South-Eastern Africa, exhibited in Section 6 (Sound), by the South Kensington Museum, sufficiently illustrates this. It is something after the style of an harmonicon, except that the notes are obtained by striking pieces of wood instead of glass, the woods being selected and arranged in musical sequence. The description attached to the instrument is as follows:—It has twelve slabs of a sonorous wood, beneath which are fastened twelve gourds, to increase the sound. In each gourd are two holes, one of which is at the top and the other at the side. The latter is covered with a delicate film, to promote the sonorousness. Du Chaillu says that the film consists of the skin of a spider. Livingstone mentions spiders' web being applied to instruments of this kind, used by certain native tribes in Southern Africa. It is a favourite instrument with the Negroes as well as the Kafirs.

Of all the applications of timber, perhaps the most important is for constructive purposes, hence the "diagrams illustrating the principles adopted in constructing wood planing machines, which are used in the lectures in the School of Forestry, Vienna, are specially interesting in connection with the organised system of training which has of late years been established by the British Government for forest officers in India. This course of training includes not only instruction under a forester in Scotland, but also in one of the schools of Austria or Germany, where forestry is taught as a science. The diagrams here exhibited are such as are used in the first part of the series of lectures on "Applied Mechanics" at the Imperial and Royal High School of Agriculture and Forestry at Vienna. In these lectures, which are attended not only by young men training for forest officers, but also by those who wish to qualify themselves for the posts of manager or superintendent of large wood-working establishments, diagrams illustrating all the kinds of tools and machines requisite for wood-working are used and explained. Thus a thoroughly practical knowledge of the nature of timber, as well as its practical applications, is imparted, such as cannot be obtained by any system of teaching in this country.

From the foregoing rambling notes, made without any attempt at scientific sequence, it will be clearly seen what an important part botany plays, though indirectly, in providing materials for the study of physical science.

HYGIENIC AND LIFE-SAVING CONGRESS, BRUSSELS.

(From a Correspondent.)

(Continued from p. 974.)

The congress resumed its labours in the Palais Ducal on Monday, 2nd inst.

Section I.— Division A.— General Hygiene.— Herr Zimmer observed that the double distribution of water was impracticable, being very costly, and besides, the water used in the household was useful for flushing the sewers. M. Gérardin considered that the chemical analysis of water was a good test of its purity; the quantity should not be less than 150 litres (33 gallons) per head per day; meters were a mistake, as there must be waste of water. M. Vandenshriek was of opinion that from 65 to 100 litres (14 to 22 gallons) were sufficient. M. Mahaux considered that the purity of water should be established by "physico-chemico-physiologic" analysis, and especially by what is called medical analysis. Of two waters, equally pure from a chemical point of view, one led to the development of goître and cretinism, while the other was completely inoffensive. M. Allard, architect to the Municipality of Paris, thought that the water of the country should be utilised in towns. M. Deluc advocated the inspection of cisterns and the filtration of their water. M. Gérardin said that all the characteristics had their importance. In his opinion oxymetric analysis was of primary importance, though it did not exclude the other tests. Cisterns should be partitioned, and the water used from each compartment alternately. M. Laussedat agreed with M. Mahaux as to the importance of immediate analysis; the goître and cretinism must not be attributed entirely to impure water. Mr. Edwin Chadwick said that water for drinking purposes should be well aerated; it kept well in closed reservoirs, but in cisterns it became affected, especially in populous places. M. Millet approved of cistern water aerated and filtered, as it was suitable for washing and the cooking of vegetables. M. Mahaux did not think that examination by the microscope could define the character of a water. M. Gérardin added that *diatoms* were characteristic of potable water and *bacteria* of impure water.

Section I. — Division B. — Medical Hygiene. — M. Howzé de l'Aulnoit read his communication on the treatment of asphyxia by submersion. M. Janssens described the process of artificial respiration derived by Professor Filippo Pacini, and the excellent result which followed its use in Italy, M. Ledeganck adding that this process had always succeeded with him in the case of asphyxia of newly-born infants. On the proposal of the President, the principal passages of Signor Pacini's paper were ordered to be included in the report of the congress.

The discussion of the report on the fourth question, as to the excessive mortality of infants and young children, was then resumed. M. Bouchut asserted that cold was a not unimportant cause, and contended against artificial nursing in country baby-farms, as had been advocated by Herr Proust. M. Bencke insisted on strict supervision and frequent weighings of each infant; the nutrition of mothers during pregnancy should be improved; and the statistics of nutrition and the nutritive value of children's food should be more studied. M. Davreux considered that the illegitimate child should have more protection from the prejudices of society and the carelessness of the mother herself. M. Dumesnil detailed the official measures adopted in Paris, as regards the inspection of nursing establishments; and a discussion ensued between MM. Janssens, Bertillon, Dumesnil, and Buquet, as to the value of the statistics collected in France on infant mortality and supervision. M. Howzé de l'Aulnoit added some information as to infant mortality at Lille, and examined into its causes. M. Van Cappelle raised his voice against burial clubs, as liable to abuse, and gave some information as to the result obtained in special *hospices* in the maritime towns of Holland. After some further information and discussion, M. Janssens proposed the following resolution :—"That the congress advocate the organisation of an inquiry in each country on the etiological statistics of the mortality of children under a year old, to be conducted on uniform bases." On the proposition of M. Bertillon, an international committee is to be charged with drawing up the questions on which the inquiry shall be based. The discussion was then adjourned.

Section II.—Division A.—Civil Sauvetage.—M. Habets, Secretary of the Liege Association of Engineers (Liege Section), gave a *résumé* of his report on the fifth question, as to the means of preventing explosions and ingress of water in mines, and the safest method of underground illumination. The following are the conclusions arrived at with regard to explosions :—Meteorological observations should be made on the surface of every fiery colliery; natural ventilation should be forbidden in such a case; every fiery mine should be provided with a ventilator capable of rapidly increasing the normal volume of air, or there should be an independent and supplementary ventilator; a Government commission should be issued as to safety-lamps; no explosive substance should be permitted in the return air ways; special schools for miners should be established; the regulations of the various countries on the subject should be embodied in a special report; in every coal district associations should be formed for the purchase and maintenance of appliances for preventing accidents, and for the instruction in their use of bands of *sauveteurs*, like fire-brigades; and the manufacturers of respirators for use in a mephitic atmosphere should study the chemical means of regenerating air already breathed. The conclusions as to the ingress of water are—(1) The best means to avoid it is to strengthen the measures of organisation, control, and underground inspection in mining operations where old workings exist; and (2) in all mining districts associations should be appointed for the purchase and maintenance of diving apparatus, while practical instruction in their use should be given with a view to form brigades of divers. Mr. J. W. Pearse feared that, notwithstanding the greatest precautions, one source of danger in fiery collieries would still remain, viz., the carelessness of the men in smoking but, for a remedy, he looked to the elevation and better education of the miner. Herr Ed. Rau, Brussels, called attention to the importance of a law being passed rendering mine-owners criminally responsible for accidents; it was to the existence of such a provision that must be attributed the results achieved in Germany.

M. Raymaekers, Government engineer, then dealt with that portion of the first question relating to collisions by land, principally as regards railways, indicating as desirable the adoption of the following measures:—(1) The addition of audible to visible signals; (2) the interlocking of points and signals in all dangerous positions; (3) the suppression as far as possible of removable signals in the working and extension of the block system; (4) perfection of the means of signalling placed at the disposal of signalmen; (5) the introduction of continuous brakes of instantaneous communication; (6) an improved *status* and education of employés. These measures were approved by the meeting; and Herr Rau begged to complete the information as to signalling given by M. Raymaekers. In Germany, where an endeavour is being made to diminish the number of fixed signals, the law as to the responsibility of railway companies has led to a diminution in the number of signalmen. Telegraphic communication, totally independent of the public service, should be provided on every line, and would enable a large number of fixed signals to be dispensed with.

Dr. Dujardin described his invention for the extinction of fire by means of steam, putting in several copies of his work on the subject; and M. Thomé de Gamond sent to the section his work bearing on the fourth question, as to guarding against high tides and floods.

Section II.—Division B.—Military Sauvetage.—President, Prince Caraman-Chimay.—On the report being brought up on the eleventh question, as to the disposal of corpses on the battle-field, M. Riant was of opinion that the responsibility of determining whether death had taken place should not be left to a society, but to a medical man. Herr Neudorfer considered that the disposal of the dead after a battle devolved on the victors. The debate then turned on the question of inhumation or cremation, with special reference to the action of the Belgian Commission at Sedan in 1870. The general feeling was that there should be some organisation for the disposal of the dead by a branch of the *Croix Rouge*, but not by a separate body.

M. Van Roy then read his report on the twelfth question, as to wounded and stray animals on the battle-field. M. Feigneaux upheld the position of the veterinary surgeon, and contended that he should be allowed the same immunity in the exercise of his duties that was accorded to the surgeon.

Surgeon-Major Porter, Netley Hospital, one of the secretaries to the British committee for this section, then read his paper on the organisation of succour in time of war, especially in connection with extemporaneous appliances for the relief of the wounded on the battle-field; and also as to the necessity of army surgeons being instructed in antiseptic treatment. Dr. Roth spoke of the difficulty of determining the position for surgeons during action, and a discussion followed upon this point. Surgeon-Major White contended that they should render what temporary assistance they could to the wounded, and then go on with their regiment, leaving their work to be supplemented by such associations as the *Croix Rouge*. Her Neudorfer remarked, in reference to a demand made by Dr. Roth that chairs of surgery should be instituted in officers' schools, that this was the caso in Austria; and M. Philloy added that at the *Ecole de Guerre*, in Belgium, a military surgeon lectures on hygiene.

Section III. — Social Associations. — The President, Señor Mariano Carreras y Gonzales, declared open the discussion on the eighth question, "What is the

organisation of the arbitration boards established in England, and the syndical chambers of masters and men existing in France and Belgium; and what results had been administered by these institutions?" M. Weiler, engineer, gave some information as to the arbitration boards at Nottingham, and the arbitration committees of Wolverhampton, these useful institutions having the effect of bringing together masters and men, and so associating the interests of capital and labour. M. Havard explained the working of the syndical régime in France, but especially in Paris; he urged the congress to discuss the following question:—Whatever be the legislation of a country, is it advisable to remove syndical associations from the common law and submit them to special regulations? M. Buls then read the report of M. Mignot-Delstanche (Belgium), which detailed the working of the syndical union of Brussels founded a year ago, and of similar institutions in Belgium. The President gave an account of the question in Spain. M. Sève advocated the constitution of an international syndical union, which should be the centre of all information, both commercial and scientific. Mr. Siltzer stated that the results achieved in England had not been so satisfactory as might be wished; the difficulty was to get the workmen to submit to the decision of a tribunal, whatever name it might bear. M. Ameline thought no change should be made in the legislation; the idea of an international syndical union was premature, but it might be tried during the Paris Exhibition in 1878. Dr. Bohmer (Saxony) advocated the *commissions de confiance*, which had achieved the best results in Switzerland. Discussion adjourned.

At the afternoon meeting of the combined sections, M. Léon d'Andimont presided. M. Desguin brought up the report as to the fourth question, the abuse of alcoholic drinks, putting forth the causes of drunkenness and its deadly effects, and advocating the institution of temperance societies in Belgium; the conclusion he came to was that the extinction of the miseries caused by alcoholism was incumbent on Government, the communes, and individuals. M. Vervoort considered that the repression lay chiefly with the communal authorities. Dr. Crocq drew a vivid picture of the consequences of an abuse of alcohol on the vital organs and on the brain. He advocated all measures in favour of a proper manufacture of beer and remission of the duty thereon. Dr. Paepe attributed drunkenness to the deficient wages of the workmen. M. Deluc contended against legislation for the suppression of drunkenness, but advocated a free and liberal supply of pure water.

WHITE LEAD *V.* ZINC WHITE.

The following recently appeared in the *Times*:—

Sir,—My attention having been called to Mr. Redgrave's report on the manufacture of white lead, which appeared a short time since in the *Times*, I wish, as having been for a long time engaged on the investigation of paints, to call attention to the fact that the evil which he complains of extends far beyond the manufacture of this substance. House-painters suffer very much from lead-poisoning in its various degrees of intensity; and it is almost impossible to make them see the need of cleanliness, and of taking other very necessary precautions. Sooner or later, white lead must be given up as a pigment; from its power of saponifying with oil, involving the loss of carbonic acid, it loses its opacity, and turns yellowish. It is valued for what is termed its body, and from the ease with which it is laid on. In my lectures for several years past, at the Royal Academy of Arts, I have pointed out its defects with, I am glad to say, some success, and many artists are now using zinc white, which retains its opacity, and does not blacken on exposure to foul air. For artistic purposes, zinc white can be prepared nearly equal in body to white lead. For more than a year I have been working on zinc pigments, with a view to their being used in lieu of white lead in house painting, and I feel convinced, from the result of my experiments, that sulphide of zinc, properly prepared, can be made to have as good covering properties as white lead, and that the addition of magnesia in the manufacture renders it as agreeable to work. I wish, therefore, to call the attention of those interested in this question to the fact that they can obtain a better paint in all respects than white lead, and one which has no injurious effects on the health of those who prepare or use it.—I am, &c.,

Fredk. S. Barff,
Professor of Chemistry at the
Royal Academy of Arts.

USE OF CHLORIDE OF CALCIUM FOR WATERING STREETS.

For some time past it has been proposed to make use of a weak solution of some deliquescent salt for watering the streets of large towns. Chloride of calcium, which has no commercial value, and is even regarded as an obstruction in some works, seems naturally adapted to this purpose. During the last few years trials have been made at Rome, the principal streets of which are watered with a solution of chloride of calcium obtained from the numerous pyroligneous acid works in the neighbourhood. The results are reported to be highly satisfactory. The dampness communicated to the road, instead of disappearing in a few hours, as is the case when water alone is used, remains for a whole week, the road continuing damp without being muddy, and presenting a hard surface on which neither the wind nor the passing of pedestrians or horses has any effect. In the course of time, too, the road becomes covered with a sort of crust which adds to the durability of the surface.

The use of this solution shows a saving over that of water alone, which M. Houzeau, in a recent communication to the Académie des Sciences, estimates at over 30 per cent. The same authority also attributes to this method of watering the streets hygienic qualities which deserve consideration. The chloride of calcium obtained from the pyroligneous acid works always contains appreciable quantities of perchlorate of iron and tarry matters, the volatisation of which in the air cannot but be salutary. Lastly, the complete suppression of dust constitutes a considerable improvement in the conditions capable of exercising an influence on public health.

NOTES ON BOOKS.

The Silk Industry in America.—By L. P. Brockett, M.D. New York, 1876.

This volume has been prepared in connection with the Philadelphia Centennial, as a record of the progress made by America on this important industry. It is published under the direction of the Silk Association of America. Its contents comprise a full account of the progress of silk manufacture in the States, and of the various establishments devoted to it. It contains many details of the lives and efforts of the pioneers in silk industry, and of the more recent achievements in the manufacture. There are also presented tables of statistics, in great part new and expressly prepared for the work, which show the large mercantile and manufacturing interests involved.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

HEALTH AND SEWAGE OF TOWNS.

A meeting of the Executive Committee has been summoned for 12 o'clock on Tuesday, the 24th inst.; and an invitation has been addressed to the Surveyors and Medical Officers of Health of the Vestries and District Boards of Works of the Metropolis, asking them to attend, to meet the Committee, and confer with them on the House Drainage of the Metropolis.

NATIONAL TRAINING SCHOOL FOR MUSIC.

Mr. Ernst Pauer's Lectures on the "Æsthetics of Music" will be continued on the 21st and 28th instant, in the West Theatre of the Albert-hall.

The Scholarship founded for the Staffordshire Potteries district, by Colin M. Campbell, Esq., M.P., and Mrs. Campbell, competed for at Stoke-upon-Trent, on the 29th ult., has been awarded to James Cliffe Forrester, of Burslem, aged 16.

The firms of Messrs. Collard and Collard, and Messrs. Kirkman and Co., have each sent a grand piano for the use of the Professors in the School.

CANTOR LECTURES.

The fourth lecture of the third course of Cantor Lectures for the past Session, on "Wool Dyeing," by Mr. George Jarmain, was delivered on Monday evening, March 27th, as follows:—

Lecture IV.

Logwood.

Perhaps, with the exception of madder, there is no one dye-ware which has such extensive application as logwood, and in wool dyeing, in which madder finds more limited use, no other ware can be compared to logwood in utility. The use of proper mordants, and a better knowledge of the properties of the colouring matter of logwood, have enabled dyers to obtain such fast and permanent colours with it, that the ban under which it formerly lay, arising from the fugitive nature of the colours obtained by the dyers who first used it, has long since passed away.

The natural history of logwood and other woods and wares which I shall have occasion to deal with, together with the properties of their colouring principles, have been so well described by my predecessors on this platform, especially by the late lamented Dr. Cracc Calvert, that I do not deem it necessary to enter into that full detail which I should otherwise have done, and I therefore intend to dwell more at length on the special properties of the colouring matters, which much concern the practical dyer, and also on those various details of the dyehouse which are so essential to the successful prosecution of the dyer's art.

Logwood is imported into this country from Central America and some of the West Indian Islands, in blocks or billets.

That brought from Campeachy is esteemed the best, but is now scarce, and the price is high. The next best is Honduras, of which there is a large consumption in the woollen trade. Jamaica and St. Domingo are common qualities which are also in considerable use.

Logwood is the wood of a large tree belonging to the Leguminosæ family, and is called *Hemaloxylon campechianum.*

It is prepared for the use of the dyer in the three following forms:—1st, in chips; 2nd, ground or in raspings; 3rd, as an extract, which is the solid or semifluid residue obtained by evaporating the decoction of the wood.

The colouring matter is developed by moistening the chips and raspings with water, and allowing the mass to ferment slightly in a heap, taking care that the fermentation does not proceed too far.

The water used for moistening the logwood should be free from iron or peaty matter, both of which damage the appearance and quality of the wood.

The chips of good logwood gradually become coated over with a green colour, somewhat like that reflected from a beetle's wing.

When the chips are used for dyeing, which is the most common form in which logwood is employed for wool and heavy pieces, they are placed in a bag, made of coarse open material, and hung down into the boiling water, which is intended as a dye-bath, until the colouring matter is extracted; the bags are then removed, and the material to be dyed put in.

Rasped logwood is thrown into the dye-bath along with the material to be dyed.

The colouring matter of logwood assumes two conditions—

1. A colourless condition, called hæmatoxylin ($C_{16}H_{14}O_6$).

2. A coloured principle called hæmatëin ($C_{16}H_{12}O_6$).

The difference, it will be observed, between the two is similar to that which obtains between indigo white and indigo blue, namely, a difference of two atoms of hydrogen.

The oxidation of the colourless hæmatoxylin results in the formation of the coloured hæmatëin from exposure to air. These facts were discovered by M. Chevreul.

The colouring matter does not exist in either condition in the wood itself, but is the result of the fermentation of a glucoside.

The hæmatëin is susceptible of further changes under the influence of ammonia.

The colouring principle, hæmatëin, is the body which the dyer uses as a tinctorial agent; it is that which gives the red colour to the prepared dyewood; and the green substance, with green cantharides reflection, which is seen on the chips, is the hæmatëin which has effloresced from the damp logwood and dried on the surface.

Logwood Colours.

A variety of shades of colour can be obtained with logwood alone as the colouring agent, and it enters into the composition of a still greater variety of composite colours. It is essentially a blue colouring matter, and is hence frequently called by the French *bois bleu*. The shade of colour which it imparts to wool is very much modified by the various mordants. Logwood colours are affected by acids which turn them red, and alkalies which change them to blue or purple. By varying the quantity of logwood, various shades of blue are obtained from lavender, with two per cent. of logwood, to a dark blue with 30 per cent., which shade becomes very dense and full, when the per-centage of logwood is increased to 60 or 70 per cent. The darker of these colours are constantly produced in the dyehouse, both on wool and cloth.

Receipts.

Though dyers' receipts are often instructive in indicating the directions which the dyer may take in order to obtain any given colour or shade of colour, the conditions under which he may work are subject to such a great amount of variation that I deem it necessary, at the outset, to give a word of caution, and to impress upon him the fact that the literal interpretation and carrying out of almost any receipt will produce results alike in the hands of no two dyers, who may happen to be differently circumstanced.

This is readily accounted for, when we consider that the wares may be different in the per-centage of colouring matter and tone of colour, the mordants of varying strength, the water often altogether different in quality, the varying dimensions and kind of dyeing vessel used, the different effects of steam and fire heat, and the variations produced by operating on a larger or smaller weight of material. In fact, the varying conditions are so numerous, that dyeing receipts are often illusory on account of the differences which have been enumerated above. The receipts which I shall therefore have occasion to give from time to time, I wish to be accepted with caution, and interpreted with some latitude as to quantities of dye wares, &c.

The receipts are given as typical examples of processes in actual use in the woollen districts, in dyeing goods on the large scale, and are not put forward as the very best modes; these can only be found out according to the different circumstances under which a dyer is placed, and they are often only the result of careful observation and long practice.

The term fast is used in the receipts for a colour which will fairly withstand scouring and milling, but not necessarily the action of light and atmospheric influences. By permanent is meant a colour that will withstand all deteriorating influences both in milling and scouring, and also those to which it may be subjected during a reasonable time of wear. The terms loose and fugitive are applied as opposites to fast and permanent. These definitions are given, not as representing what is frequently attached to them by authors on dyeing, but as those which I wish to be attached to them in these receipts, and which I think may be conveniently applied. The receipts are all given for 100 lbs. of wool or cloth, except when otherwise stated.

Common Black at one Operation.

	Per cent *
Logwood	40
Sulphuric acid	0·5

Boil half an hour.

Copperas	3
Blue vitriol	1

Throw on solid or in solution, and boil half an hour longer. Let off and leave over-night.

Colour, loose, turning brown in the wear, used for dyeing coloured waste intended for low class goods. Sumac might be used with advantage for a black of this description.

This is a loose colour because a good deal of the colouring matter is converted into a lake, and is, therefore, only loosely attached to the fibre. "The old dyers generally dyed in one bath only, which in part explains the bad results obtained."†

Common Doeskin Black.

Mordant—

	Per cent.
Copperas	3½
Blue vitriol	2
Alum	2
Red argol	3
Logwood	3⅓

Boil for five minutes, cool down to 100° F. with water, enter the goods, raise to the boil in three-quarters of an hour, and boil for an hour and a half. Lift out and leave over-night. Some dyers wash off, others leave unwashed.

Dye—

	Per cent.
Logwood	24
Red argol	1

Boil for five minutes, cool down to 180° F. with water, enter the goods, raise to the boil in half an hour, turning by the wince — quickly at first—and boil for another half hour, wind out, cool down over the perch, and wash on the machine with fuller's earth.

If the goods have been manufactured partially from mungos, which often contain cotton threads commonly called burls, it will be necessary to burl-dye them, an operation in which the particles of cotton are dyed black. This operation consists in steeping the cloth in a cistern containing an infusion of a tannin material, commonly sumac or myrabolams, afterwards passing them through a solution of pyrolignite or so called nitrate of iron (nitro-sulphate of iron). The pieces are then finally washed on the machine with fuller's earth. Colour fast, but not very permanent, becoming brown in the wear.

Doeskin Black for Wool.

	Per cent.
Camwood	8

Boil for 50 minutes. Then add

Bichrome	3
Alum	1
Argol	1

Boil for 50 minutes, let off, and allow to stand over-night.

* The per-centages given in this and the following receipts are for 100 of wool or woollen fabric.

† Van Laer.

Dye in

	Per cent.
Logwood	45
Fustic	8
Sumac	4

Boil for $1\frac{1}{2}$ hours; let off. Colour fast and permanent.

This formula contains all the colours necessary to produce a black, namely, red, blue, and yellow. Camwood furnishes the red, logwood the blue, and fustic the yellow. Chromed logwood colours have a tendency to become green, from the production of chromic oxide; the presence of camwood or other red colour makes this change less apparent.

Chrome Black with Blue Reflection (blue through) for Wool.

Mordant—

	Per cent.
Bichromate of potash	2
Sulphuric acid, D.O.V.	0·25

Boil $1\frac{1}{2}$ hours, and leave overnight.

Dye—

Logwood ....45 to 55

Boil one hour.

If required very clean, as in mixtures of black and white (black and white checks for example), the colour may be fixed more firmly by finally passing it through a warm bath containing 5 per cent. bichromate of potash.

Chrome Black with Violet Reflection (violet through) for Wool.

This is mordanted and dyed as the last. The violet reflection is obtained by using the following modifier—Single muriate of tin, 1 to 2 pints. Mix the tin spirit in 20 or 30 gallons of water and throw it on the wool, handling up for 15 minutes.

Chrome Black with Green Reflection for Wool.

Mordant—

	Per cent.
Bichromate of potash	2
Sulphuric acid	·25

Boil $1\frac{1}{2}$ hours, and leave overnight.

Dye—

Logwood	40
Fustic	10

Boil 1 hour.

Colour fast and moderately permanent, becoming greener and paler.

Woaded Blacks.

These are the best blacks for either cloth or wool; they are obtained by first dyeing the goods in the indigo vat a light or medium shade, and then dyeing them as for chrome blacks, using less logwood in proportion, as the indigo bottom is more or less dark. Colour fast and permanent.

Lavender on Wool.

Alum	$1\frac{1}{2}$
Tartar	·25
Logwood	$2\frac{1}{2}$
Indigo extract	·25

Boil for five minutes, cool to 180° F., with water; enter the goods and boil for one hour. Let off and wash. Colour moderately fast.

Cudbear, Archil Paste, and Archil.

These colouring matters, though not obtained from wood, may with advantage be described here, as they are often employed with logwood and the other woods in many composite colours; these three colouring matters are all obtained from the same sources; namely, certain lichens or weeds, the two principal species of which are *Rocella tinctoria* and *Rocella fuciformis.*

The weeds contain no colouring matter, this being produced by exposing them to the action of ammonia. Drs. Stenhouse, Schunk, and others, have investigated the colouring matter contained in these dye wares, and have found several distinct colouring principles in them.

Cudbear is made by drying archil paste, and then grinding the residue to a fine powder; the colouring matters of cudbear are more red than those of archil, but even these may be varied by differences in the manufacture, both red and blue archils being produced for the market.

These colours are employed largely as a bottom or ground for indigo on wool and cloth, and also as before stated, for many mixed or composite colours, but the colours are somewhat fugitive.

The mordants affect the shade of colour only to a small extent, in fact they may be employed without mordant. They are most affected by a mordant of tin, chiefly through the influence of the free acid contained in the tin spirit, which, like all other acids, reddens and brightens the colour, changing it to a maroon. The weed colours, as they are called, are mostly used for the purpose of modifying and blooming other colours, but as they are fugitive, the bloom soon passes away. Their brightness and beauty, however, render them exceedingly well adapted for the colours required for ladies' wear.

The following formula is given as an illustration of the use of cudbear along with logwood:—

Logwood Blue for Wool.

Mordant—

	Per cent.
Bichromate of potash	1
Alum	3
Tartar	$1\frac{1}{2}$

Boil for $1\frac{1}{2}$ hour, let off, and leave overnight.

Dye—

	Per cent.
Logwood	20
Cudbear	1

Boil for one hour, then throw on 20 quarts single muriate of tin, diluted with 20 or 30 gallons of water. Handle up for fifteen minutes; let off and wash. Colour moderately fast.

The Red Woods.

These important dye wares comprise two classes: —1. Red woods, whose colouring matters are freely soluble in boiling water; these include Brazil-wood, Lima-wood, Santa Martha or peach-wood, Sapan-wood, and Pernambuco-wood. 2. Red woods which are almost insoluble even in boiling water; these include camwood, barwood, and sanders-wood, and caliatour.

The first class is imported in the form of blocks or billets from Central and South America, and the West Indies, and is sold to the woollen dyer in the powdered state. They are said to contain

the same colouring principle, called by Chevreul, who first obtained it, by the name of brazilin; it can be obtained in needle-shaped crystals, which are nearly colourless, and have a bitter-sweet taste. By oxidation it is transformed into brazilëin, by a change which is analogous to that which takes place when indigo white becomes indigo blue, and when hæmatoxylin becomes hæmatëin. The change may be expressed by the following equation:—

$$\underset{\text{Brazilin.}}{C_{22}H_{18}O_7} + O = \underset{\text{Brazilëin.}}{C_{22}H_{16}O^7} + {}_7H_2O$$

I find that peachwood is almost the only wood of this class which is employed in wool dyeing, and that only to a limited extent; it is never used as a self colour, its chief employment being for the purpose of imparting a purple tone to other colouring matters.

The second class, embracing camwood, barwood, sanderswood, and caliatour, is very important to the woollen dyer. They are the produce of several species of Pterocarpus, which grow in tropical countries, and are imported into this country in the form of knotty billets or blocks, which are prepared by rasping for the use of the dyer; the wood, on account of the very slight solubility of its colouring matter, is generally boiled in contact with the article to be dyed. The colours which they impart to wool are red, or red brown, with a mordant of tin, alum, or bichrome, the colour being of a dull shade when copperas is used; the colours are very permanent and fast, and are on that account much employed in the dyeing of wool and woollen cloths, which have to be scoured and milled.

The colouring matter seems to be the same in all; there is a colourless principle called santal, which by oxidation is transformed into the red colouring matter, santalin, by a reaction analogous to those which take place in the colouring matters of indigo, logwood, and peachwood.

These woods are seldom or never used alone as a colouring matter for wool, their principal employment being to give the requisite red tone to browns, clarets, violets, maroons, blacks, and other colours which contain a red in their composition; they are also the best bottoms for indigo which can be put on, being much faster and more permanent than a bottom obtained with archil or cudbear.

Claret Brown on Wool.

Mordant—

	Per cent.
Bichromate of potash	$1\frac{1}{2}$
Sulphuric acid	25

Boil for one hour; leave overnight.

Dye—

Camwood	34
Barwood	10
Logwood	2
Cudbear	1

Boil for two hours; let off.

The shade may be considerably darkened by the addition of copperas towards the end of the operation.

Madder.

This colouring matter is more extensively used by the cotton dyer and calico printer than it is by the woollen dyer. It has been the subject of much research, and the composition and nature of its colouring principles are now well understood. It has long been used as a dye stuff; the ancient Egyptians, the Greeks, and the Romans are said to have used it.

Though not a wood it will be best to discuss it here in connexion with the red woods, as it holds, as a woollen dye, a position intermediate between that of the red woods and the yellow woods. It is the root of a plant called *Rubia tinctorum.*

Dr. Schunk states that the colouring matter exists in the plant as a glucoside, that is, in combination with a sugar. He calls the glucoside rubian.

The principal colouring matters yielded by madder are alizarin, purpurin, and pseudo-purpurin, of which the first is by far the most important, being the only madder colour which may be considered fast and permanent.

The artificial production of alizarin from anthracene, one of the products of the distillation of coal tar, is one of the most important and interesting applications of chemistry to the arts that has been made of late years.

In 1868 Græbe and Liebermann found that when alizarin and zinc dust were distilled, the hydrocarbon anthracène was obtained, and by reversing the process they succeeded in obtaining alizarin from anthracene. The artificial colouring matter seems to possess all the properties of the alizarin of madder.

I am not aware that artificial alizarin has yet been used in the woollen districts as a dye for wool.

In wool dyeing the chief uses of madder, besides acting as a ferment in the indigo vat, are for the production of drabs, browns, and olives, for which its colouring matters are well adapted. The colours obtained with madder on wool are very fast and permanent.

Brown on Wool.

Mordant—

	Per cent.
Bichromate of potash	1
Sulphuric acid (D.O.V.)	5

Boil one hour; let off, and leave overnight.

Dye—

Madder	11
Logwood	1
Camwood	8
Fustic	10

Boil for two hours; colour fast and permanent.

Mode of Testing the Value of Dyewoods.

The best practical test that the dyer can employ is to dye swatches of cloth of equal weight with equal weights of the dye to be tested, and of a known good sample, and comparing the results in each case. The master dyer will find it to his advantage to test his dyes himself, by which means he will be able to know when he is having full value for his money.

The annual distribution of the prizes offered by the Turners' Company for specimens of turned work and diamond cutting, took place last Thursday. There were 25 competitors for the prizes in wood turnery, five in pottery, and six in diamond cutting. The work exhibited was, in the opinion of the judges and the others who took part in the proceedings, of a high character; and in the speeches made on the occasion several compliments were paid to the Turners' Company for their efforts to promote their own branch of technical education.

MISCELLANEOUS.

THE LOAN COLLECTION AT SOUTH KENSINGTON.

Appliances for Instruction in Mechanical Philosophy.

By the Rev. Arthur Rigg, M.A.

For many years past very great efforts have been made to win attention to the importance of scholastic and collegiate instruction in technical handicraft and scientific knowledge. Occasionally this importance has been recognised, and where personal and local interests are aroused, then, within a very limited area, some scheme or other has been tried. The removal by death or otherwise of the early promoters often extinguishes a continuous local interest, and the plans adopted fall into disuse. Thus, from the earliest dawn of mechanics' institutions until the present time, the English people have not accepted any device for that systematic and continuous instruction in mechanical philosophy of which so many recognise the need. Happily, the indifference of ourselves has not been an example copied by other nations, and the development of instruction in mechanical philosophy and science, with or without any efforts to cultivate skill in handicraftism, has elsewhere been very successfully effected.

So far as her Majesty's Government have been concerned, each of the representatives of the two great political parties in the State has admitted that the want of instruction in science and technics should be supplied. With the exception of communications with consuls abroad, and obtaining trade and industrial reports on the products and manufactures of different countries, and occasionally obtaining more specific information, as for example in the comprehensive report of Dr. Lyon Playfair on industrial instruction on the Continent, published in 1852, and of Mr. Samuelson on technical education in various countries abroad, published in 1867, and in the reports of international exhibitions, and occasionally in the direction in which inquiries have been made by Committees of the Houses of Parliament and Royal Commissions, nothing beyond has been offered to meet the admitted need. Speeches and books excite a temporary interest, but they cannot dispense with the office of a teacher. Lectures, which are an outcome of an increasing national love of talking, are not lessons, and until tutorial work, long-continued and earnest, precedes professorial, but little advance will be made by the people in a mental study of either physical or mechanical science. It may be doubted whether any people were ever more deluded than the English, in the impression that because much is said and written upon a subject therefore much is done. It does not seem to be generally received that they who talk most about the importance of a work are generally those who steadily and quietly do the very least to foster and develop it. Action—silent, unobtrusive action—and not talking is the basis of educational success.

Granted, there are museums. So, also, there are shop windows. The articles in the former have hitherto been as little, or even less, available for scientific and technical instruction than those in the latter. In the cases of the former, the articles can only be looked at; in the windows of the latter they may be looked at and handled.

In the Loan Exhibition of Scientific Apparatus novel and very hopeful plans, in reference to the preceding remarks, inaugurate this most extraordinary and valuable collection. By a simple form, divested of all needless routine, the contents of cases can be examined; and it is not verbal and complimentary but sincere and heartfelt praise to say that perhaps never before has the product of so much human mental labour been collected under one roof. Consequently, the knowledge to be acquired, either from inspection alone, or from inspection and examination, is proportioned to the concentrated forms on which so much time has been expended, and so many generations of men have been employed in designing and producing the instruments there exhibited. Let us hope that the experiment of permitting an examination of any special apparatus, as between the guardians of museums and the public, which the authorities of the Loan Exhibition are making, may be contagious, and that the example will be generally followed.

In cases of art, facilities for handling and examining are not so requisite. Inspection alone suffices. No one cares to obtain permission to look at the cobwebs on the back of a picture, or at the roughnesses in the interior of a cast.

Where, however, motion is a consequence of the grouping of the parts, this acquiescence in inspection alone does not satisfy. The motions and the means by which the motions are produced must be examined, if valuable results are to follow from the inspection. The crowds who cluster round an open case in the Loan Exhibition of Scientific Apparatus, or who congregate where motion is being caused or explained, are the best confirmations of the correctness of these views of the wants of the people. That curiosity in "motions" is a natural impulse will be admitted, when it is observed with what interest children run from one side of a railway-bridge to the other in order to watch an entering or emerging train.

Now, this notice has to deal not simply with contrivances in relation to motion, but with the means which the collections at South Kensington, directly and indirectly, suggest or supply, showing how men have endeavoured to select what is most valuable, with a view to the instruction of the people, young and middle-aged, in the subject of mechanical motions—motions be it remembered, by which all, from the Queen on her throne to the peasant in his hut, earn or obtain their daily bread, and without which no progress could be made in physical research or commercial prosperity.

Wonderfully complicated as well as almost childishly simple have been the mechanical combinations which the wants of society have called forth. They are, however, (speaking generally) detached mechanisms—not elaborated one from the other, the results rather of "happy thoughts" than of progressively developed mental labour. It is not difficult to account for this. Rules and principles have not been recognised; every novelty (so-called) has had its day, and few have been the minds which have contentedly laboured to lay in a good foundation for a mechanical superstructure. Before the close of the last century, when the study of geometry had not been displaced by the less laborious amusement of analysis, there was the dawn of a true and sound foundation for mechanical philosophy.

Let anyone turn to the treatise of Emerson, the second edition of whose work "On the Principles of Mechanics" was published in 1758, and he will see how much more clearly he appreciated with what and in what to lay the foundation for real practical terrestrial work than the analytical mathematicians who succeeded him, for they, fleeing from all terrestrial work, directed the alphabetical characters of Greece and Rome to unriddle celestial motions by cabalistic symbols, which very rarely indeed admitted of interpretation in any solid or intelligible form. It seems strange that, whilst the newly-developed science of analysis busied itself with motions of such almost inconceivable speed, complexity, and curious influences, it did not condescend to the every-day requirements of terrestrial machinery. On the contrary, it shut the door or nearly so, for it laid the foundations of its work chiefly in the statical conditions of what had very erroneously been regarded as the elements

of all machines. Now, the statical condition of a machine is a state of uselessness, and so far as the purposes for which a machine is made are concerned there is very small satisfaction in even looking at it, much less then in the study of it when in a state of rest, and therefore of idleness. Had the writers after Emerson's day (he died in 1782) walked in the geometrical steps in which he trod, we might have been far advanced in the study of mechanical philosophy, instead of having to return and commence as he did. To those who are interested in the progress made in mechanical science, let me commend a perusal of the preface to "The Principles of Mechanics, Explaining and Demonstrating the General Laws of Motion," by Emerson. Briefly there is set forth the main result of works prior to his day, and the great importance of the study, especially as the means of producing "motion" and the economic utilisation of "force."

A returning acknowledgement of the usefulness of geometrical reasoning may lead to a better appreciation of "mechanisms," and the work of Prof. Reuleaux translated by Prof. Kennedy, and published in July last by Macmillan and Co., to be followed by another volume, may turn the minds of men to see in machinery splendid opportunities for the exercise of geometrical reasoning, not unmixed with the higher generalisations of analysis. Let not these remarks be interpreted as casting any disparagement upon analytical mathematics, which in lines of thought other than machinery have done so much useful work.

The late Mr. Babbage was so impressed with the necessity for a mental study of mechanical philosophy in connection with practical mechanics, that he designed a notation by which a machine might be expressed in its progresive stages, from the source of its power to the point of application, in a form which may be described as partly literary and partly algebraic. It may suffice to remark that, although his notation was not received, yet it seems to have been suggestive to the late Prof. Willis, who, in a volume on the principles of mechanism, published in 1841, not only introduced algebraic and other mathematical symbols into mechanical engineering, but developed a more convenient notation, and illustrated his views of the value of it by a few examples taken from well-known machines.

In reference to the subject of the present article, this notation question is not the most important in his work. He classified various motions, and gave illustrative examples of the modes of treating them, both in their simple and in their compound forms. It is not too much to say that, both in Europe and America, this work of Prof. Willis has been appealed to as one of universally recognised authority. Still, the notation which he adopted cannot be said to have made any progress. Not so with the selections and investigations he made of mechanical contrivances. All succeeding writers upon mechanism have not only drawn largely from him, but have also acknowledged their great indebtedness to his writings.

Apart from other causes which may have contributed to the testimony so generally rendered to Prof. Willis' efforts, there remains this, he was a workman as well as a mathematician. He could, as a workman, convert (if convertible) even an analytical equation into an actual machine. Ere this notice is closed, there will be occasion to direct attention to one or two simple but most instructive original combinations of his, now in the educational department of the South Kensington Museum, along which the visitor passes to the Loan Collection of Scientific Apparatus.

The study of mechanical philosophy, so as to combine either analytical or geometrical reasoning with actual practice, has been seldom undertaken. Not that it is unworthy of notice, but because there are not any treatises which harmonise such reasoning with practice. Certainly the volumes issued from the University press do not, for the mechanical questions contained in them savour more of the imaginations of the writers than of the workshop of the engineer.

The subject, however, which has been so much neglected in England, has been taken up in Europe, and notably in Germany. The illustrations of the aids to teaching mechanical philosophy in its broad aspect, and not as restricted to any particular business—*e. g.*, shipbuilding—which the educational department of the museum at South Kensington and the Loan Exhibition of Scientific Apparatus supply, have been obtained chiefly from Germany, the School of Mines in London, and from Chester. It must be understood that no reference is made in this notice to trade collections.

In seeking thus to instruct workmen to exercise their intelligence, it must not be overlooked that handicraft mechanical skill is becoming more and more rare. It is not far from the truth to say that the race of good handicraft mechanics is dying out; the cause thereof is obvious. Wherever a high-class mechanical turn of mind has given itself to the study, there has been developed some labour-saving contrivance. In metal work men cannot compete with the finish and accuracy of that delivered from the slide-lathe or planing machine, hence hand-turners and flat surface chisellers and filers—and the day cannot be distant when the "scraper" also—will find "their occupation gone." If, therefore, natural aptitude in mechanical contrivance is not cultivated by a study from motive illustrations, the men who might benefit themselves and their generation will degenerate into "machine-minders" or "tenters"—an occupation needing no mental work—a dull, stale, profitless employment of the human powers, not requiring the exercise of either thought or feeling. Well may the term "hands" be applied to these, for not as "men," but as "machines" such workmen are employed.

In the year 1855, the Committee of Council on Education became impressed with the necessity for directing attention to a study of mechanics, and following the course which then presented itself, they commissioned the Rev. Robert Willis, Professor of Mechanics at Cambridge, and also at the School of Mines, to devise means for a more intelligent and thoughtful use of what were called the mechanical powers. After making various experiments in his workshops, he produced a set of apparatus. This set was not only bulky but required much table room. Mr. Willis loved contriving, designing, and building up; whilst for professorial or collegiate work the apparatus might be available, it was unsuited in form for ordinary scholastic use. Knowing how much the writer of this article had been doing at Chester in reference to the same objects, the Committee of Council on Education sent Professor Willis' apparatus to him, with the request that it might be made more compact and suited for ordinary schools.

In the exhibited selection from the models produced at Chester will be found five which relate more to machinery than to mechanism. The circumstances which led to the production of these are of interest in relation to the action of the Committee of Council on Education.

In the year 1856 the Committee had been "educated" to the importance of "mechanical philosophy" as a subject which, in its most elementary form, was well worthy of the attention of young men about to undertake the instruction of artisans in town and country. They gave effect to this view by requiring that, in the examination for certificates of merit, candidates should be able to show an acquaintance with one or more of the following subjects, viz., how grain was separated from straw and chaff, how corn was converted into flour, how water was raised from wells, how gas was measured in houses, and the construction of an ordinary door-lock. Conscious that very many minds cannot follow "motion" as explained by textual notes on printed diagrams, it seemed very desirable that, to carry out these sensible views of the Education Department, illustrative moving diagrams should aid the teacher. Hence the production of those now seen in the Educational Collection of the South Kensington

Museum, along with others of a class belonging more exclusively to pure mechanism.

In 1861 or a little later, the authorities on national education had changed their views, and mechanical philosophy was relegated to that obscurity from which it may be trusted an early generation will rescue it, and little could it have been anticipated that, by the Committee on Education, Latin would be placed in its stead as of more importance to the labourer and the artisan.

Thus the future masters of national schools were drawn aside from the every day surroundings of the scholars they would have to teach, and instead of being rendered more qualified for the responsibilities that would be placed upon them, they were being separated in sympathies from those for whom they were to labour, and tempted to step from the desk of the school-room to the pulpit of the church. The wisest and best of teachers, some eighteen hundred years ago, drew His most valued lessons from what the eyes saw and the hands handled, and addressed them to men, women, and children who knew nothing of language as a mental study.

But to return to these Chester models, the mechanism models deal chiefly with "linkages" and "cam" motions. The value of these as studies has very recently been acknowledged, in the importance which is being attached to the "Peaucellier cell," now so successfully introduced into the ventilating apparatus in the Houses of Parliament, and by attempts at the interpretation of algebraic analysis, and the conversion of some of its less complex results into mechanical linkages. Although attention has been given chiefly to straight line movement, and although the three-bar linkage of Watt, illustrated in three or four of the Chester models, was deemed by him the most valued of his contributions to practical science, yet it is now seen that these are but at the threshold of a mansion in mechanical philosophy which has yet to be entered and explored. There may be many workers in this storehouse, as various cases in the Loan Exhibition of Scientific Apparatus abundantly illustrate.

There is one linkage in the Chester set, the instructional value of which in the model form can hardly be exaggerated. It is that which shows the relationships between the crank (*i.e.*, the eccentric), the connecting rod, and the travel of the slide valve. A reference to the second edition of Professor Willis' volume on Mechanism shows the importance he attached to this contrivance of his. On one occasion some mechanics from Manchester came over to Chester to see this; they had been told "it would convince them." The statement is not an exaggerated one, that a thorough mastery of the teachings of this one mechanical model alone by the makers of small steam-engines, would save the users of them many thousands of pounds per annum.

There is another of these models which teaches what from diagram inspection could not have been easily foreseen. It also is a linkage. The combination is such that for practical purposes there is conveyed to two links alternate rest and motion. In fact, the well-known phenomenon of the superposition of two waves of light in different phases producing darkness is here—two mechanical motions combining to produce alternations of motion and of almost complete rest.

It has often been said, of "what use are such models as these—once known, always known." True. Extend the same principle of reasoning, and our picture and art galleries are swept away. Note how the walls and shelves in studios are laden with models; here a limb—sometimes a hand only, sometimes a foot—there a plaster animal. If these still-life models of the very parts of our bodies are essential for the progress of youthful students, how much—how very much—more must models in which motion—may we not say, life—can be infused at the will of the student. Let the art-student be supplied with a model capable of adaptation, as if with clothed muscular contrivances, the value of such a model would be extolled in all quarters; yet the motive parts of the elements of all machines are generally disparaged.

It should be borne in mind that here, as well as in other branches, there are successive generations of students to be instructed; and, as in art, or botany, or geology, or natural history, or even music, the models used for one generation have ever the same instructional value for another generation, so in the study of mechanical philosophy. A museum of the elemental and simple combinations of these elemental contrivances for producing motion in varying paths, and at varying velocities, and a director of such a museum competent to extract instruction from these, and to point out the special features of each contrivance and its effect in combination with other designs for producing motion, would render as great a service to the State as any man to whom a nation has tendered its thanks.

To the Rev. Robert Willis (late Jacksonian Professor of Experimental Philosophy in the University of Cambridge), mechanicians are greatly indebted for the efforts he made, not only in the application of mathematical reasoning to practical mechanics, but also for the illustrations of motion he placed before the students who attended his classes. Many of those of his contriving are in use in the science schools at South Kensington, and the majority of those at Chester are from diagrams in his book. As thoroughly useful, though perhaps not inviting in form and finish, are two of his designs placed outside the cases in the educational collection. From one of these may be studied why straps on driving pullies always seek the largest diameters, and therefore strap driven pullies are rounded; and from the other, the conditions requisite that straps may drive lines of shafting at right angles to each other. As these contrivances are not in glass cases, and there is no prohibition as to touching, mechanics can readily examine them. In the cases in the room where these are, are many illustrations of mechanical motions—chiefly, however, as models of machines or parts of machines. They have been made upon no settled plan, and can hardly be said to furnish consecutive lessons either in theoretical, mathematical, or practical mechanics. They have, however, been of use for many years, and are still employed in the science schools at South Kensington.

About the time when efforts were being made by Professor Willis, and at Chester, to draw attention to the importance of working illustrations of motion as essential in a course of instruction in mechanical philosophy, Mons. Schroeder, at Darmstadt, gave great assistance to the movement. A few, a very few, and not at all the most important of Mons. Schroeder's designs, are seen on two tables in one room of the educational collection. Unfortunately, the selection from his stock consists either of well-known every-day contrivances, such as are met with in any machine shop, or models of portions of constructive machinery to which motion is not imparted. In these two respects they hardly attain to the importance sought to be attached to the class included in this article. Those, however, who wish to follow out what Mons. Schroeder has done, can form some opinion from the series of excellent photographs of his contrivances for scholastic and collegiate instruction which are in a special portfolio, and may be examined in the Educational Library of the South Kensington Museum. It must be remembered that these photographs are utterly worthless from an instructional point of view, because they cannot be endowed with motion, and it is the consequences of the motion imparted to the mechanism, and not the pictorial mechanism, that has any value.

Although England has not procured these models, yet on the continents of Europe and America the same lethargic spirit is not found. Whilst rendering every credit—and very great credit—to the pioneer labours of Emerson, Babbage, Willis, and Schroeder, and whilst admitting that the generations with whom they are identified have not availed themselves of that within

their reach, it may yet hail in hope of the "good time coming" the contents of many cases in Room K of the Loan Exhibition of Scientific Apparatus relating to kinematics, dynamics, and statics.

These cases contain some ingenious linkages, the embodiment of mathematical analysis by A. B. Kempe, Esq., also the integrating and tidal apparatus of Sir W. Thompson. This notice, however, is concerned only with "appliances for instruction in mechanical philosophy," and, therefore, further references to these and other mechanical articles would be misplaced.

The attempt made by Herr Reuleaux, Director of, and Professor in, the Königlichen Gewerbe-Akademie (Royal Trades Academy), in Berlin, member of the Könighl-technischen Deputation für Gewerbe, has been so prominently brought before the British public by Alexander B. W. Kennedy, C.E., Professor of Civil and Mechanical Engineering in University College, London, as to claim a very thoughtful consideration on the part of all who can appreciate the importance of any advance in a systematic study of mechanical philosophy. It may be stated that many of the students are young men who, having passed some time in handicraftism in ordinary mechanics' workshops, come to the Royal Trades Museum, both for intellectual study and instruction, as well as to continue their workshop practice. These students (there are about 600) have here not only every machine facility for mental study or manual dexterity, but the further aid of about twelve skilled mechanics.

The work of Herr Reuleaux appears to the writer of this notice to divide itself into three parts; one, the volume entitled "The Kinematics of Machinery, or Outlines of a Theory of Machines," published in July last by Macmillan and Co., having been translated from the German by Professor Kennedy, and consisting of 622 pages large octavo; a second work being

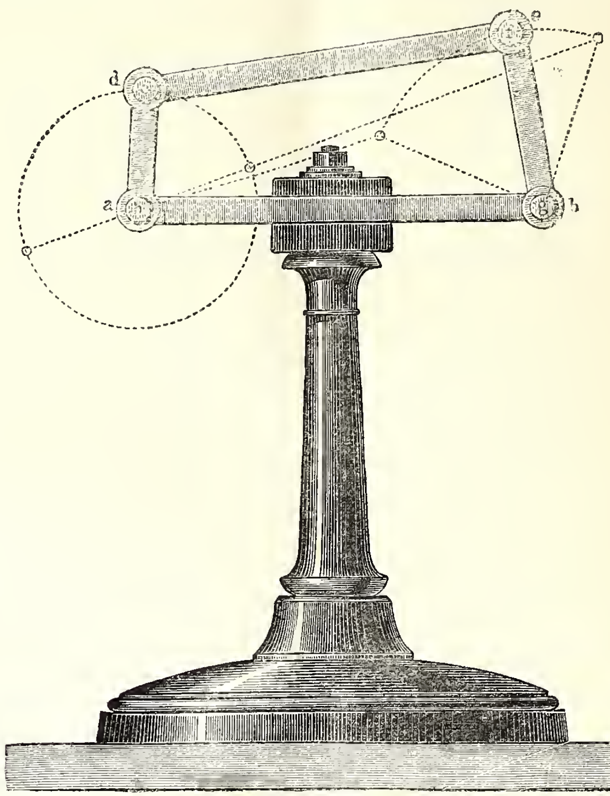

Fig. 1 (see page 994).

the contents of eight large wall-cases in the Loan Collection of Scientific Apparatus now in the Exhibition buildings at South Kensington; the third work being the natural or obvious sequel to these, and consisting of the application of the instruction to be derived from the two former to practical machinery. The non-appearance of this latter work necessarily renders very imperfect any judgment that may be formed respecting the usefulness of the two former, to persons whose inclinations or necessities induce them to enter upon a thoughtful study of the principles which underlie a superstructure of mechanical philosophy. Although this is certainly the case, yet such need not deter students from acquiring some familiarity with the fundamental technicalities of what, from the pen and the hands of Herr Reuleaux, promises to become an entirely new science, for it really sets out with a fundamental new "departure."

It may assist, if, at the outset, the connection between the first and second works is somewhat anticipated.

"Kinematics" is a word of comparatively recent introduction into English science, and therefore it will probably be some time before a distinctive and unvariable meaning is attached to it. It will suffice if for our present purpose the meaning attached to it by Herr Reuleaux is alone considered, without any reference to the use of either "Kinematics" or "Kinetics" by other writers. Those who from inclination or necessity have to arrange machinery for special purposes, generally restrict themselves to the one problem before them, and in so doing take into account all the elements with which the proposed machinery is likely to be concerned. To

such persons, combinations of natural scientific and mechanical specialities are of paramount interest, and so far from generalising their views, the contrary is the case, for each adopted element in the machine design is an advantage to them, but a restriction upon an enlargement of views of mechanical philosophy. "Kinematics" as a study is no concern of theirs. Closely associated with this is a consideration of proportion and strength of parts, when the questions of form and combination have been determined. To this branch of machine study belongs the stability of structures. Essential as these are, they must be excluded from Prof. Reuleaux's views as hitherto enunciated by him.

If one considers machinery apart from special wants, and therefore apart also from any constructive details, it will be found that there is left a very skeleton-like combination of pieces, which are dependent in some simple or complex manner for their inter-relationships. It is the study of these skeleton-like combinations and inter-relationships which constitutes the study of mechanism, and out of which is elaborated that machinery on which the whole human race rely for so many social comforts.

Separated from the usual accessories, it follows then that one who would hopefully enter upon the work of machine designing must first turn his attention to the "study of those arrangements of a machine by which the mutual motions of its parts considered as changes of position are determined" (p. 40). To this study Profs. Reuleaux and Kennedy give the name of "The Kinematics of Machinery." Thus enunciated, the first work of a machine designer is to resolve the problem before him into so many and such elemental parts, that the mutual motions in each part may be separately considered. He may then anticipate, that having mentally grasped the elemental mutual motions, he may grasp the mutual motions in the combination of two or more of these elemental parts. To each one of these elemental parts Prof. Reuleaux gives the name of a "kinematic chain." It is clear there may be many "kinematic chains," inasmuch as there are many elemental combinations. But it is equally clear that the same "kinematic chain" may be so clothed with external appendages, and the forms of its elements may be so varied, as effectually to disguise its hereditary descent. Nay, so complete may this be, that the mechanical child may be regarded as the parent, and the parent as the child. We have only to look at the troublesome disguises which

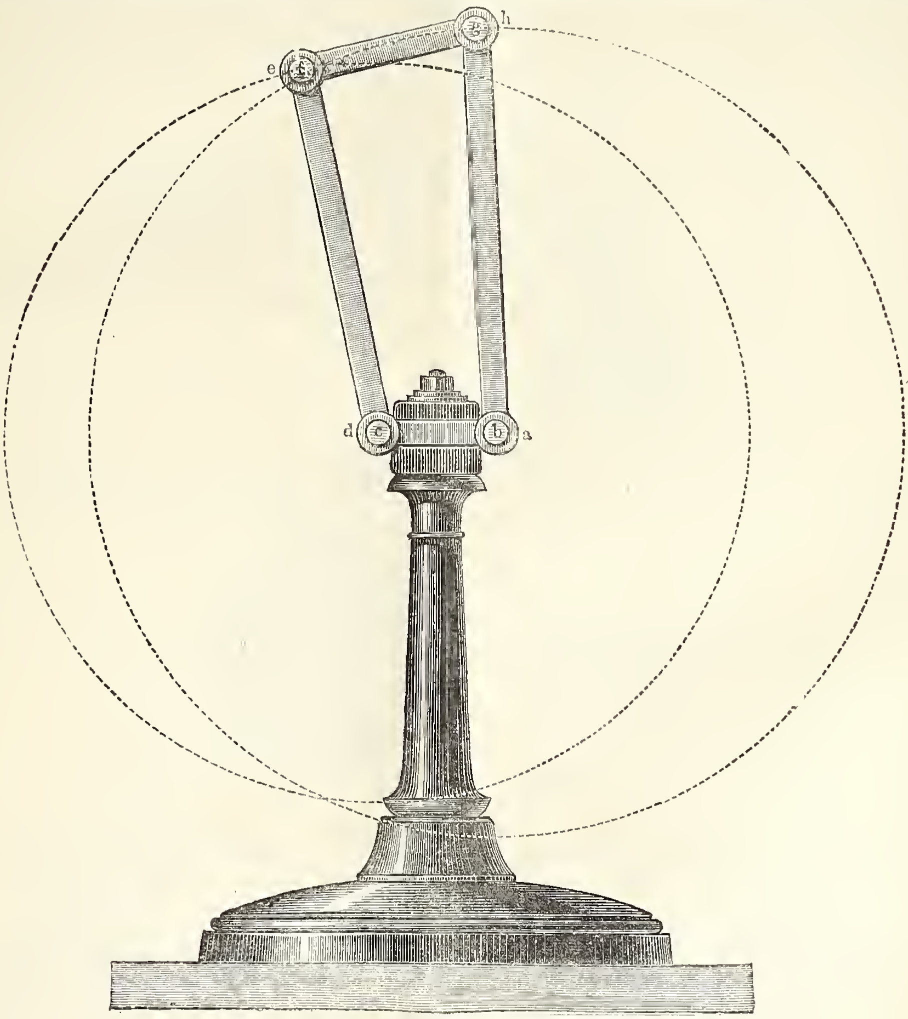

Fig. 2 (see page 994).

men and women wear in order to satisfy ourselves ef the effectiveness of the disguise of form and dress in preventing identification.

To strip these disguises, and to present evory machino in relation to its unclothed simplicity, forms a very important feature in Prof. Reuleaux's volume, as also in the numerous illustrations in the Loan Collection. It is very much in aid of this object that the extraordinary (the word "extraordinary" is both appropriate and deserved) collection of mechanical contrivances in the Loan Exhibition ef Scientific Apparatus has been formed. He very much misinterprets the use and purpose of these who regards them simply as models of machines, or parts of machines, conventionalised for class instruction, in reference to the machines of which each is a part. Let me suggest another view.

If any one can recall the time when first the study of mutual motions occupied his earnest attention, he will be conscious that diagrams in books aided but very littlo in conveying mentally tangible stages of progressive mutual motions. Perhaps he will further admit that in the laborious struggle to realise the actions of a partially developed machine, he has been vanquished, and with pieces of suitable material he has produced such mutual motions as have rendered clear that which neither grammar, logic, literature, nor diagram could do. We need but look round in various museums to note with what interest the crude first visible expressions of designed motions are preserved—aye, even respected and cared for, as historical documents. Now the pieces of apparatus from the Berlin Academy are to be regarded not only as supplementing diagrammatic illustrations, but passing very far indeed beyond these, and giving to the student living forms which he may "vivisect" withent fear of social or legal reproach. Those only who have studied thus can testify to the economy of time, the diminution of labour, the clearness of conception, the facility in combination which result from handling and analysing these under the guidance ef scientific principles, aided by a well-arranged system of symbelism.

The apparatus and the volume should be deemed parts of one whole—they are mutually dependent, and to regard the one without reference to the other is to read the play of "Hamlet" with the part of Hamlet emitted. Thus mutually and interchangeably related, it is difficult to notice either the volume or the apparatus without appearing to ramble as it were from one to the ether in a kind of labyrinthine confusion.

Let these remarks be at the same time explanatory and apologetic.

Passing by the preface, introduction, and statement of the machine problem which occupy forty pages in the volume, we are then face to face with the fundamental principle. Briefly, it is this—two pieces are the fewest that can constitute a machine, and, relatively to each other, one of these must be fixed. Although resolved into these alphabetic forms, it will soon be seen what varied motion results. Take for example the screw and nut. Fix one. If the angle of the screw can be reduced to zero, what is called the screw becomes a shaft rotating in a bearing: if the angle be increased to 90°, the rod screw becomes a plunger or piston. The forms of the parts remain; the character only of the "pairing" is changed. It will therefore be readily conceded that various motions result from various modes ef pairing elements.

Prof. Reuleaux takes the reader onwards, until he presents him with the apparatus illustrated in the volume by the annexed diagram.

The motion thus in Fig. 1 (p. 992), presented to the reader, is that of the crank and beam of a steam engine, *a d* being the crank, *c d* the connecting-rod, and *b c* the beam, the link *a b* representing the part of the machine which is fixed. Let the reader note how changed is the resulting motion when even the mechanism and the inka e being unchanged, one of the other lin viz., *a d*, which in the former case was the crank, is fixed: see Fig. 2 (p. 993).

Now Prof. Reuleaux seems to lay down as a rule from which there is no exception, saving when there are physical impossibilities—that to study a "mechanism" the student should be able to *fix* in succession each and every one or more of the moving parts. Regarding the links only in the diagram before us, there are four "mechanisms;" because there are four links, and as in the illustration these are of different lengths, it follows that the "motions" resulting will be different also, if different links be fixed; if to these we add the pins and fix one of these successively there are four more mechanisms. Although these are far from exhausting the whole of the motions to be obtained from the "mechanism" before us, they will suffice to ask the reader if from a diagram *alone*, and the most cautious "scientific use of his imagination" he can see how varied, and what will be the eight motions thus obtained. Will he not rather make a perfect or substitute a very imperfect imitation, and observe what are the paths of the parts. Now, the apparatus in the Loan Exhibition enables him at once, by a very simple clamping, to fix any piece of the "mechanism" and note the result. The value of even this one piece of apparatus to a thoughtful student in mechanical philosophy is greater than words can express.

Although it is obvious that between any two links of this simple elementary "kinematic chain," it is easy te introduce other links, *i.e.*, other "kinematic chains," yet for the purpose of this notice it is not needful in this way to compound the elementary mechanism. Whilst, however, thus avoiding the confusion which the incorporating of new elements is sure to introduce, it will not do to omit all notice of the consequences simply of changes of form and magnitude. Prof. Reuleaux has given, perhaps, undue prominence to this, for many pages of the latter part of the volume are occupied with the disguises that have been unwittingly draped over the "kinematic chain" we are considering. They seem like deductions from prepositions in Euclid, and we are tempted te exclaim—when and where will the series end?

It should here be stated that the cases in the Loan Exhibition of Scientific Apparatus; contain the actual mechanical illustrations of this "kinematic chain" in many if not all the disguises it has assumed, and for want of such methods of mechanical analysis as Prof. Reuleaux proposes, it has effectually deceived inventors and patentees for several successive years. Whilst thus omitting any further detailed reference to the many contrivances so elaborately and perfectly placed before the student, it will not be without interest to note how these disguises have been so worn that the common parentage and brotherly relationships have escaped detection. The wish to be brief will, it may be feared, lead to a want of clearness; the remedy for this is an inspection and (if permission be obtained) a handling of some of the "mechanisms" in the Loan Exhibition, and a reference to the volume relating thereto.

1. Change in the proportionate length of the arms will evidently produce change in the resulting motions.

2. Substituting (Fig. 3, p. 995) a slot for the arc described by the lever *b c* in Fig. 1, no change in the mechanical relation of moving parts has taken place: in fact, the "motions" are the same as in Fig. 1. (The shaded part shows which is fixed on the universal stand, Fig. 1.) Now let the radius of this slotted arc become infinite, then the arc becomes a straight line (Fig. 4, p. 995), and the mechanical identity of the horizontal engine with the beam engine is very apparent.

3. If instead of the slotted piece being fixed, the axis of the crank is fixed, then the same "kinematic chain" appears as a well known "quick return motion." (Fig. 5, p. 995.)

4. Other and very (apparently) different "mechanisms" result from enlarging one of the pairs ef elements se as to include another. The crank pin at the end of a large

shaft is a case in point. (Fig. 6) Of this Sir Joseph Whitworth has availed himself in one of his "quick return motions." (Fig. 7.)

The mechanism shewn in the annexed figure and used in slotting and punching machines is the same we have been considering. (Fig. 8).

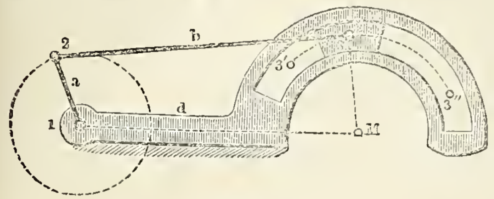

Fig. 3.

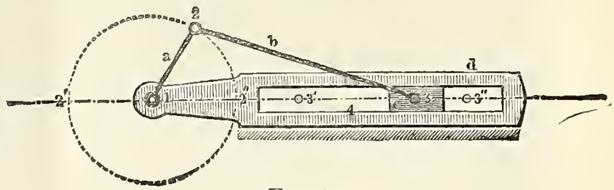

Fig. 4.

In this enumeration we must pause: it will suffice to state that Prof. Reuleaux enumerates thirty apparently different "mechanisms" obtained by the simple and obvious changes of form of parts to which reference has been made; there is, however, another great family, having, at first sight, no likeness to those we have been considering.

Bearing in mind that the object of the present notice

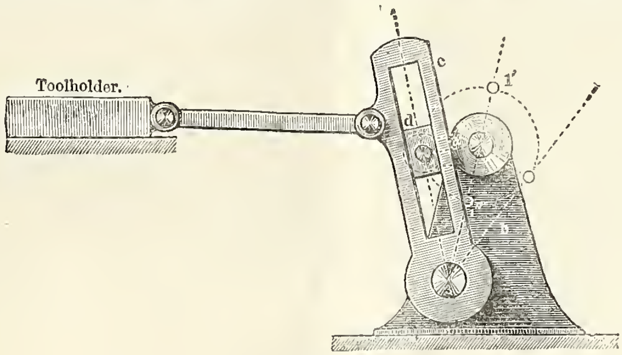

Fig. 5.

is quite as much to set forth the fundamental notions which have been elaborated into a system within which it is expected all machinery can be brought, as to impress upon others the great value to a mechanical student of access to such a collection of compounded pairs of elements as the Loan Collection offers, it seems to the

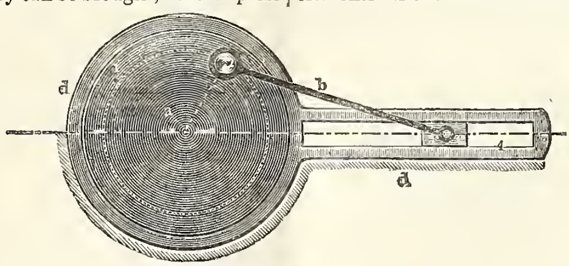

Fig. 6.

writer more desirable to omit what may be called a step in advance of elementary considerations, and therefore leaving unnoticed much of intense interest to the mechanic, to direct attention to the notation Prof. Reuleaux proposes to use.

Mathematics and chemistry have adopted a symbolic

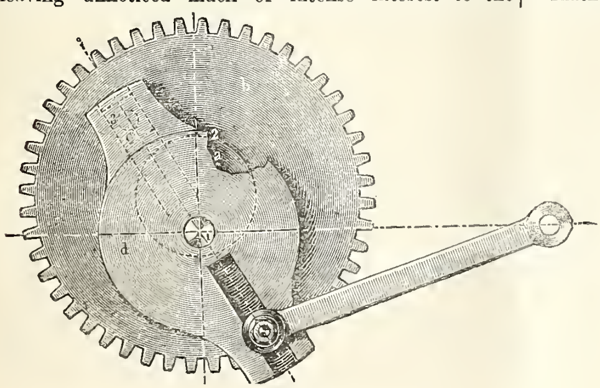

Fig. 7.

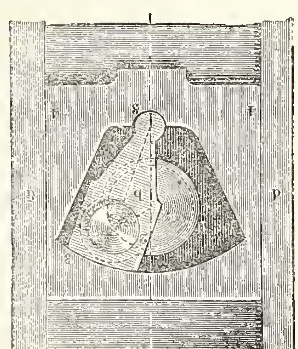

Fig. 8.

notation as the most simple for embracing the almost endless variety of elements to which their systems are applicable. *A priori*, it is reasonable to expect that a system of symbols which has bid chaos cease, where without it all was chaotic, might successfully do the part of the Eucalyptus or blue-gum tree, and turn the miasma of a swamp into the sanatorium of a city of Hygeia. How others with but very partial success have attempted this, has been already set forth. It remains only to give an outline of that which Prof. Reuleaux proposes.

Three distinct kinds of symbols are required, one kind indicating the nature of the pair of elements with which the student is dealing. These are called Class or Name Symbols.

A second kind to which is given the title of Form Symbols.

A third kind is required, to show the mutual relation between two or more elements of a mechanism; these are named Relation Symbols.

In choosing Class or Name Symbols, following the example in chemical notation, Roman capital letters are used, making these, where possible, the initial letter of the name of the Form. Only twelve such letters are requisite. Three for illustration may suffice, S is for screw, P for prism, and C for cylinder. With regard to these and the remaining nine Prof. Reuleaux pleads—"The letters have been chosen with care so as—as far as possible—to suggest the form for which they stand, and also to be available in other European languages than our own." It is to be hoped that the love of introducing change simply for the sake of change, and which has damaged much that was good in poetry as well as in science, may for some years leave our mechanical symbols untouched as the mathematical ones have been.

The Form Symbols are mainly to distinguish between solid and hollow, + for full bodies, — for open; *e.g.*, C+ full cylinder, C— open cylinder, S+ screw spindle, S— nut.

Of the Symbols of Relation, the most important are those of pairing and of linkage. The pairing is indicated by a comma. Thus C+, C+ would stand for two full cylinders rolling together; C—, C+ if one were full and one were open, as for example, a journal and its shaft.

Linkage is denoted by a dotted line; thus, C+. . . . C+ is a link having two full cylinders for the elements it connects. C— . . . . . C— is a link connecting two open cylinders or eyes. The fixing of a link is indicated by underlining the dotted line; $\underline{\text{P+ . . . . . C+}}$ stands for a fixed link, *e.g.*, such an one as is clamped in Fig. 1, connecting a full prism with a full cylinder. Besides these the ordinary mathematical symbols of relation are used.

Let the foregoing very brief and imperfect outline of the notation by which Prof. Reuleaux hopes to systematise mechanical conceptions suffice for such a notice as this.

Turning now to the cases of apparatus exhibited (so far as they connect themselves with the published volume), there will be noticed many well-known contrivances executed in iron and brass, and finished in the best style of engineering work. Whilst for the purpose of storage these are mounted on simple stands, they may be separated from their own stands, and mounted on the one shewn, Fig. 1. The parts are so arranged that sometimes one link or pin and sometimes another may be the fixed one, and so a more extended view of the relationships between the parts may be studied. Indeed, it seems to be one of Reuleaux's fundamental principles that, to study any mechanism, the place of application of the power, and the place where the power is utilised, should be interchangeable. Not only in the elementary and well-known "mechanisms" to which this notice has hitherto referred, but in those higher and compound arrangements, *e.g.*, the one in which the double-acting steam-engine is shewn to be only what he calls a "ratchet train," this interchange of parts is so far carried. Those who have noticed the Berlin apparatus may have observed a tall wooden post, external to the cases, on the top of which are ratchet wheels, links, eccentric fly-wheel, friction brake, &c. This is the apparatus now alluded to. By the action of a descending weight through the agency of the ratchet wheels, connecting rod, and eccentric, the fly-wheel rotates and a weight is raised. Interchange the weights, and by a complete reversed process the weight is being raised where the power was previously applied. Various reversing link motions can be attached to this mechanism.

Although it may prove a digression, yet the present seems a convenient occasion to direct attention to the varied, and one might almost think exhaustive illustrations for the study of ratchet gearings, which an examination of the cases furnish. In the volume on "Kinematics of Machinery," there is but little notice of this class of gearings compared with the prominence attached to them in the collection of educational apparatus in the Loan Exhibition. It will probably be found that in that future volume, being "Outlines of Practical Machinery,"—the present volume professes only to be "Outlines of a Theory of Machines"—there will be abundant matter not only on the "ratchet trains" exhibited, but upon the many other mechanical combinations and novelties which seem so well worthy of study, and would form excellent tests of the universality of the scheme Prof. Reuleaux has so successfully inaugurated in the Prussian Royal Trades Academy.

There is one class of mechanical combinations into which it would be well that some skilful geometric analyst would make an inroad, and open up new fields for mechanical research. Prof. Reuleaux skirts this almost untrodden ground, but he enters it not. Colonel Peaucellier, an officer of engineers in the French army, Professor Tchebicheff, of St. Petersburg, Professor Sylvester, of Woolwich, and more recently A. B. Kempe, Esq., have entered so far within the borders as to satisfy us there are mines of hitherto unknown mechanical wealth; but whilst many cases in the Loan Exhibition contain some curious productions of the results of link motions, yet Peaucellier's link motion under the Houses of Parliament, for the guidance of a rod in a long straight line, is the only one known to the writer of this notice which has attained practical value, and has resulted not from necessity—the mother of invention—but is the mechanical embodiment of an analytical mathematical equation.

There may be said to be two very different proposals as means for exploring this terra incognita; one by algebraic analysis—the other by Prof. Reuleaux's geometric system of "centroids."

To turn from those portions of the volume, and the cases which have treated mainly of the "kinematic chain," to those which bring before the student a study of mechanism through a system of "centroids," is essential for an appreciation of the exhibits on many shelves, and the contents of many pages.

The writer has reason to believe that attention has not yet in England been given to a consideration of "centroids," and it is a question for future investigators to determine how useful an exploring tool "centroids" may become.

Hitherto this notice of Prof. Reuleaux's volume and exhibits has dealt almost exclusively with what he names the lower pairs of mechanical elements, and the modifications of motions consequent upon the enlarging of these, so that one should include another, or combining them by "linkages" of varying proportions.

In all cases, however, rotation has taken place about cylindrical axles, and sliding motion in constrained guides where such motion was not otherwise constrained. There are, however, a series of practical arrangements by which mechanical motions very different from the foregoing may be had and studied. The group of

pairs of elements concerned introduces two considerations which seem to escape notice in the lower pairs, although the construction is such as to obviate any necessity for the notice of them. These are that the restraints against "sliding" and "turning" should be effective. Thus provided, Prof. Reuleaux investigates an elementary illustration of what may hereafter be much extended, the motions of what he names a "duangle" within an equilateral triangle. In the various forms of apparatus for this and other combinations as exhibited in the Loan Collection, the interchange of fixture previously referred to is duly provided, and the student may note either the effect of a "duangle" rotating in a "triangle" or a "triangle" rotating about a "duangle."

The object, however, for which references to these are here introduced, is a retrospective one. It will at once be seen that the path of any point in the moving piece is that of the arc of a circle which has for its centre the point of contact of the duangle and triangle.

This centre is itself following a path marked out by the relation between the pair of elements under consideration. If the figures in rolling contact be given, then an expert in constructive geometry would be able to determine the path which would result from any pairs of elements. Without further remark the conclusion of a detailed investigation may be stated. For the centroid of the equilateral triangle is "an equilateral curve-triangle inscribed within it, and for the duangle is a similar duangle which has the minor axis of the first for its major axis, and which rolls in the centroid of the triangle."

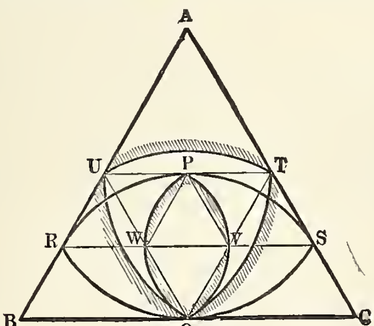

Fig. 9.

U T Q is the "centroid" of the triangle, and P W Q V is the "centroid" of the duangle.

This system of study by "centroids" developes into "teeth of wheels," and viewed retrospectively, is much employed in determining the motions of the elementary "kinematic chain" so often referred to. The size of the diagrams, the novelty of the investigation, and the length to which this notice has already extended, forbid details, which earnest students would find more interesting elsewhere than in the pages of this *Journal.*

THE USE OF NATIONAL WORKS OF FINE ART.

An address was lately delivered by Mr. Morley at Birmingham, when he recommended that "portions of our vast and varied collections should be sent to different local centres, where, from their relation to the trade and industry of the place, their value would be specially appreciated, and their influence felt." The *Times* on this observed, "We spend public money on collections, not to increase the splendour of the metropolis, not to gratify the taste of *virtuosi*, but because we hold them to be effective and indispensable means of education and refinement." Sir Henry Cole, the late Secretary of the Science and Art Department, and Director of the South Kensington Museum, accordingly, reminding the *Times* of what that museum had been doing for more than twenty years in aid of these suggestions, wrote:—

"In justice to the Lords President of the Council on Education, beginning with Lord Granville, I hope you will give me the opportunity of stating that, from 1855, the Science and Art Department has done its very utmost to induce schools of art to receive deposits of works of art for study and popular examination, and to circulate its choicest objects useful to manufacturing industry. In corroboration of this assertion, please to turn to p. 435 of the 22nd Report of the Department just issued. You will there find that upwards of 26,907 objects of art, besides 23,911 paintings and drawings, have been circulated since 1855, and in some cases have been left for several months for exhibition in localities. They have been seen by more than six millions of visitors, besides having been copied by students; and the localities have taken the great sum of £166,182 for showing them.

"The Department, besides, has tried every means to induce other public institutions, which are absolutely choked with superfluous specimens, to concur in a general principle of circulating the nation's works of art, but without success.

"The chief of our national storehouses of works of art actually repudiates the idea that its objects are collected for purposes of education, and declares that they are only 'things rare and curious,' the very reverse of what you and common sense would say they are.

"Further, the Department, to tempt schools of art to acquire objects permanently for art museums attached to them, offers a grant in aid of 50 per cent. on the cost price of the objects.

"I must not occupy your space with details. But I venture to express a hope that Mr. Chamberlain, the new member for Birmingham, will devote himself to this subject, and move for a committee of inquiry in the next session of Parliament, to see what increased use can be made of these indispensable means of education and refinement, from which the artisan, the producer, and the consumer all derive equal benefit."

HYGIENIC AND LIFE-SAVING CONGRESS, BRUSSELS.

(FROM A CORRESPONDENT.)

(Continued from p. 984.)

Tuesday, 3rd October.

Section I.—Division A.—General Hygiene.—Baron Meydell mentioned some cases of lead poisoning at St. Petersburg through the use of water from the Neva, conveyed through lead pipes, which were attacked by the water. M. Mahaux said that this question was now settled, important investigations having been made after the lead poisoning to the family of Louis-Philippe at Claremont. M. Coutelaine made a communication as to the colouring of wine by fuschsine.

With regard to the ninth question, M. Moreau made a communication as to the influence of mills and dams on the condition of water. The President proposed the question:—"Should mountains be planted, and if so, with what kind of trees?" M. T'Serstevens acknowledged the necessity for replanting, but pointed out the difficulty of making it obligatory. M. Millet mentioned the regulations as to expropriation and indemnification in France. M. Bergé observed that the practice of retting flax polluted the rivers, and it was of great importance to discover a process for superseding the old method; that of M. Lefebvre gave the desired results both from a hygienic and an industrial point of view. M. Hoffmann, in support, said that the Lys, which retted all the flax of Flanders, rendered Ghent so unwholesome that the

river had to be diverted. M. Millet stated that the retting poisoned men and cattle, and killed the fish.

Section I.—Division B.—Medical Hygiene.—This section was engaged in the discussion of the social evil; and the President, Dr. Crocq, announced that a congress on this subject would be held at Geneva in September, 1877, and he hoped the Hygienic Congress would be held coincidently with it.

M. Melsens read a paper on the efficacy of iodide of potassium in metallic poisoning, when a discussion arose between the author and M. Liouville as to the advantages and disadvantages of this drug.

M. Doixhe insisted on inherited disposition to disease as the cause of the mortality of infants, and pointed out the dangers arising from too great reliance being placed in midwives by young mothers. M. Billaudeau read a paper on the causes of mortality in newly-born infants and children, legitimate and illegitimate. Herr Kuborn touched on the principal points of his report, and read his conclusions. With regard to conclusion 4, M. Fauvel thought that the essential point was to get mothers to suckle their infants, instead of leaving them to public assistance; he hoped that the congress would express the desire for public assistance being given to poor women who fulfilled their duty. On a committee of inquiry being appointed to study the question of the mortality of infants, Dr. Hardwicke was elected to represent Great Britain. After a discussion, in which MM. Kuborn, Fauvel, Bucquet, Crocq, Liouville, Janssens, and Proust took part, the meeting passed certain resolutions given in the report.

Section II.—Division A.—Civil Sauvetage.—M. D. Alvin read the report of Professor Smet, École Militaire, as to the best means of preventing falls in earthwork, and the measures for rescue to be employed on such accidents happening. As regards the preventive measures, the reporter proposed the following questions:—

(1.) Are the regulations as to works sufficient to guard against accidents in the fullest degree possible? (2.) Is it lawful, with the object of obliging contractors to exert a more active supervision, to subject them to a fine when accidents happen in underground workings, under whatever circumstances these accidents may occur; and, if so, how to formulate the measures to be taken? (3.) In order to oblige workmen to be careful themselves, cannot punishment be inflicted on those who expose themselves to danger unnecessarily or by pure imprudence? (4.) How to ascertain that the works are being prosecuted with proper care? (5.) Is there occasion to forbid the sinking of a pit, or the execution of similar work, without the written authorisation of a competent authority, after ascertaining that proper plant has been provided?

These questions, not being opposed, were considered as carried in the affirmative. The questions as to the saving of life were expressed as follows:—

(1.) What measures should be adopted when a man is buried at a slight depth? (2.) When, as regards depth, &c., should a trench be dug, or a pit sunk? If a pit be determined upon, where should it be sunk; and at what level, with respect to the man buried, should a gallery be driven? (3.) If a trench be dug, what should be its width and inclination? (4.) If a pit be sunk, to what kind of shaft or gallery should preference be given? (5.) How are air and food best supplied to the victims? (6.) If, in works undertaken for saving life, it be necessary to damage property, can this be done without the previous authorisation of the owner, and who should be responsible for the indemnity?

M. Dumoustier de Frédilly gave an account of the penalties in force in France, in the case of accidents happening in private works, or those of the State. He thought nothing need be added to the common French law, as that was sufficient to deal with the questions raised by the reporter. M. Wybo said that the regulations were double in Belgium, rural and urban.

Dr. Phené, delegate from the Social Science Association, read his paper on the necessity for improving the ventilation of collieries, and of preventing accidents, especially as, on account of the increased output of coal, the tendency was to sink deeper and deeper, with an increase of temperature and a greater rarity of the air. The paper quoted recent statistics obtained from the mining records, and was illustrated by diagrams.

Section II.—Division B.—Medical Sauvetage.—M. Romberg gave a *résumé* of his report on the fifteenth question, as to prisoners of war: (*a*) succour; (*b*) transport and interment; and (*c*) exchange. He concluded by recommending measures of protection, which must be agreed upon at an international convention. MM. Pilloy and Heyfelder made communications on the fourteenth question, organisation of information in armies on campaign; both reports arrived at the same conclusions, which are as follows:—the publication of a list of dead, wounded, and missing should be prepared by the military authorities and circulated among the offices of information, which are to be organised in great numbers under the auspices of the *Croix Rouge.* M. Heyfelder added that, for proper organisation, a minister of hygiene and medicine should be appointed. Prince Caraman-Chimay, giving up the chair to M. Romberg, advocated the organisation of special bureaux attached to a legation residing in the nearest neutral country. After further discussion, M. Howard made a communication as to the measures to be taken for restoring animation to drowned persons.

Section III.—Social Economy.—M. Albert Picard, president, declared open the discussion on the ninth question, "How to organise a supervision over liberated criminals." M. Vander Linden then read his report on the subject, and gave some additional details. Dr. Boëns established the correlation which exists between the cellular system and supervision; he agreed with M. Vander Linden that the supervision of the Government should be superseded by that of private persons. He concluded by proposing to add to the conclusions of the reporter a fourth article:—"It is advisable to modify the organisation and the powers of the present administrative committees of prisons, in order that they may exercise an effectual supervision ever liberated criminals." Mr. Hodgson Pratt gave some information as to the supervision exercised in Dublin, and its good results. Baron Mackay said that a society for supervision of prisoners in Holland was composed of members nominated by the Government, besides which there was a non-official society which acted in the prisons, and also looked after the criminal after his liberation. Dr. Marjolin spoke highly of the reformatory schools of Ruysselede, Bernham, the French agricultural colonies of Mettray and Cîteaux, and the Douaires establishment, the three last of which owed their success to private initiative.

The meeting of the united sections was held under the presidence of Prince Caraman-Chimay, of the military *sauvetage* section. Dr. Appia (Switzerland) introduced the seventh question: A. "How to organise committees of succour before and during war? (*a*) by the intervention of the civil element; (*b*) staff to organise, and *matériel* to prepare; (*c*) measures to take for avoiding the abuses which occurred during the last war. B. Confederation of committees." Dr. Appia, in the absence of Dr. Moynier, read the report as to the second portion (B), of which the following are the conclusions:—There should be no federated societies except in those countries where the Geneva Convention has the force of law; one society of succour is sufficient for one country; it would be unwise to admit into the federations a society not authorised by its Government; the general feeling requires a common sign, a red cross on a white ground; the central committee of each society should represent it outside; the executive power of the federation should be confided to a central permanent body, independent of the societies of succour; the con-

federation of the different societies should take the title of "Federation of the Red Cross." The president thus summed up the debate which ensued:—"The meeting is divided between the fear of an exaggerated centralisation of societies, and the desire of a union as intimate as possible of the different associations of help to the wounded." Mr. John Furley, delegate of the English branch of the Order of Knights Hospitallers of Malta, read a communication, in which he denounced some irregularities in the Geneva Convention, asked if in future the voluntary association of neutral States would have the right to succour the wounded on the field of battle, and invited the Congress to support their right. The discussion was continued by M. Howsé d'Aulnoit.

Wednesday, 4th October.

Section I.—Division A.—General Hygiene.—A very important discussion on the sewage and drainage took place in this section, as to which a special communication from a high authority is promised. Information as to what had been done in the matter by different countries was given by Mr. Edwin Chadwick, for Great Britain; Professor Hubrecht, for Germany; M. Mille, government engineer and inspector, for France; and M. Symons, for Holland. At eleven o'clock, the members adjourned to the Hôpital St. Pierre to witness some demonstrations as to a new system of ventilation devised by Dr. Casse. This is termed by the inventor, who has no intention of protecting it by a patent, *ventilation renversée;* the vitiated air is drawn through apertures in the lower part of the walls, along flues under the floor, and up the exterior casing of the chimney of a furnace outside the apartments, the fresh air, warmed by the furnace, entering about the middle of the wall.

The section met again in the afternoon, when the discussion as to sewage was resumed, on M. Depaire reading his report on the second question: "What is the most practical system for freeing a town of its fæcal and putrescent matters, and its mud?"

Section I.—Division B.—Medical Hygiene.—The eighth question was down for discussion:—"Enquire into the methods (*a*) of consolidating, in the different states, the statistics of mortality for the different occupations, while taking into account the habits of the workmen and the substances they have to deal with; and (*b*) of utilising, for statistical purposes, the data of the civil powers." M. Janssens read his report on the first portion of the question; he complained of the absence of documents from which to compile a statistical table of mortality by occupations, which exercised an important influence. It would be very useful to fix upon a uniform classification for all countries; and he hoped that a special commission would take this in hand. In the meantime he put in a table of mortality for Brussels during the last fifteen years. M. Bertillon thought that the age should be added, in which Herr Böckh and Herr Flinkenberg (Berlin) concurred. M. Proust drew attention to the rules necessary for establishing a general classification; he had divided accidents connected with occupation into those caused by dust, by steam and gas, and by poisoning. Herr Kuborn communicated the programme of a course of lectures on industrial hygiene, which he had lately given at Seraing, and which might serve as a guide for classification. The conclusions of M. Janssens were approved of by the section, and M. Bertillon read his report on the second portion of the question. He passed in review the information furnished by births, marriages, and deaths, and proposed to divide the population, not according to the amount of taxes they paid, but according to their status, and the number of servants they kept. M. Delavoigne read a paper on maritime establishments for ricketty and scrofulous children, and Herr Kuborn also contributed a report on the same subject. Before the meeting closed, Herr Kuborn expressed a hope that a permanent museum of hygiene and life-saving might be established in Brussels, and M. Liouville conveyed the thanks of the section to Dr. Crocq for acting as its president. Dr. Crocq, in replying, said that another hygienic and life-saving congress would be held in Paris during the Exhibition of 1878.

Section II.—Division A.—General Sauvetage.—Captain Dufour, chief of the Belgian Mail Service, raised the subject of a competent jurisdiction as to crimes committed on the high seas. M. Sève said that in France the consuls were competent to commence proceedings as to these crimes; he hoped that all the Powers would consent to an international convention for adopting the French method of procedure, a conclusion which was favourably received. M. Dumoustier de Frédilly accepted the task of reporting the labours of the section; and a vote of thanks to M. Janssens for presiding closed the proceedings.

Section II.—Division B.—Military Sauvetage.—The last question dealt with by the section was that of the intervention of charity in the re-victualling of military ambulances on a campaign. M. Costere, who presented the report, said that private charity might to a large extent come to the aid of the official service; not that there was any lack of individual charity, but that it had not been properly organised. All that related to transport of provisions and medicaments, immunities for those engaged in the service, free transport, &c., was perfect; what was wanting was military discipline. The exigences of war rendered unrestrained charity often useless, and almost always dangerous and embarrassing. The conclusions arrived at by the reporters were that charity should be absolutely excluded from the battle-field, and no ambulances should be permitted on the scene of strife except under military discipline, though this he feared would be the death of charity. The last clause only of the report, which was well received, gave rise to a discussion, Dr. Riant, delegate of the Société Française de Secours aux Blessés, being of opinion that charity would be all the stronger through being placed under control. Count de Beaufort brought the discussion to a close by advocating a distinctive and bright uniform for those engaged in this service. Dr. Feigneaux was appointed reporter to the section, which closed its labours by a vote of thanks to the bureaux, including Prince Caraman-Chimay, the president.

Section III.—Social Economy.—The *ordre du jour* was for the consideration of the depopulation of the country in favour of towns, and was thus expressed: "Study the causes of the depopulation of the country and the remedial measures; seek the best method for combining the elementary education of children and adults with the technical instruction of boys and girls:—(*a*) in the country; and (*b*) in towns." M. Geelhand, secretary-general of the Brussels Société Royale de Philanthropie, submitted his report, the conclusions of which are: that the moral and material position of the agricultural labourer should be improved in a rational and constant manner; that all the branches of industry which pertain more especially to agriculture, such as the grinding of corn, sugar refining, brewing, distilling, &c., should be gradually transferred from the town to the country; and that minute subdivision of land should be avoided, which give rise to small farms, with difficulty carried on to a profit. M. Novent, delegate of the *soirées populaires* of Verviers, spoke to the good effect of popular libraries and publications. Professor Andréeff, St. Petersburg, in the interest both of agriculture and manufactures, pleaded the cause of compulsory education, and especially of technical instruction. M. L. T'Serstevens said that three levers must be set to work, science, credit, and cheap railway fares. M. Dumoustier de Frédilly, director-general of commerce and agriculture of France, in a long and eloquent address detailed the different measures adopted in France for the development of agriculture and industry, concluding with the opinion that, in a few years, agriculture would have no cause to complain of its position.

This section again met in the afternoon under the pre-

sidency of M. L. d'Andrimont, for clearing off the business still on hand. As to the seventh question (savings banks) Dr. Engel, of Berlin, gave particulars of a special method of fire insurance in Germany. M. Salomon, Paris, praised the working of benefit societies in the Belgian mines. Professor Böhmert, Dresden, combatted the principle of workmen participating in profits, and proposed an international inquiry on the subject. Mr. Hodgson Pratt divided benefit societies into three classes, those for aid in sickness, for providing for widow and children, and for assistance in old age; he advocated the English system, free and direct insurance by the workman without the intervention of law or the master.

The question of syndical unions was then resumed, M. Havard making some additions to his report. Mr. Hodgson Pratt showed the beneficial influence of workmen's clubs, which M. Sève remarked existed already in Belgium and the United States; and M. Lombaert offered some considerations on the necessity for rest on Sunday, independently of the religious aspect.

The sixth and last general meeting of the united sections was presided over by M. Bergé, the subject for discussion being sewage, which had been dealt with by the Hygiene Section in the morning. On the platform were exhibited some fruit and vegetables from the Plain of Gennevilliers, irrigated by the sewage water of Paris. The question, brought up by M. Depaire, was: "What is the most practical system for freeing a town of its fæcal and putrescent matters and its mud? What are the means (*a*) for purifying sewer water, (*b*) of utilising the outfall, (*c*) of preventing the deterioration of watercourses by manufacturing refuse, and (*d*) of neutralising the injurious effect of manure heaps near habitations? What are the circumstances which should govern the choice of disinfectants and antiseptics?" The report was in favour of sewage irrigation and—only when this was impossible—of a chemical purification of the outfall. Mr. Edwin Chadwick, M. Mille, of Paris, M. Verrine (Russia), M. Hubrecht, engineer to the City of Berlin, M. Boerner, of Berlin, and many other eminent men, took part in an animated discussion. M. Depaire, the reporter, was glad to learn that the question of the utilisation of sewage was nearer solution, there being only one obstacle—saturation; he concluded by calling attention to the pollution of streams by manufacturing refuse.

Closing Seance.

This was held on Wednesday afternoon, under the presidence of M. Vervoort, the president of the congress. The reports of the various sections were presented by MM. Yseux, Ledeganck, Dumoustier de Fredilly, Feigneaux, and T'Serstevens. The president read a letter from the Turkish Minister, expressing sympathy with the work. M. Hubrecht (Holland), and Baron Meydell (Russia), as foreign delegates, congratulated Belgium on the success of her work. General Obroutcheff, president of the Russian delegation, proposed that an address of acknowledgment should be presented to the King of the Belgians for his patronage. M. Vervoort announced that His Majesty would place at the disposal of the next congress the prize of a gold cup, value 5,000 francs (£200), to be awarded to the municipality, local authority, association, or private individual that should, by improving the dwellings of the industrial classes, achieve the greatest success in diminishing the death-rate; and that the Queen would grant a gold medal to be awarded to that institution, public or private, for the care of orphans, in which the preservation of infant life should have attained the greatest average. The address to their Majesties was then voted with enthusiasm, and various complimentary votes were carried. The president said that the question of a future congress would be considered by the executive committee, and then closed the first session of the International Congress of Hygiene, Life-saving, and Social Economy.

THE ASSIMILATION OF PATENT LAWS.

At the Hague Conference, last year, of the Association for the Reform and Codification of the Law of Nations, a paper on "Assimilation of the Patent-laws" of various nations, was read by Mr. W. Lloyd Wise, and referred to a committee. At the Bremen Conference on the 26th ultimo, this committee presented the following report:—

"We have had under our consideration the subject of assimilation of the Patent-laws of various nations, in connexion both with the paper of Mr. Lloyd Wise referred to us last year, and with the resolutions of the International Patent Congress, held at Vienna in 1873. A copy of the first three of these resolutions, excluding only some formal ones relating to a permanent committee which has practically ceased to exist, accompanies this report. We consider it to be abundantly established by experience, that it is for the commercial interest of every nation to grant protection in the shape of patents to inventors. But in these times of international intercourse, the patent granted in one country may become to some extent a restriction, unprofitable and obstructive, if the same invention, without limitation or increase in price, becomes in an adjoining country common property; although a country offering the protection of a Patent-law will usually obtain the earliest benefit of new inventions. Hence the wide-spread practice of patenting the same invention in several countries, and the necessity for assimilation of the law of patents in the different civilised States. Unless some common principle be agreed upon, it is evident that much of the benefit of patents will be lost, by their being granted in one country, whilst they are refused, or granted upon wholly different conditions, in another; for by such inequalities, the reward by which the inventor is stimulated to exercise his ingenuity for the benefit of the commercial world at large is rendered precarious, and stimulus becomes less powerful.

"Influenced by these considerations the Congress of Vienna, in its second resolution, laid down certain principles as the basis of a model Patent-law, to which future legislation on the subject should conform. That congress was a very influential and representative body, including many eminent patent lawyers, inventors, manufacturers, and other authorised persons from the different civilised States, and we do not think it would be advisable to depart from the general principles then laid down. We, therefore, recommend that in any action taken by this Society in favour of the assimilation of Patent-laws, the Vienna resolution should be adhered to as a basis, though it may be necessary to supplement the principles there enunciated by some others. In particular, it may probably be found desirable to embody in the framework already sketched out some suggestions to be found in Mr. Lloyd Wise's paper, among which may be indicated (first), that the preliminary examination mentioned in Clause C of the resolution already referred to, should be limited in its scope to the questions whether the specifications are clear, and whether the invention is open to objection, as being contrary to morality or wanting in novelty, regard being had to prior publications; (secondly), that an adverse report should not disentitle the applicant to a patent, except in cases of fraud, or where the invention is contrary to morality; (thirdly), that if the applicant specifies the prior matter found by the examiners, and clearly defines what he, nevertheless, claims as his invention, no adverse report should be published.

"At the present time there are two important countries which have no Patent-laws, Holland and Switzerland. In Holland, where a Patent-law existed until 1869, there is evidence that it was repealed because of its defects as a measure, and not because the principle of rewarding inventors in this way was considered objectionable *per se*. In Germany, a draft law, founded on the

second resolution of the Vienna Congress, is now under the consideration of the Government, for embodiment in the revised Code of the Empire. In England, a Bill for the modification of the existing Patent-law has been twice before Parliament, but has not yet been discussed in the House of Commons. It has met with great opposition from inventors, manufacturers, and others. The Patent-laws of several other countries are far from conforming to the principles enunciated at Vienna; but, as far as we are aware, the only bodies which are doing anything to carry out the resolutions of the Vienna Congress are the committee in Germany which prepared the draft law just spoken of, and a committee in London of which Dr. C. W. Siemens, F.R.S., is chairman.

"We therefore suggest that a committee be appointed by the Conference to deal with the subject of Patent-laws alone, with power to add to its number, and especially to invite the co-operation of persons who have already devoted themselves to this subject, and may be willing to join our association. That such committee be empowered to take such steps as they may think desirable in promoting the reform and assimilation of Patent-laws, on the basis of the resolutions of the Vienna Conference, amplified by any additions they may consider necessary to the equitable working of the system, and in bringing the subject before the attention of the Governments and people of the various civilised States, including in particular those of Holland and Switzerland. We hope that in this way a comprehensive and efficient committee may be formed, capable of satisfactorily dealing with this important practical question."

NEEDLE MAKING AT REDDITCH.

Redditch, in Worcestershire, and Aix-la-Chapelle, in Germany, may be regarded as the seats of the needle trade of the whole world, comparatively few needles being made elsewhere; English needles are, however, more in request than those of any other country. As the needles undergo a considerable number of processes, from tho rough steel wiro to the highly polished hand instrument, which is not yet superseded by its machine competitor, perhaps some account of their manufacture may not be found uninteresting.

The steel wire, which must be of excellent quality, being hand-drawn for best needles, is first cut into lengths capable of making two needles each. This operation is performed either in bundles by means of hand shears, or four at a time in self-acting machines, the shears of which are worked by an eccentric while the wire is fed up to them. The two-length pieces of wire are then formed into bundles from three to five inches in diameter, according to the size of the wire, and held together loosely by a pair of iron rings, in which state they are annealed in a furnace heated by a wood fire. When sufficiently soft, the wires, still in bundles, are rolled one over another by the aid of what is termed the smooth file, and thus made to straighten each other.

The next operation, that of pointing on grindstones, formerly involved greater loss of life than any other industrial occupation. The needles (twenty-five at a time) were made to rotate against the stone between the fingers and thumb of the operator; and the subtle dust from the stone and the needles was inhaled with the breath, and found its way into the lungs, causing the malady known as grinders' asthma, to which all grinders succumbed at an early age. All this is now changed, however. The needles are made to rotate between two india rubber bands travelling over the concave face of the grindstone, of special quality, obtained from Frankfort; and the fine dust is carried off through a channel under the grinder's seat, by an exhausting fan, which does duty for all the stones.

The middle portions of the wires, now pointed at both ends, are next brought under a falling die, worked by the foot, which stamps the gutter for the eye, roughs ou the heads, and marks the position of the eyes. The flattened portion has become hardened by the blow, and this hardness has to be removed in the annealing oven. The holes for the eyes are then punched out by a pair of small punches in a hand screw-press; these punches require careful workmanship, both in making and adjusting, and employ special operatives, who work with magnifying glasses like those of watchmakers. A number of the pairs of needles, still united, are then threaded, or "spitted," as the term is, on a pair of fine wires; and the burr or fin, made in stamping the heads, is then removed by a file. After the lengths have been divided, by bending the wires backwards and forwards between the two spits, the rudely-formed needles, now for the first time separate, have their heads rounded off by filing, especial care being taken to avoid weakening the eyes.

The needles are next heated in small iron trays, and then dropped separately into cold oil, which makes them very hard; they are then tempered by being heated on a hot plate, or in a charcoal stove, until a dark blue film forms over them. These two operations cause some amount of warping, to counteract which the needles are straightened by hand hammers on small anvils. To ascertain if they are straight, the needles are rolled by tho finger on a smooth steel plate, and such as do not run smoothly are again straightened with the hammer.

The next operation is scouring, to remove the black coating, and give the needle that high polish which is necessary to enable it to pass readily through the fabric. Formerly, from seven to eight days were occupied in the case of best needles by this one process; but now the time is considerably shortened, owing to improvements in the appliances. The needles are weighed out into lots of from 400,000 to 500,000 each, according to size, and tied up with emery powder, oil, and soft soap, in a square piece of strong canvas, and securely bound with cord, thus forming rolls or bundles about two feet long and three inches in diameter. These bundles are rolled backwards and forwards in the scouring machine under a heavily-weighted slab, worked by cranks driven by the engine. This process is repeated from seven to eight times, according to the quality of the needles, the needles being washed in soapsuds after each scouring. The final polishing is accomplished in the same manner, but with putty powder, and the needles are then dried in ash-wood sawdust.

The needles are now highly polished and well-tempered, but with the eyes not yet perfect. The heads are all arranged in the same direction by gradually bringing them up to the edge of a board, and letting the heavier heads fall over, so that they may be taken up and turned the other way; this is done by means of a couple of metal plates, as touching the needles by the hand would cause them to rust. For picking out defective needles, which must be done by hand, an operative of the gentler sex is chosen whose hand is cold and dry. Before the eyes are drilled, they are softened or "blued," by being made to pass through a gas flame by means of a revolving wheel, which picks them up by an ingenious arrangement. This seems to be the only process where any inconvenience is felt by the operatives, who complain of headache after remaining for any length of time in the room where several of these gas flames are burning; but the withdrawal of the fumes from the gas by a hood and exhausting fan, like that used for the grindstones, would obviate this inconvenience. The eyes of the "drilled-eyed" needles are smoothed by a fine counter-sunk drill of delicate workmanship, several drills being driven by one pulley. The eyes are polished by being again "spitted" on wires smeared with emery and oil, and hung in a frame made to travel backwards and forwards by the engine. As the wires are stretched in a direction oblique to the line of motion, the needles are shaken about in different directions so as to effectually round out the eye. Both heads and points are finished on small grindstones of very fine texture, a number of

needles being rolled together between the finger and thumb, then polished in the same manner on emery buff rollers.

After passing through these multifarious operations the needles are at length quite finished, although some extra qualities now have their eyes gilt by the electrotype process; all that remains to be done is to put them up in packets, generally containing a quarter of a hundred, ready for sale. The better kinds are stuck through strips of cloth pasted to the paper; but even with the commoner kinds an improved wrapper has lately been devised, which enables one needle to be selected without the danger of all the rest falling out of the packet. Women and girls are employed in many branches of this interesting manufacture, and do not seem to suffer in health, except in the one instance above mentioned.

ADULT INSTRUCTION THROUGH PUBLIC MUSEUMS.

(*Subsidised by Parliament.*)

The results, giving important information for public education, are obtained as correctly as possible, from inquiry and Parliamentary returns, in the hope that they may hereafter be officially collected and published periodically, like the Registrar-General's returns. Number of visitors for the months of August and September, 1876. When they are counted by sight the letter "S" is used, when by turnstile the letter "M":—

Institutions.	Amounts voted in 1876.	Number of Visitors in August.	Number of Visitors in September.	How counted.	Remarks.
	£				
1. British Museum	108,947	50,166	28,844	S	Return refused. (1)
2. National Gallery, Charing-cross	6,898	107,167	148,775	S	13 public days in August, and 17 public days in Sept. Open from 10 to 4.30. (2)
3. Kew Gardens and Museum ..	22,622	136,886	30,676	S	Open on Sundays and week days. (3)
4. South Kensington Museum ..	39,058	139,313	133,027	M	Total for year, 839,212. Open daily all the year and in the evening, except Sundays (4)
5. Bethnal-green Museum	7,200	41,777	92,283	M	Total for year, 522,098. Open daily all the year and in the evening, except Sundays. (5)
6. National Portrait Gallery, South Kensington	2,000	..	..	M	Return refused. Open daily except Sundays. (6)
7. School of Mines and Mining Record Office, Geological Museum, Jermyn-street..	8,947	980	1,800	M	Open daily, except Sundays and Fridays, and in the evenings of Mondays and Saturdays. Closed from 10th Aug. to 10th Sept. (7)
8. Patent Office Museum, South Kensington	..	24,483	23,018	M	Open daily, except Sundays. (8)
9. Edinburgh National Gallery..	2,100	19,626	11,841	M	(9)
10. Edinburgh Museum of Antiquities	..	20,985	11,407	M	(10)
11. Edinburgh Museum of Science and Art	10,320	33,838	32,090	M	(11)
12. Edinburgh Botanic Gardens ..	1,750	7,856	6,689	M	(12)
13. Dublin Museum of Natural History	1,742	9,670	7,820	M	Open daily, and in the evening. (13)
14. Glasnevin Botanical Gardens and Museum	2,224	26,597	23,230	M	Open daily, including Sundays. (14)
15. National Gallery of Ireland ..	2,339	9,758	9,137	M	(15)
16. Museum of Royal Irish Academy, Dublin	300	..	..	M	(16)
17. Zoological Gardens, Dublin ..	500	12,315	9,480	M	Open daily, including Sundays. Number of visitors in July, 15,281. (17)
18. Tower of London	1,590	34,690	33,171	S	Open daily, except Sundays. (18)
19. Royal Naval College, including Greenwich Painted Hall	38,051	39,821	27,526	S	Open daily, including Sundays. (19)
20. Royal Naval Museum, Greenwich	1,055	8,668	6,106	S	Open daily, except Fridays & Saturdays. (20)
21. India Museum, South Kensington	..	70,821	75,830	M	Paid for by Indian Government. (21)
22. Hampton Court Palace	7,475	..	..	M	Open on Sundays, and on week days except Fridays. (22)

(1) Open Mondays, Wednesdays, Fridays, and Saturdays. Closed, except to students, on Tuesdays and Thursdays. The numbers are those for the corresponding months of last year, as given in the Parliamentary return.

(2) Open Mondays, Tuesdays, Wednesdays, and Saturdays. Closed on Thursdays and Fridays. Total of five months to August 30th, 360,980. Closed since May 1st. At South Kensington Museum on May 20th. Re-opened to the public on Wednesday, Augnst 9th.

(4) (5) Open morning and evening till 10, on Mondays, Tuesdays, and Saturdays. Students' days—Wednesday, Thursday, and Friday, 6d. entrance.

(4) Visitors in May, 101,635.

(5) Visitors in May, 37,501.

(7) (8) Open till 10 in evenings of Monday, Tuesday, and Saturday.

(9) (10) (12) (15) (16) (20) No information as to opening.

(11) Open daily (10 a.m. to 4 p.m.) except Sundays, and Friday and Saturday evenings (6 to 9). Students' days, Monday, Tuesday, and Thursday; admission 6d.; other days, admission free.

(21) Open on Mondays, Tuesdays, Fridays, and Saturdays, 1d. admission; on Wednesday and Thursday, 6d. admission.

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All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

TECHNOLOGICAL EXAMINATIONS, 1876.

The following is a list of the candidates who passed this Examination:—

Carriage Building.

89250—Mullins, Matthew, aged 22, Cork School of Art—2nd Honours, with the Prize of £10.

Cloth Manufacture.

89246—Sykes, Edmund, 33, Elland Science Classes—2nd Advanced.

Cotton Manufacture.

89239—Ashworth, James Edward, 20, Manchester Mechanics' Institute—1st Honours, with the Prize of £10.
89226—Blackwell, William, 31, Oldham Science School—1st Elementary.
89241—Firth, William, 19, Huddersfield Mechanics' Institution—1st Elementary, with the Prize of £5.
89240—Fisher, John, 20, Elland Science School—2nd Elementary.

Gas Manufacture.

89256—Akroyd, Benjamin, 33, Elland Science Classes—1st Elementary, with Extra Prize of £2.*
89254—Dempster, Robert, 23, Elland Science Classes—1st Elementary, with the Prize of £5.
89208—Dronsfield, John, 19, Oldham Science School—2nd Elementary.
89253—Hepworth, Reuben Alfred, 22, Elland Science Classes—1st Advanced, with the Prize of £7.

Silk Manufacture.

89243—Wilkinson, Edward, 29, Leeds—1st Elementary, with the Prize of £5.

Steel Manufacture.

89204—Ashby, George, 20, Oldham Science School—2nd Elementary.
89237—Daltry, Thomas Lewis, 22, Dublin—1st Honours, with the Prize of £10.
89235—Dobson, Stephen, 33, Islington Science School—1st Elementary, with the Prize of £5.
89218—Dunkerley, John, 20, Oldham Science School—2nd Elementary.
89234—Foster, James Yates, 20, Preston—1st Elementary.
89197—Garside, Franklin, 21, Oldham Science School—1st Advanced.
89215—Geddes, John William, 17, Oldham Science School—1st Elementary.
89203—Gomersall, George, 20, Oldham Science School—2nd Elementary.
89232—Harris, Sydney Joseph, 18, Crewe Mechanics' Institute—1st Elementary.
89301—Harvey, Ernest William, 17, Woolwich—1st Elementary.
89231—Latham, William Barnes, 23, Crewe Mechanics' Institute—1st Elementary.
89200—Needham, Joseph Edward, 19, Oldham Science School—1st Elementary.
89199—Ogden, Fred, 17, Oldham Science School—1st Advanced.
89233—Pillow, Edward, 23, Crewe Mechanics' Institute—1st Advanced, with the Prize of £7.

Wool Dyeing.

89244—Davis, Frank, 21, West-vale, Halifax—1st Elementary, with the Prize of £5.

The following candidates have passed in Technology, but have failed to obtain a Certificate, not having the requisite Science Certificates:—

Carriage Building.

89305—Butler, Lewis James, 20, Bryanstone-street.
89248—Heywood, William, 35, Huntingdon.

Cotton Manufacture.

89238—Bury, John, 38, Bolton Science School.
89209—Holden, Thomas, 16, Oldham Science School.
89206—Kearsley, Alfred, 21, Oldham Science School.
89219—Mellor, Charles, 18, Oldham Science School.
90606—Taylor, William, 21, Oldham Science School.
89227—Wolstencroft, William, 21, Oldham Science School.

Gas Manufacture.

89211—Ashton, William, 18, Oldham Science School.
89251—Plant, Joseph, 33, Wolverton Science School.
89252—Vinson, William Ellis, 22, Chelthenham Science School.

Steel Manufacture.

89225—Firth, Matthew, 26, Oldham Science School.
89202—Harrison, George, 17, Oldham Science School.
89201—Hayes, Thomas, 25, Oldham Science School.
89223—Hilton, Edwin, 18, Oldham Science School.
89214—Wynne, John Freer, 17, Oldham Science School.

Wool Dyeing.

89245—Orchard, Francis, 21, Cardiff Science School.

* This prize is given by the Bath and West of England Gas Company.

CANTOR LECTURES.

The fifth lecture of the third course of Cantor Lectures for the past Session, on "Wool Dyeing," by Mr. George Jarmain, was delivered on Monday evening, April 3rd, as follows:—

Lecture V.

The yellow colouring matters which I have now to describe are complementary to those which I have already brought under your notice, as they enable the dyer to complete the range of colours which are employed in the dyeing of cloths, the colours of which are required to be fast and permanent in the sense in which I have used these terms.

We will confine our attention, at the present,

to the following yellow colours:—Fustic, American bark, flavine, turmeric, Persian berries.

Fustic is the wood of a tree called *Morus tinctoria*. It is imported chiefly from Central America and the West Indies. It is known to the dyer under the names of old fustic and yellow wood. It is prepared for the use of the dyer as chipped fustic, rasped fustic, fustic extract. It is used extensively in all three forms. When the chips are used they are placed in a bag in the boiling water, in the same way as that in which logwood is used. Rasped fustic may be thrown into the pan along with the goods to be dyed.

The tinctorial principles contained in fustic consist of moritannic acid, a pale yellow crystallisable substance, freely soluble in water, morin or moric acid, a crystallisable substance nearly insoluble in water. As moric acid is but slightly soluble even in boiling water, the moritannic acid is the principal available colouring agent in fustic. Fustic gives a yellow colour on wool which has been mordanted with chloride of tin, alum, or bichromate of potash, and olive green with a mordant of sulphate of copper or copperas. Fustic is rarely or never used as a self colour, but it is very extensively employed along with logwood and the red woods in producing that infinite variety of shades of composite colours known as blacks, browns, olives, drabs, &c., for which it is eminently adapted. Dyed on wool, with a bichromate of potash or copperas mordant, it produces a fast and beautiful and permanent colour.

In the heavy woollen cloth districts, where pilots, beavers, naps, reversibles, fancy trouserings, and such like goods are manufactured, it is more extensively used that any other yellow dye-ware.

Its use and modifying action on other colours, such as logwood and the red woods, are best studied by dyeing equal weights of mordanted wool or cloth with varying quantities of fustic, and of the woods I have just named.

As examples of its modifying influence, I have placed before you samples dyed with the following quantities:—

Mordanted with two per cent. bichromate of potash; boiled one hour.

Sample.		Fustic.	Barwood.	Logwood.
1.	Dyed with	60	0	..
2.	”	30	30	..
3.	”	60	30	..
4.	”	20	40	..
5.	”	0	60	..
6.	”	40	20	3
7.	”	40	20	saddened with copperas.

Sample.		Fustic.	Madder.	Logwood.
1.	Dyed with	60	0	..
2.	”	40	20	..
3.	”	20	40	..
4.	”	0	60	..
5.	”	40	20	3
6.	”	20	40	saddened with copperas.

Sample.		Fustic.	Sanderswood.	Logwood.
1.	Dyed with	60	20	5
2.	”	60	20	10
3.	”	60	20	15
1.	”	80	10	3
2.	”	80	30	3
3.	”	80	50	3
4.	”	50	80	3
5.	”	10	80	3

Sample.	Fustic.	Logwood.
1.	60	5
2.	60	10
3.	60	20
4.	60	30

It will be observed that each of the red woods and madder imparts its own special tone of colour along with the fustic, and as the practical dyer has generally to dye to a pattern, it is almost useless to give any special formula for particular shades.

My purpose will be better served if I endeavour to indicate to you the specific purpose the dyer has before him, when he makes a selection of the red woods to be used:—As a rule, the different shades of brown are obtained by using more than one red colour, and sometimes three or four of the red colours are required in order to produce shades exactly like a given pattern. In my opinion there is no department of dyeing which requires such an amount of skill, and practical experience, and knowledge of the modifying action of colours upon one another, as in the dyeing of the different tones of blacks, browns, and drabs, and it is wonderful to see with what precision some of our practical dyers can arrive at any particular tone or shade.

In the use of the red woods as modifying agents, the following points should be borne in mind:—

1. Camwood is stronger, faster, and brighter than either barwood or sanders.

2. Barwood gives brightness and lustre, but lacks body.

3. Sanderswood gives a more yellow red than camwood or barwood. It contains more colour than barwood, but its colour is not so bright.

4. Madder gives the finest, brightest, and fastest colour; it contains more yellow colour than the red woods, but its red colouring matter is superior to those of the red woods.

5. Sumac gives a fine olive yellow shade to brown, and helps to sadden when copperas is used.

6. Logwood in small quantities, say one, two, or three per cent., saddens or dulls the colours of the red and yellow woods.

7. Cudbear has a brightening effect, giving a purple tone to colours.

Incidentally, I may mention a particular effect which is frequently met with in dyeing of wool. The tips of the locks of wool often take a deeper shade of colour than the remaining portion of the lock, and as the wool becomes thoroughly mingled in the processes of carding, scribbling, and spinning, to which it has to be subjected preparatory to its final manufacture into cloth, the dyer has to take into account the effect which will be produced by such admixture of colour.

In cases of this kind, the general effect produced by the dye may be ascertained by teasing out in the hand a small sample, so that the whole is made as even as possible. On comparing this with the pattern, it will be seen whether the proper effect has been obtained, or whether some additional colour, and what colour, is required.

There is another effect which is often perplexing to a young dyer; the red and yellow colours have different affinities for the mordanted wool; the red wood colours partially displace the yellow colours. If wool, in the course of dyeing, appears to have received a sufficient amount of yellow, but there is a deficiency of red, and the dyer proceeds to add what he conceives to be a sufficient quan-

tity of red to make up the deficiency, and bring the goods up to sample, he will frequently find that he will then have on too much red and too little yellow. The additional quantities of wood required are added in the form of rasped or ground wood, which is well worked up with the goods, or a solution of the extract may be employed for the same purpose.

The following receipts are examples of the use of several woods which were found to be required in order that a particular shade of colour might be obtained:—

Tan Brown.

Mordant—

	Per cent.
Bichromate of potash	1

Boiled for one hour.

Dye—

	Per cent.
Madder	3·2
Fustic	4·8
Camwood	2·
Barwood	1·75
Sumac	2·2

Boiled two hours.

Tan Brown, redder shade.

Mordant—

	Per cent.
Bichromate of potash	1

Boil one hour.

Dye—

	Per cent.
Fustic	7·2
Madder	4·8
Camwood	2·8
Sumac	2·4

Boil two hours.

California.

Mordant—

	Per cent.
Alum	1
Bichrome	1
D.O.V	$\frac{1}{3}$

Boil one hour.

Dye—

	Per cent.
Fustic	25
Madder	2
Camwood	3

Boil one hour and a half.

Dark Drab.

Dye—

	Per cent.
Camwood	6·5
Sumac	2·
Madder	2·5
Fustic	4·
Logwood	2·5

Boil one hour and a half. Sadden with 1 per cent. copperas.

Olive Drab.

Mordant—

	Per cent.
Bichromate of potash	1

Boil one hour.

Dye—

	Per cent.
Fustic	10·
Sumac	2·
Madder	5·
Logwood	·2

Boil two hours.

Madder Brown.

Mordant—

	Per cent.
Bichromate of potash	1

Boil one hour.

Dye—

	Per cent.
Fustic	22·7
Madder	11·35
Logwood	1·13

Boil two hours.

Drab.

Dye—

	Per cent.
Fustic	1·7
Madder	4·
Cudbear	·1
Sumac	·8

Boil one hour and a half, and sadden with ·2 per cent. copperas.

Quercitron Bark.

Quercitron bark is the inner bark of *Quercus tinctoria*, another species of oak indigenous to North America. For the use of the dyer the bark is dried and ground.

The principal colouring matter contained in it is quercitrin, a glucoside which is capable of breaking up into a sugar and quercitin. Both quercitrin and quercitin are yellow colouring matters which, in their effect upon mordanted wool, act very much like the colouring matter of fustic.

In woollen dyeing the use of "bark," as quercitron bark is frequently called, was introduced by Bancroft, to whom we are also indebted for the most original work on dyeing we possess in the English language.

The use of the bark is not as extensive as that of fustic, but it may be used for the same purpose, though it does not give the same amount of body of colour.

Flavin.

A preparation of bark known under the name of flavin is often used, when shades brighter than what can be obtained with fustic or bark are required.

Flavin consists mainly, if of good quality, of the colouring principle itself, namely, quercitrin or quercitin; its colouring power is therefore far greater than that of bark. One ounce of good flavin is equal in tinctorial power to 1 lb. of bark.

The best qualities of flavin are imported from America, where it is believed to be made from the fresh bark, but there seems to be some mystery about its mode of preparation.

Flavin is used for the yellow part of scarlets and oranges, and for almost any colour where a good bright yellow is required.

The colouring matters of fustic, quercitron bark, and flavin may be described as fast and permanent dyes for wool.

Young Fustic.

This is the wood of the *Rhus cotinus*, a tree which grows in southern Europe and the West Indies. It is prepared in the form of chips for the use of the dyer. Young fustic contains an astringent principle and two colouring matters, a yellow and a red.

The name fustin has been given to the yellow

colour, which possesses many of the characteristics of quercitron, but there are some slight differences. On wool mordanted with a tin salt it produces a fine and tolerably fast yellow orange. Its chief employment in woollen dyeing is for the production of scarlets and oranges along with cochineal, for which purpose it is extremely well adapted.

The two remaining yellow dye-wares which I have to describe, on account of their loose and fugitive character, cannot be used with advantage for the dyeing of woollen cloths for men's wear. They are turmeric and Persian berries.

Turmeric.

Turmeric is the underground stem of *Curcuma tinctoria* and *Curcuma longa*, and is imported from India, China, Java, and Barbadoes. The Indian variety is the most valued. For the use of the dyer the stems or tubers are dried and ground to a fine powder. The powder has a powerful odour, and a strong aromatic taste. The colouring principle contained in turmeric is called curcumin. In wool dyeing, the use of turmeric is confined to the dyeing of a certain class of browns on stuffs, and is often associated with colours of a fugitive character like itself. It finds no use in the heavy cloth districts, and if its employment were altogether discontinued as a woollen dye material, it would be no great loss to the public who happen to have to wear goods dyed with it. It serves a useful purpose in the laboratory, as a test for alkalies, which turn it brown; it is also used as a test for boracic acid.

Persian Berries.

Persian berries are the fruit of the buckthorn, and various species of *rhamnus* which grow in various parts of Southern Europe and Asia.

The nature of the colouring matter contained in Persian berries has been the subject of much research, but it is still involved in much obscurity.

It seems, however, to be established that there is a glucoside in Persian berries which crystallises in yellow silky needles, to which various names have been assigned, such as chryscrhamnin, xanthorhamnin, and rhamnin.

In wool dyeing Persian berries find no use in the heavy woollen trade, the colour which they give to mordanted wool not being sufficiently fast to withstand milling and scouring processes. It is, however, often employed as a yellow dye for goods for ladies' wear, such as scarlets and oranges.

Sumac.

This astringent substance is of considerable importance in the dyeing of certain drabs and browns on woollen goods, as, in addition to the tannin which it contains, there is also a yellow colouring matter which has not yet been studied, but which performs an important part in the production of browns and drabs.

Its action on wool mordanted with bichrome is to produce a fine olive yellow; with a mordant of tin, a bright yellow; and with one of copperas, a dark slate. This last effect is owing to the action of the tannin in the sumac upon the salt of iron.

Sumac, as met with in commerce, is the ground-up leaves and twigs of a tree called *Rhus coriaria*, which grows in Sicily, France, Spain, and other countries. The Sicilian variety is the most esteemed. Dr. Stenhouse has proved that the tannin of sumac is the same as that contained in gall nuts, which is called gallo-tannic acid. This acid gives a blue-black, or slate colour, with copperas mordanted material. The compound so formed is the gallo-tannate of iron.

The chief use of sumac to the woollen dyer, however, is for the purpose of dyeing cotton or vegetable matter which may happen to be mixed up with wool.

1. In the form of burls, or threads, or seeds.
2. In union or mixed goods, in which there is a cotton warp with a woollen weft.

The goods, after having been dyed in the ordinary way, as for wool, are steeped in a decoction of sumac in the cold, and then in a solution of so-called nitrate of iron, or of pyrolignite of iron, if the colour is black; but for the red wood, yellow wood, and aniline colours, the goods which have been steeped in sumac decoction are transferred to a solution of oxymuriate of tin of 2° or 3° Twad.

A tannate of tin is probably formed in this operation, which enables the cotton to take up dyes in the same manner as wool.

There are certain red colouring matters which are extensively used in one branch of dyeing which I will now describe.

Cochineal.

Cochineal is the dried body of an insect which lives and feeds upon a cactus; the insect is called *Coccus cacti*, and it is the female which furnishes the dye, The male insect is furnished with wings, but the female is wingless, and remains stationary on the plant. The insects are brushed off the leaves with a soft brush, and dipped momentarily into boiling water, to kill them; they are then dried and sent to market.

There are two principal varieties met with in commerce—(*a*) Silver cochineal, which is coated over with a mealy substance; and (*b*) black cochineal.

I have met with silver cochineal adulterated with sulphate of barium, which at the same time gives it a mealy appearance and adds to its weight. Such a cochineal as this leaves too much ash when burnt.

The present price of cochineal is very low, ranging from 1s. 4d. to 2s. per lb.; this is due partly to the depressed state of the woollen trade, but also to the fact that some of the aniline dyes compete with it.

Cochineal is prepared for the use of the dyer by grinding it in a mill like a coffee mill. The ground cochineal is thrown into the vat along with the goods.

The colouring matter of cochineal is carminic acid, which gives to wool mordanted with chloride of tin a scarlet colour, and with alum and tartar a crimson. The colour is very bright, and fairly fast and permanent.

On wool its chief use is for the production of scarlets, oranges, and crimsons, rose pinks, and such like colours, flannels and serges being the goods mostly dyed with cochineal colours.

The yellow portion of the scarlets is obtained by

using flavin, which is the best for the purpose; or young fustic, which answers very fairly; and lastly, Persian berries are sometimes used, but the yellow colour obtained with them is not fast.

The mordant used in dyeing scarlets is a salt of tin along with tartar. There is a great diversity of practice among the dyers in the use of tin spirits in scarlet dyeing. Some use the ordinary double muriate or single muriate, others the muriate to which is added one or two per cent of oxalic acid; some again use a nitrate of tin or a sulphomuriate. I do not know that any special preference should be given to any particular tin spirit, for I have seen equally good results with all of them. When the single muriate will answer, it seems to me unnecessary that the operation should be complicated by the use of a more complex mixture.

When goods are hard woven, a tin spirit which contains but little free acid does not answer well. The colour is deposited too much on the surface of the cloth, and the centre is often not dyed at all. A tin solution which contains a good deal of free acid, however, enables the colour to penetrate better into the centre of the cloth, because the coloured lake which is formed by the combination of the carminic acid with the oxide of tin is kept longer in solution by the free acid.

The penetration of the colour into the centre of the cloth may often be accomplished by entering the goods at a temperature below the boil, and heating the bath up to the boiling point very gradually.

A proportion of tartar greater than 4 per cent. of the woollen material to be dyed has the effect of yellowing the shade of scarlet, the yellowing being in proportion to the excess of tartar.

An increase of the tin mordant, the other materials remaining the same, has the effect of intensifying the shade of colour without sensibly increasing the yellow.

In dyeing scarlets and oranges with cochineal, the mordanting and dyeing are done in the same bath, kept at a boil for an hour or an hour and a half; wood cisterns being generally employed for the bath, and the boiling is done by perforated steam pipes.

Lac Dye

Is a red colouring matter, which has been manufactured and used in India for centuries. It is now extensively used in this country, along with, or in the place of, cochineal. It produces a colour on wool which has greater body than cochineal, but not quite so much brilliance.

Lac dye is a secondary product in the manufacture of a gum resin, called lac, which is found on the surface of the small twigs of trees of the genus *Ficus*, on the banks of the Ganges, being deposited there by a small insect called *Coccus lacca*, and belonging, therefore, to the same genus as the cochineal insect.

The crude matter taken from the tree is coarsely powdered, and macerated in hot water; the liquid is then evaporated to dryness; the dry residue is the lac dye, which often contains 50 per cent. of colouring matter.

The identity of the colouring matter of lac dye with that of cochineal has not been fully established, but there is a great similarity in their action on mordanted wool, the chief difference being in the tone and intensity, or depth, of colour. Lac-dyed colours are also somewhat faster and more permanent than those of cochineal.

Lac dye is imported in the form of hard cakes, which are ground to a fine powder for the use of the dyer. The dyer works up the powdered colour into a paste, with a mixture of hydrochloric acid and his tin spirit, and then adds it to the dye-bath, along with the goods to be dyed; the dyeing is then performed exactly in the same manner as with cochineal.

In practice it is found to be advantageous to combine the brightness of the colour of cochineal with the solidity and permanency of lac dye; this is done by dyeing the goods first in a bath of lac dye, and then in a separate bath with cochineal, washing out from the first bath before entering it in the second.

The following are the proportions and cost of dyeing goods on the large scale by this process:—

Scarlet.

For 100 lbs. of cloth:—

	s.
Lac (mixed, varying from 1s. 6d. to 6d. per lb.), average 1s.	8·08
Cochneal 2s. per lb.	6·00
Argol (110s. per cwt.), 1s. lb.	5·
Tin spirit of 45° Twaddell as stannous chloride. .... } $1\frac{1}{4}$d. per lb.	2·4
Flavine at 2s. 6d. per lb.	·08
Cost of materials for woollen cloth....	21·56

Ammoniacal Cochineal.

When cochineal is ground and worked up into a paste with strong ammonia, say 16° of the ammonia gauge, the colouring matter becomes transformed into a new colour called carminamide. According to Schutzenberger this change may be represented thus:—

$$\underset{\text{Carminic acid.}}{C_9H_8O_5} + NH_3 = OH_2 + \underset{\text{Carminamide.}}{C_9H_9NO_4}$$

This colour does not produce red or scarlets, but is employed along with cochineal for the production of rose pinks, crimsons, and such like colours.

The mordant which works best with ammoniacal cochineal is the nitrate of tin.

The following are the proportions used on the large scale for the production of a rose pink:—

For 150 lbs. cloth:—

$1\frac{1}{2}$ lbs. ground cochineal, made into a paste with $1\frac{1}{2}$ pts. ammonia 16°, and left overnight.
$2\frac{1}{2}$ lbs. ground cochineal.
$1\frac{1}{4}$ lbs. tin dissolved in 13 lbs. nitric acid.
5 lbs. argol.

Boil one hour.

Eosine.

A new dye known under the name of Eosine has recently been added to the list of red dyes, and as it is likely to be a competitor in the production of scarlets on wool, I have thought it advisable to give a short account of it here.

The word "Eosine" signifies day-dawn, implying that the colour is that of the rosy hue of morning. On silk, the colour is that of the rose, but on wool it is scarlet.

In order to produce it, a substance called

resorcin, obtainable from a variety of sources, is treated with phthalic acid, whereby a new and fine yellow colouring matter is produced, called fluorescine, on account of its possessing the property of fluorescence in a marked degree. This new body, when treated with bromine, gives the colour in question, eosine, which is a bromine of fluorescine. Eosine also possesses fluorescent properties, which you will readily see, as I pour the eosine solution into this tall cylinder of water, and illuminate it with the magnesium light.

Woollen goods are dyed with eosine, using alum as a mordant in the same bath.

The goods are boiled for a few minutes with 8 per cent. of alum, and the dye in solution is then introduced at intervals, until the requisite depth of shade is obtained.

The dye will bear soap washing fairly, but will not stand severe milling. It dyes readily along with aniline and other colours, and promises to be a very useful addition to our present list of dye wares.

Errata in Lecture IV.—*Claret Brown on Wool.*—For sulphuric acid 25 per cent., read 0·25 per cent. *Brown on Wood.*—For sulphuric acid 5 per cent., read 0·5 per cent.

HEALTH AND SEWAGE OF TOWNS.

A meeting of the Executive Committee on this subject was held on Tuesday, October 24th, when the Surveyors and Medical Officers of Health of the Metropolis were invited to attend. The chair was taken at 12 o'clock by Lord Alfred Churchill, Chairman of the Council.

The Chairman, in opening the proceedings, said that since the Conference, which met in the summer, a deputation had waited on tho Metropolitan Board of Works, to urge upon it the more strenuous carrying out of the Acts respecting the sewage of the metropolis, and they now contemplated going to Mr. Sclater-Booth, with a view of calling on the Government, if necessary, as it was believed would be necessary, to take further powers to compel Vestries to perform these especial duties. It was for the purpose of conferring on this matter that the Committee had been called, and he would now ask Sir Henry Cole to introduce the matter.

Sir Henry Cole, K.C.B., said—This meeting is intended for friendly discussion, as to the kind of difficulties which appear to exist in getting the house drainage of the metropolis as good as it ought to be. The Society of Arts has published its own opinion upon the subject, and has invited the surveyors and medical officers of the metropolitan district to give their advice on the subject. We are all aware of the Metropolitan Local Government Act of 1855, which seems to be all "mays." You "may" do this, and you "may" do the other; but my own personal experience is that that "may" is very inoperative. I know a case within a few yards of my own house, where a gentleman, finding his house was infested with stinks, investigated the system of drainage, when he found that, having been erected before 1853, the whole drainage of a very large area was conducted through a wretched pipe six inches in diameter, and thus it was not conducted away at all simply because the pipe was too small, and therefore found its way wherever it could into the basement and elsewhere. On making further inquiries, he found that several other neighbours were in the same position. He applied to the Kensington Vestry, and pointed out these facts, and made, he understood, something like 20 applications, but at last, judging that writing letters did nothing, and that personal applications were no better, he set his lawyer to work, and threatened to take legal proceedings against the Vestry, to cause the house to be properly drained and connected with the main sewer. That woke up the Kensington Vestry, and then they set about draining the district. But there are few men who will act in this way, so general is the ignorance as to the danger arising from these sewer gases. The practical effect is this: the ratepayers of the metropolis have had to find four millions of money for the main sewers; the law says that new houses must be connected with these main sewers; but as regards those built before 1855, it is left to accident whether they are or not; and it does seem to me that the four millions of money are very much wasted if they are not made effective for the whole of the metropolis. Take the case of this very parish, the particulars of which have been kindly furnished by the District Surveyor of St. Martin's. With regard even to our own house, there is no doubt that the drainage is very bad; and it is found that with regard to one-third of the houses in this parish, the owners do not know whether they are or are not connected with the main sewers. It certainly seems to me, that when the Legislature authorised the making of these main sewers, and the raising of four millions to make them, they intended all the houses, whether built after 1855 or before, should have the advantage of them. Various comments have been made upon our suggestion; one parish says it would give people a great deal of trouble. Of course it would; there are very few things in the world which do not give trouble. But why should we have spent four millions in main drains if only those houses built after 1855 are to be benefited? Some think it an unnecessary expense, and intimate that it is quite sufficient for a few people to die before the thing is investigated in any particular case. I do not mean to say that they say that in so many words, but I believe that is the effect of it. The Society of Arts thought it would be evidence whether the house drainage is in a good state, if the owners of houses were compelled to furnish, within a specified time, plans of all house drains, on a certain scale. This is done in many places abroad, for I know, as a fact, that where they are making main sewers in German towns they see that every house is connected with them. Mr. Warrell, the Chief Clerk of the Vestry of St. Pancras, says that "it would involve the necessary examination of the house drains throughout the metropolis." No doubt it would, but what use are the main sewers if you do not see that the drains are properly connected. Then it would involve "an enormous outlay by the owners of property," but it would be a very valuable outlay, as a protection to the health of the people and the prevention of disease. Also, "a serious disturbance of the comfort and possibly of the health of the inhabitants." Doubtless, but if we make sewers costing four millions are we not to use them? Lastly, it would be "utterly incommensurate with the advantage supposed to be gained." That is the Vestry mind of St. Pancras, and it seems to me wholly indefensible. However, the Society of Arts wished to collect a knowledge of the difficulties to be encountered—of course there are difficulties—and then to present them to Mr. Sclater-Booth, and to leave to him the responsibility of the remedy, and of saying whether the Metropolitan Board of Works shall have the power of compelling people to use the main sewers.

The Secretary—The Act says in the 73rd section that all houses shall be drained into the main drain; but it is nobody's business to see that this is carried out.

Sir Henry Cole—No doubt they may compel the owner to construct drains, but they do not. These Vestries seem to think it is their function to save the rates as much as possible, not to do the work which the law sets them to do. Instead of having a sufficient number of surveyors to do what is absolutely necessary, they have

one man to look after everything. If the law says that people are to be healthy and clean, and gives them the power of being clean, we want some power to set these Vestries in motion. When we went to the Board of Works, one gentleman there, representing Camberwell, said they were perfect in that district, everything was done that ought to be. I want to know, therefore, what has become of the houses in Camberwell that were built before 1855, and what is the system by which it is insured that houses built after 1855 are properly connected with the sewer. I think I have now said enough to invite you to help the Committee with your experience. Perhaps if any gentleman will answer these questions it will be useful; first, what parish he takes an interest in, whether privately or publicly, and, next, if he knows that the main drainage is thoroughly used in connection with the house drainage.

Dr. Tripe (Medical Officer of Health for Hackney)—I think the observations already made show that the powers given by the Act of Parliament to Vestries, and the duties cast upon them, are not fully understood. There can be no question that, so far as regards houses built before 1856, there has not been in all cases that amount of supervision which has taken place since; but in the majority the Commissioners of Sewers have plans of every house; they supervise the drains of every house by their own officers; and every house was considered to be perfectly drained in accordance with the knowledge then existing. There is no necessity for any one being ignorant of the plan of the drainago of his house, except in the case of old houses, because all plans in existence that belonged to the Commissioners of Sewers were handed over to the Metropolitan Board of Works, and are at their office. If they have an index, any one can ascertain for himself what is the system of drainage. I think it is universally admitted that, so far ar regards the powers conferred on Vestries by Acts of Parliament respecting houses built since 1856, they are very ample.

Sir Henry Cole—Have they been exercised?

Dr. Tripe—That is what I am coming to. There can be no question that the drains, water-closets, and everything connected therewith have to be made to the satisfaction of the surveyors. The sections which give that power are the 75th, 76th, and 81st, and the latter goes so far as to say that it shall not be lawful to newly erect a house without a water supply. Under that section I last week summoned a builder for having let a house without a water supply and a supply to the closets, and the magistrate fined him 40s. under the Act. On the same day I summoned two persons for not having a proper water-supply apparatus to their closets in old houses. Scarcely a week passes but we take out summonses against persons for defective drainage or water-supply apparatus in old houses. The powers are ample. The words are "shall" and not "may," and the Vestry is bound as much as it can possibly be bound to carry out these particular laws. I will read the words of the Act, "If on such inspection as aforesaid, any drain, water-closet, privy, or cesspool appear to be in bad order and condition, or to require cleansing, alteration, or amendment, or to be filled up, the Vestry or Board shall cause notice in writing to be given to the owner or occupier of the premises upon or in respect of which the inspection was made, requiring him forthwith, or within such reasonable time as shall be specified in such notice, to do the necessary work; and if such notice be not complied with by the person to whom it is given, the Vestry or Board may, if they think fit, execute such works, and the expenses incurred by them in so doing shall be paid to them by the owner or occupier of the premises." That section has to be read in connection with another section, and I think some persons have looked at that by itself without reference to the other. I mean the 25th and 26th of Victoria, chap. 102, sec. 64, which gives the Board alternative powers of going for penalties. We do not do the work, but we go for penalties under the 64th section of the amended Act, and in that way we compel persons to carry out the law. We do not think it a fair thing to throw on the officer of the Board the duty of reconstructing the drains of old houses. This section recites all the various sections I have just mentioned, and goes on to say that, in case of neglect, a fine of five pounds may be inflicted, with an additional fine of forty shillings for every day the offence continues. If you want more powers than that, you can ask Mr. Sclater-Booth to give them, but where you have these powers to sue for penalties, I do not see, myself, what greater powers are wanted. The difficulty is this, that the Vestries have no power to recover the cost of making examinations. These examinations of the defective houses cost money and occupy time, and the Boards, as a rule, do not think it fair that this should be thrown on the rates, excepting in the case of very small properties. In Hackney, during last winter, we examined, at the cost of the parish, between 300 and 400 old houses of small size, and where the drains were found to be defective, we served a notice on the owner, and compelled him to reconstruct the drains. But in the caso of persons who can afford to pay, it is considered that if they are suffering from any nuisance, they are not to ask the public to abate the nuisance, but to do something towards abating it; that they are to put their hands into their pockets and to pay the cost of examining the drains. If they do that, and show the drains are not made in accordance with the regulations of the Vestry, then we take proceedings. That is the course adopted in Hackney, and it is, I believe, followed out in other districts. It is a mistake to suppose that the Vestries are asleep, and letting the matter alone. As regards the houses built since 1856, we have regulated every drain that has been put in, and have plans showing how they run, which are examined by a person appointed for the purpose. It seems to me that what really is required is uniformity of regulation and uniformity of practice throughout the metropolis, the same as there is with regard to slaughter-houses. If you can get Mr. Sclater-Booth to make bye-laws for the whole of London, saying that certain things shall be done in a certain kind of way, and that the surveyors are to look after them, and that there shall be certain officers appointed to see the bye-laws carried out, then I say you will be doing a great good. The difficulty is that what is carried out in one district is not carried out in another. London consists of a large number of districts, the practice in which differs, and in fact it comes to this, that what is overcrowding in Hackney is not legally evercrowding in Bethnal-green and Shoreditch. I think it is time that London should be governed on a uniform system; we do not require more legislation, but a uniform practice, and some system by which Vestries can be compelled so to act.

Sir Henry Cole—Would you mind my asking you one question? I do not differ with your observations at all; but with regard to the actual practice in Hackney, do you know, as a fact, the number of houses built before 1855 which are properly drained? As regards those since 1855, you have plans of them; but do you know much about those built before?

Dr. Tripe—We know about them in this way. We have examined a very large number indeed. I should say that during the last 20 years we must have examined the drains, not merely the outlets, but the condition of the drains of over 1,000 houses, certainly. We now have 22,000 houses in our district, and, speaking from memory, I should say there were certainly not more than 11,000 in 1855. We always make this rule—if we get any complaint at all of bad smells, the house is immediately inspected; and if, on pulling the drain to pieces, an error is found, notice is served on the landlord to do certain work. If he does not do it, we summon him for the penalties provided by the Act. And we find no

difficulty in carrying that out. There is one difficulty, perhaps, and that is that the law makes you serve the notice at the private residence of the owner; and the magistrates hold that service at his office is not sufficient. Sometimes there is great difficulty in finding out the private address of the owner, and if that can be altered there is no doubt we shall be greatly assisted. Under the Nuisances Removal Act, we can serve the notice on the premises, and summon the owner—*quâ* owner, without giving the name or address. But under the Metropolitan Management Act we cannot do that; and it sometimes causes a great expenditure of time in finding out the address of the owner, and serving a notice upon him by hand or by registered letter. The magistrates hold, however, that in going for penalties you must show that the parties summoned have had notice of the course you are taking.

General Cotton—Do you give instructions to the builders as to the actual direction in which the pipes and drains are to run?

Dr. Tripe—They lay their plans before us, and if we do not like them, we object.

General Cotton—You do not prepare the plans yourselves?

Dr. Tripe—If we disapprove of their plans, we object, and make them carry it out as we wish.

General Cotton—If you approve of their plans, and some future Vestry disapprove of your notion of those plans, they must alter them?

Dr. Tripe—I suppose so.

General Cotton—I put a question of this kind the other day to the Kensington Vestry, if any instructions were given to the builders? They said printed instructions were issued to the builders, and it was those instructions I wanted, if possible, to see. I understand that instructions are given.

Dr. Tripe—Oh, yes; there are printed instructions on the plan.

Sir Henry Cole—Do I understand you to say that in Hackney, whenever anybody complains, you act? But you wait until you receive complaint?

Dr. Tripe—Undoubtedly; so far as regards houses over the value of £20 a year; if they are under that value we make a regular inspection once a year. There are 6,000 of those, and they are examined every year, and anything which is found to be wrong in any way has to be altered.

Sir Henry Cole—You seem to be a model parish.

Mr. Hartz—I understood you to say that there were instructions on the plans?

Dr. Tripe—Accompanying the plans.

Mr. Hartz—That is to say, the regulation how the work is to be done.

Dr. Tripe—There are regulations on a separate sheet, but there are certain things printed on the plan as well. There is a sheet given to the builder over and above the plan. They have printed directions how they are to carry out the regulations of the Board.

Mr Hartz—I wanted to know whether there are regulations of the Board with regard to house drainage.

Dr. Tripe—Certainly.

Dr. Whitmore (Medical Officer for Marylebone)—I came rather to listen than to speak; but, as you have invited opinions, I will trouble you with a few observations with respect to what I know of the drainage of Marylebone—a parish which numbers 160,000 inhabitants. I would first say that I regret the meeting has not before it a copy of the report which was furnished to the Metropolitan Boards of Works some three or four ears ago, showing the sanitary work which had been carried out in various parishes by the District Boards of the metropolis since the passing of the Local Management Act. The Metropolitan Board invited from the various parishes a return of the number of feet of drains laid, the number of cesspools abolished, the amount of paving done, &c., and the returns really did show that a very large amount of work had been done; and I think would have convinced Sir Henry Cole himself that the Metropolitan parishes and districts have not been altogether negligent of their duties. I know in Marylebone we showed we had laid down 40 or 50 miles of new pipe drains, and had done a corresponding amount of other sanitary work. I fully endorse all that Dr. Tripe has said with regard to the efficiency of the Act, if carried out, to provide an efficient house drainage in the metropolis. But I do not go so far as to say that it is universal, and generally adopted in all places. With regard to the parish I represent, I have no hesitation in saying that our surveyor and the Vestry are very vigilant in carrying out efficient house drainage. We have, within the last three or four years, incurred a very considerable outlay in improving our sewers, and something like £30,000 have been spent in making new ones. With regard to the house drainage, the plan adopted is precisely that adopted in Hackney, with this difference, that we are disposed to seek out defects in drainage, and do not wait until we have complaints made. By means of inspectors and others, we search for defects, and, having found them, notice is served on owners of property to improve their drains. The person, when he receives notice, knowing that he must comply with it, intimates his intention to do so. He has to pay a small fee for taking up the pavement, and giving notification to the surveyor of the work he proposes to carry out, and that work is to be carried out to the satisfaction of our surveyor. As a general rule it is carried out satisfactorily, as regards the nature of the materials used; but there is one great defect I ought to bring to the notice of this meeting, and that is, that much of the work is very badly done. I have frequently taken upon myself the trouble of investigating the cause of offensive smells in houses, and have afterwards found, when drains have been laid within three or four weeks, that the plumber's work has been very imperfectly done. Within the last two years we have laid down in Harley-street a new sewer, and I suggested to the foreman of the works the expediency of looking up into the house drains to see in what condition they are. It would be hardly believed, but there was scarcely a single house drain that was perfect from the opening, as regards its connection with the sewer. I think I, myself, made out in Harley-street alone 28 to 30 notices to owners to carry the house drain from where it terminated in the vault to its proper communication with the sewer. This was an abominable nuisance, and I believe a great deal of the foul smells continually brought under my notice originated in this defective state of the drains; the drainage of the house has fallen from the end of the vault into the house, and has never found its way into the sewer at all. That, I am happy to say, has been remedied, and that has induced us and our surveyor to look into the matter. There is another evil in Marylebone, and this, I am afraid, exists in many other parishes, and that is, that with respect to many old houses built before 1856, one drain has to supply six or seven houses; that is to say, there is a sewer in the street, and there is a row of houses at right angles, and a drain commencing at the furthest house, receiving as it goes the drainage from each, and that is carried through the sewer. The effect of that is that these drains continually get stopped up, and, in many instances, we have found it necessary to order new pipe drains to be laid on to every separate house, and not unfrequently the parish have had to pay for it, because, by the Act of Parliament, if you want to improve the drainage, you must do it at your own expense.

Mr. Hartz—I wish to ask how it was that this frightful state of things, which has been described in Harley-street, had existed so long, seeing that the Local Management Act was passed some 20 years ago?

Dr. Whitmore said he could not answer that question.

Dr. Liddle (Medical Officer of Health for Whitechapel) said—The commencement of the work in Whitechapel was to have every house inspected, rich and poor alike, because I did not think it fair that any distinction should be made. We had a report from our inspectors as to the condition of the drainage, and I need not tell you that of course in many cases it was very bad. We gave orders for it to be put right, but in many cases we were deceived. We insisted on proper drains, traps, and water-closets; but when we made an inspection the second time we found that the nuisance arising from cesspools was so far abated. But after a certain time we found the nuisance recurrent, and that so far from complying with the orders to make the drains into the sewers, they had simply put a trap over the cesspool, and thus deceived our inspectors. Of course, at that time, we were all new to the work, and things were not in such a satisfactory state as they are now. With regard to the observations made by Dr. Whitmore, as to the return sent to the Metropolitan Board, showing how the Vestries had complied with the Act of Parliament, I declined to have anything to do with it, and said to our clerk, "Had they put down in this list what we have not done as a Vestry as well as what we have done, I would willingly have complied with it, and would have supplied the information." But I declined to do one thing without the other; because there are many things not yet done which unquestionably ought to be done. I need not go further than to point to one simple fact—that we are still wanting a mortuary in the different parishes, and also a proper room for holding coroner's inquests in. It is a disgrace that they should be held in public houses; and I am surprised that the Legislature has not insisted that this practice should be abolished. I may mention another circumstance which is very objectionable, as to the main sewers. When the Metropolitan Board of Works undertook to lay out £4,000,000, it was a great pity that they did not then take the whole of the sewers under their jurisdiction, and not put one portion under the guidance of the Vestries, and take another portion under their own. Had they, in the first instance, taken the whole management of the sewers, we should have been in a much better state. Some of the sewers now have scarcely any incline at all, but are simply elongated cesspools. These have frequently to be cleansed, and cause a great nuisance to the district. The Metropolitan Board should take the whole of these things under their care; and I am quite sure a great saving would have been effected had they arranged all the sewers in the various districts to suit their new outfall at Barking. Instead of that, they left them to the several outfalls which they had considerably higher up the river; and the sewers, I am sorry to say, often stink abominably. With regard to the supervision of drains of private houses, that, of course, is a most desirable thing to be done; but I do not think we shall get it accomplished until we get a new Building Act. Nothing, perhaps, is more required in London. The sewers are very frequently laid in the most imperfect manner; but the great difficulty would be to have a sufficient staff of officers to examine these things, and especially in large parishes like Hackney, where there is much building. We have not so many houses built in Whitechapel, because we have no room; on the other hand, we are going to take down some, and no doubt the Metropolitan Board will see that the new ones are properly constructed. The great thing, after all, is to have skilful builders, and these small houses are mostly erected by those men who do everything as cheaply as they possibly can, and, instead of house drains being properly cemented, they are often left without cement at all. Soon the earth falls out; there is a great gap between one pipe and the other, and then a considerable nuisance arises. All these things may be remedied, perhaps, by bye-laws; but I rather dislike bye-laws, for this reason, that every Vestry would make its own, and they would not agree.

Dr. Tripe—They ought to be general throughout London.

Dr. Liddle—That would require an Act of Parliament, or else they would have no authority. I am in great hopes we shall get some benefit from this inquiry, and I must say I feel obliged to those gentlemen who have kindly summoned us here, for I have already learned something that I did not know before.

Dr. Tripe—Allow me to explain one thing. I said the old houses had not been examined, but that is an error; I meant to say not habitually. We have destroyed about 6,000 cesspools from old houses in our district since 1855, and the new drainage is under the immediate supervison of the surveyor.

Mr. Stayton (Chelsea)—I quite concur with the Medical Officer of Whitechapel, in thanking the Society for giving those interested in the local government of the metropolis an opportunity of conferring upon this important matter. I addressed to the Society a letter which sets forth some views which I hold on the matter, but I think two or three points require further explanation. I would commence with the 76th section of the Act of Parliament of 1855, which simply requires that builders and persons doing work shall give seven days' notice in writing to the Vestry before commencing, but it is not said that they shall deposit proper plans. This is done in practice, but in a most imperfect manner frequently, and I have known many cases where the plans have been perfectly unintelligible. In those cases I have been advised that the Vestry have no power to compel persons to deposit such plans. I think, therefore, this should be ascertained, and if this power does not exist, steps should be taken to obtain such power. Unless the drains are properly laid out, and the Vestries give their sanction, so that the work shall be done thoroughly well, they have very little to do in the matter. All they have to do is to give notice, "On the expiration of seven days I intend to lay the drains to 79, Robert-street," or whatever the street may be; and, following up the section of the Act of Parliament, it is for the Vestry to say in each case how the works shall be done. But how can they advise the persons who are going to build unless they know what kind of house they are going to erect; and if they have no plans, how can they specify what drains shall be made, where they shall be made, what fall they shall have, how they shall be ventilated, trapped, and so on. Therefore, until persons about to build are compelled to give such a notice, I think our powers with regard to house drainage are very defective. Again, with regard to the ventilation of drains, I hold this is a most important thing. It is a well known fact that at the top of all soil-pipes, when you raise the handle of the water-closet, so much foul air is displaced by the quantity of water let down to clear the drain; there is no question about that; every bucket of water let down a closet or sink must displace so much foul air, and what becomes of it? Naturally it goes into the house. This is because there is no outlet for the foul air. But Vestries have no power to compel persons to ventilate the drains by stack pipes, or by cutting off the sinks from them; and until this is done there will necessarily be great defects and much illness. I am convinced that there is in the metropolis a vast amount of poisoning from sewer gas caused in this way. I find it in numbers of houses. In my own house, when I first went to Chelsea, I found a cesspool existing in the coal vault under the street, none of the drains were ventilated, and we were completely poisoned. I at once took steps

to have drains properly connected and trapped, and the soil-pipes ventilated, and since then we have had no smell whatever. It is well known that there are numbers of old brick drains still existing, some 18 inches or 2 feet square, providing for the drainage of a single house. These are half a brick thick, the joints are imperfect, and the sewage leaks, in addition to which very often the sewer gas escapes into the house through the rat holes. Pipe drains would obviate these evils. I hold, therefore, that Vestries ought to have the power to compel these old brick drains to be abolished, and pipe drains substituted. No doubt it would entail a large outlay, but the question is whether we are to go on year after year having sickness and all kinds of disease from sewer gas, or whether we are to give the Vestries power to enable them to have the drains made perfect. Again, as to the construction of the drainage, the surveyor has to see that the whole of the drains are properly made, but at present it is utterly impossible to see every joint and every pipe as you ought to do, because there is no power compelling a builder to keep open the drains for the inspection of the surveyor. To comply with the Act of Parliament strictly, the surveyor would have to be there constantly. In many towns in the country there are powers of this kind. In Portsmouth the builders are obliged to lay the drains and leave them open in the trenches for 48 hours that they may be inspected. If that power were given in the metropolis they might be properly inspected, and a certificate given that they were perfect. Such a certificate would necessarily entail responsibility on the surveyor, but the health of the public is of such vital importance that surveyors ought to have sufficient assistance, and to be placed in such a position that they can inspect drains of every house, and certify as to their character. As to the Vestries themselves, although this is trenching on rather delicate ground, it certainly is found that there is great difficulty sometimes in getting a large body of gentlemen to order the drainage of small properties to be reconstructed in a proper manner. They are very willing to reconstruct the old sewers in the streets, and that is generally being done, the usual plan being to have a sewer large enough for a flood-trap to be placed at the outlet of every drain, which prevents a vast amount of sewer gas entering, and sufficiently large for a man to enter in case of any stoppage. Pipe sewers are found to be a very great evil, and in Chelsea we have had to take up miles of them, for the simple reason that, after so many years' work, they gradually get choked up, and if they are cleared out one year they soon become foul again. With regard to the question of bye-laws, I do not think they would be sufficiently binding. In the first place, you must go to Parliament to get power to make the bye-laws, and if you do so, I should say, do the thing effectually, and not only get all these bye-laws, providing for the details of ventilation, pipe drains, inspection, and certificates, but let them be made an enactment, so that there shall be no failure in carrying them out.

Dr. Tripe asked if the Chelsea Vestry had ever made any regulation in accordance with the powers conferred on them by the 83rd section of the Act, for the destruction of brick drains, for the ventilation of house sewers, and for the prevention of the other evils which had been mentioned?

Mr. Stayton said there was no provision for the ventilation of house sewers.

Dr. Tripe—You can make any regulations you like. The Vestry have only to say what should be done, and see that their regulations should be carried out.

Mr. Stayton repeated his former statement, that there was no power in the Act to compel intending builders to deposit plans.

Dr. Tripe said in Hackney they did not allow a man to build until he had done so.

Mr. Stayton said there was no legal power to require these plans.

Dr. Tripe contended there was.

Mr. Stayton said a builder, who was a member of their Vestry, refused to deposit plans, and on representing the matter to the Vestry, they referred him to their solicitor, who advised that the Vestry had no power to compel the deposit of any plans.

Dr. Liddle remarked that if bye-laws were made they must be in accordance with the Act of Parliament, or otherwise they would be held *ultra vires*, and of no force.

Mr. Elkington (Bermondsey)—I have had the honour of being the surveyor for Bermondsey district for 22 years, and my district is a very peculiar one, abutting on the river Thames. There is one element which has not yet been touched upon, of considerable importance to me. We have some extraordinary manufacturers, tanners, leather dressers, and so on, who pass their refuse into the main sewer; this has to be dealt with, and experience proves that some of these compounds are highly poisonous. Therefore it requires the utmost vigilance of the local officers to prevent a great deal of mischief. With regard to the plans and notices, from the time we have been established, we have never had a notice without a plan attached to it, and that is a point of the highest importance. The level of the basement storey which a builder is going to erect is very material, and many orders have been issued from the Board prohibiting parties laying their basements at such a level that they are not capable of efficient drainage. They are also required to give the size and direction of the pipe, and I have never found any difficulty in parties complying with these regulations. I think I may say, after twenty-two years' experience, that my own view of the Act of Parliament is that the powers of the Act have proved to be sufficient. But I must admit with some regret that there is very great diversity of practice in the way in which those powers are carried out. My own feeling leads me to this, that I should be very glad to see some uniform bye-laws laid down by authority, whether by the Local Government Board or Metropolitan Board of Works I care not, by which a Vestry should be enabled to act in the regulation of these details of drainage, which I had rather hoped would be discussed this morning; I mean those questions of ventilation which Mr. Hartz has dealt with. My own experience leads me to this, that the more simple you can make the construction the better, and therefore I have found that if the drains are connected direct from the sewer to the house as perfectly as may be, the more you disconnect the rain-water pipes, and sinks, and lavatories, and the more you allow means for cold air passing between them, the better it will be. My district is one which rather favours that, because it is chiefly inhabited by working men, who do not insist on that state of refinement which is supposed to be so very essential in the highest class of buildings, but which I am sure those who examine them will find are often very pernicious in the result. I have known cases of fever arise, in which the rain-water pipe coming down from the top was carried direct into the sewer without any trap whatever, and it was as direct a case of cause and effect as if you had given instructions for a few cases of scarlet fever to be produced in the house. These are technical questions, but even after twenty years' experience of the working of the Act the ignorance of speculative builders as a class is something astounding. You have to be constantly behind them, getting these things carried out. I think the Society would be doing a good service if they could get a set of technical regulations agreed upon by a central authority for the guidance of the whole of London. I cannot agree with my friend Mr. Stayton, who is rather new in office in the metropolis, with reference to these powers. In the earlier part of our own work, when the late Dr. Challice

took up the question, we had a great deal to do, partly from the complaints of parties, and partly on the Vestry's own motion in taking old districts, and by degrees getting them improved. We had many hundreds of houses in which the old brick drains were taken up and abolished. We had miles of what were termed high level sewers taken away and laid down on the lower level; but directly we got to the police-court we found that we had the powers with new houses to compel a water supply to be laid on, but the magistrate would not give any order for supplying the water to the closet. He would give an order to make a new drain into the sewer, but he would not give an order to connect the water supply with the closet apparatus. I recollect Dr. Challice thanked him for all the good that had been done by his illegal orders up to that time. We have put in force the 81st section to a very large extent, though we do not follow the same course as is adopted in Hackney and recover penalties, but we do the work ourselves. It was somewhat surprising to find that in the better class houses the greater nuisance and greater necessity for supervision occurs. The first case the Board took in hand was the old parish church, where there was a most filthy cesspool; that was done away with, and a proper closet substituted. The next house was a very nice rectory adjoining it, and there we found two good old fashioned family cesspools, each six foot square. Again, in Bermondsey-street, it was astonishing the number of cesspools existing. I never found any difficulty in putting in operation the sections Dr. Tripe has alluded to; but a great deal more might be done by getting uniformity of practice; and if something could be done, more particularly with regard to the ventilation of sewers, in the way of bye-laws, with proper officers to look after them, still further benefits would accrue.

The Secretary then read a communication from Mr. Weaver, of Kensington, which described the regulations adopted in Kensington in the case of new houses, and stated the instructions given to builders.

General Cotton—Perhaps it may interest the committee if I give an incident of my own experience. I bought a house in the district referred to by Mr. Weaver, and it was in consequence of what happened that I asked the question whether any instructions are given to the builders, because it appears pretty evident that if the instructions are given, they are either unsound or unintelligible, or they are set at naught. The faults I found in my house I stated in a letter which I have addressed to the Secretary, and which are as follows:—"The soil pipe was of iron, with open joints, so covered by the clamps that held it to the wall, that it had the appearance of being closed from top to bottom. It was, in short, one of the rain water-pipes used for all sorts of purposes. It carried off water from the roof, the waste water from the bath, the housemaid's sink, and the pantry, as well as the discharge from all the water-closets. It was of necessity in close connection with the house drains, while, as will be seen, it was in open communication with all parts of the house." That was the result of the instructions sent out from Kensington; but, of course, I cannot say who is to blame.

Mr. James Lovell (Surveyor of Hackney)—It has been the practice for the last 20 years in Hackney to issue a list of regulations, instructing the builder as to the mode in which the drains shall be constructed. There is a provision for a plan being furnished to the surveyor, and in no case have we granted an application for a drain without the production of that form properly filled up. One of the regulations involves the presentation of a plan showing all the particulars of the required drain, and one of the regulations goes very clearly to the construction of the portion which would come underneath the house. The builder is required to excavate the ground to a sufficient depth to admit the laying in a bed of concrete; upon this bed the pipe is laid, and it is also covered with concrete. With regard to the various defects mentioned, I fail to recognise one which could not be altered by putting into force the power of the existing Acts of Parliament, and if we were to have three or four other acts, they would get rid of the difficulties and defects from which we at present suffer. I agree with Mr. Elkington that the defects in the drains occur, not because we have not sufficient power, but for want of direct and continuous surveillance. The workmen may have to dig down 18 feet to start with, in laying a drain, passing through different soils, often very porous, and the trench being just large enough to lay in pipes; sometimes they see that the soil is of a very treacherous nature, and consequently, for their own safety, they lay in the pipes and get out of it as quickly as possible. That should not be allowed, the trench should be properly timbered, and the workmen have sufficient elbow room to lay down the pipes with greater care and less speed. I have sometimes seen regulations issued looking very pretty, with a lithograph section of a drain pipe surrounded with a bed of concrete, and so on, but unless there is a direct and continuous supervision, it is obvious that when the men are at work in dangerous ground it is not sufficiently carried out. Another great matter of complaint is the material used in the construction, and I do not think we have yet hit upon the right material. Brick is bad, pipes are better, but we want something even better than them. What is wanted is a pipe which shall be hermetically sealed, at least for the lower half of its section, and, if possible throughout, and we want also some means of detecting without so much labour and annoyance any stoppage when it occurs. Not unfrequently, when a stoppage occurs in a drain, the workmen will sink a hole, and the sewage will boil up; then he sinks another hole, and so he may go on in three or four places, through which the sewage bubbles up, and may remain five or six days before the obstruction is discovered; and sometimes, when the drain is within a few feet of the floor of the house, the sewage will find its way into the subsoil, and where that is of a spongy character, it absorbs the sewage for a long period, until the whole subsoil is comparatively saturated. This is a question which appears to me well worthy of the attention of engineers, and I hope some better scheme may be devised. Concrete had been proposed, but that might not be properly laid, or the drum might be drawn before it had properly set, and then the ground being filled in, we should not know whether the work is sound or not. The most favourable material which occurs to me is iron pipes, such as are used for gas and water; no doubt they would be more expensive, but I am not sure that it would not be more economical in the end. Another idea which has occurred to me is that of having a double drain, one laid hermetically sealed, and another around it, so that at certain points you might lift up a box cover, and ascertain whether the interior drain was sound or not. The prevailing defects appear to me to be these—first, leaky joints; second, imperfect traps; third, imperfect materials; fourth, imperfect foundations and imperfect levels, whilst in many cases the drains are very much longer than they ought to be, a small system of sewage being allowed to travel over an unnecessary length of line. At the present time, I think we can only insist on a thorough supervision, and that no portion of a drain should be covered until it has been examined by a competent officer. This is always done in the Hackney district. With regard to the ventilation of drains, I have seen a principle advocated which I conceive to be exceedingly dangerous. It is said that traps are fallacious things, because they are unsafe; that we should have no traps at all, but send a good current of air right through the drains, and dispense with the traps. I hold it is impossible to expose with safety the entire surface of even two or three feet of house drains; every portion of the surface of a drain, or drain inlet, in contact with soil and liquid sewage

should be absolutely sealed and shut out from the house; water traps cannot always be trusted, and therefore the smaller the number of drain inlets the better; and I remember some years ago, when, on being called in to look at some houses in Kensington, that one of the first things I did was to abolish a great many of these unnecessary inlets into the drains.

Capt. Douglas Galton, C.B., F.R.S.—I think the whole tenor of this discussion leads to the propriety of our suggesting to the Local Government Board some further legislation, so as to secure uniformity in the action of the various Vestries of the metropolis, and that that action should be practically limited to laying down certain conditions to be observed with respect to all house-drains; but there is another point connected with that which I think might also be considered. One of the evils of house sewage permeating the soil outside, on its way to the sewer, is the injury which occurs in the air in the ground, which is thus passed into the house, and in respect of that there is one source of danger to health in a great many new houses which is of enormous importance. A builder gets a tract of ground, and finds that it has gravel and sand on it. He digs out all the gravel and sand, and then has the hole filled up with refuse brought from every part of the town, very often of the most foul nature. Upon this he builds a house, and of course the air from this foul stuff must gradually pass up into the house. If we do suggest any regulations for the sanitary condition of our drains, I think that we should require that the surveyors charged with the duty of looking after this should also see that houses are never built upon such deposits of refuse, or, if they are so built, that, at all events, a thick bed of concrete should be laid over the whole, so as to prevent a rising of these foul gases. I may give an instance of what happened to myself. I had adopted every precaution with my drains when I took the house; had them thoroughly renewed, and they were all in very good condition. But in one of my rooms I suffered for a long time from a smell which I could not account for. It was on the opposite side of the house to that in which my own water-closet is placed, but still it was a smell which I was convinced arose from sewer gas. Last winter my wife became very ill, and we were told she was suffering from symptoms of typhoid fever poisoning. I then pulled down the skirting of the wall and found there were crevices in the wall close by the place where my neighbour's soil-pipe went down. I wrote to my neighbour, who lived in the country, and told him that I found this sewer gas coming from there and begged him to have the soil-pipe examined. This he declined to do, so I appealed to the medical officer of the district, Dr. Corfield, who sent an inspector of nuisances to examine it, and it was then found that this soil-pipe was defective from top to bottom; that it had been placed in a chase in the wall, which was so shaken in being cut that the cracks came through into my house. My neighbour did not suffer from it because he had had it carefully plastered up, and therefore the smell came into my house instead of into his. I should say that when I wrote and asked him to have it examined, I offered to pay the expense if no defect were found. It has, of course, now been remedied.

Mr. Hartz—With regard to the carrying out of the present Act of Parliament, I think it is a very good plan to take the bull by the horns, and make the regulations which are considered advisable, and then let the law, if it must be so, break down. In my own district that has been tried, and regulations have been made of the most advanced character; they have been in force for some time, and no one has yet disputed them. No doubt the question will be tried some time, but if the law should break down then we shall be in a good position to go to Parliament and say—the law has broken down, you must put it right. The real object of the meeting, I think, must be taken to be this. I think it would hardly have been held if there had not been a certain amount of dissatisfaction with the present state of things. It may be conceded that the Local Management Act has done good service in its day, but there may perhaps be something more to be done. The most important point to be considered is the extent to which care should be carried. If we take the case we have heard of in Harley-street, or the case of soil-pipes being made of iron instead of lead, with the joints so carelessly made as to let the foul air pass through, then I say that if care is to be carried to that extent, and Parliament may think fit to say so, by all means let it be so; but if inspection is to be carried out so minutely, instead of having one or two public officers over a large area, you must, in some cases, have two to attend to one single building, because I defy almost any one to beat the builder who is determined to beat you. When there is a great pressure to get work done in a hurry, sometimes the men are at work from four o'clock in the morning to nine or ten o'clock at night. And this shows what the ultimate result must be, if it be held that that extreme care must be taken. At the same time there cannot be any doubt that it would be possible to have some general regulations made, and then the extent to which they must be carried must also be agreed upon.

The Chairman—I think we ought to feel ourselves very much indebted to the gentlemen present for having attended on this occasion, and giving us a great deal of valuable information. I think I may say they have afforded us ample grounds for going to the Local Government Board, and laying before Mr. Sclater-Booth the various defects of the law, or the method of carrying it out, which we have been informed of to-day. There appears to be a considerable difference of opinion as to the power of the Act of Parliament and the reading of the Act of Parliament. One gentleman says it is amply sufficient; another seems to think it is not so sufficient as it ought to be. The gentleman representing Hackney, who takes the most lively interest in everything that ought to be done, and is very energetic in putting the Act in force, still thinks there is a want of uniformity throughout the metropolis, and that that, more than anything else, is at the bottom of the mischief. Others take a somewhat different view. The most remarkable thing, I think, was that mentioned by Doctor Whitmore about making the new drain in Harley-street, when he said there were 28 to 30 of the houses had no immediate connection with the sewer. That was a point raised some time ago; but Sir Henry Cole himself, with regard to his own house, spoke as to the necessity for further investigation into the condition of sewers in the metropolis, and of calling on the Vestries to be more rigid in their supervision, and if they have not powers enough, to go to Parliament for further powers. Again, Dr. Liddle, of Whitechapel, says many builders put traps into old cesspools, without connecting the sewer pipes with the sewers; and that one of the evils was that the sewers and main drainage were under the Metropolitan Board of Works, while the smaller drainages were under the supervision of parish authorities. Here is a double authority working under what ought to be in the hands of one Board. That does appear to be ground for calling the Legislature to put an end to this state of things, because it is obvious that all drains, from the closet to the outfall, should be under one sole authority. The gentleman from Bermondsey complained of the difficulty he had in dealing with refuse from manufactories, and from the district lying very low; no doubt that difficulty would be increased. There appears, therefore, to be a general belief that it is uniformity in reading the Act which is required; and if that is the case, we must go to Mr. Sclater-Booth, and tell him he must bring in such regulations, and, if necessary, such an Act of Parliament, as shall compel necessary uniformity. Mr. Rawlinson, who is the engineer to the Local

Government Board, in a report of his appears to bear out very strongly indeed the very argument we have been pressing, for he says:—"Most of the houses in London are drained from the back to the sewer in the street at the front, so that basements are traversed by drains, many of them square on cross section, and leaky at the joints, so that the subsoil is saturated by sewage and is putrid. Then there are cess-pits which serve no good purpose, but retain sediment to corrupt and ferment. All such foul drains or cess-pits should be removed, as also the sewage-tainted subsoil, and new water-tight drains be laid in concrete; and these should be fully ventilated externally. There has been one remarkable blunder in draining many West-end London houses—namely, making no connection with the street sewer. The sewers have been made by the parish, the house drains by the builders, and it has been no one's duty to see and to certify to a correct junction, or, indeed, junction of any sort; so that when such houses are inhabited, subsoil flooding goes on, until both subsoil and basement are alike saturated. This has been pointed out over and over again, but no remedy is as yet applied. There are also, in some districts, old sewers not sufficiently deep to drain the new houses; one case has been made public (Park Lane—the Duke of Cambridge's house), but there are other cases of a similar kind in the metropolis. House-drain ventilation is almost altogether neglected, the house-drain forming a continuous flue from the sewer to the house. Many cases of suffering to the weakly, delicate, and susceptible, spring from this sewage-gas poison." We could not have a higher authority than Mr. Rawlinson, and that is his view of the matter. I think, therefore, there are ample grounds for going to Mr. Sclater-Booth, and calling on him to take such measures as are necessary to remove the evil.

A vote of thanks to the Chairman, moved by Dr. Tripe, and carried unanimously, closed the proceedings.

MISCELLANEOUS.

NATIONAL TRAINING SCHOOL FOR MUSIC.

On Wednesday, October 18th, an influential public meeting was held in the Town-hall, Rhyl, in connection with the National Training School for Music, Kensington-gore, London, to promote the foundation of free scholarships, to be competed for by the musically-endowed youth of North Wales. His Grace the Duke of Westminster presided, and on the platform were Sir Henry Cole (a member of the Committee of Management), Rev. J. Richardson (Registrar of the Training School), Very Rev. the Dean of Bangor, Rev. Canon Morgan, Rev. W. Hicks Owen, T. Mainwaring, Esq., Col. Humberstone, P. Ellis Eyton, Esq., M.P., &c. The attendance was select and large, considering that the proceedings took place at mid-day.

The Chairman opened the meeting by reading letters of apology from Lord Penrhyn, the Very Rev. the Dean of St. Asaph, Lord Newry, Major Cornwallis West, and others. His Grace laid stress upon the letter of the last-named gentleman as an example to be followed, for it included a promise of an annual subscription of £5 for five years, and expressed a wish that the conditions of admission to the school should be sufficiently stringent to exclude from its benefits all those whose musical talents were not of the highest order. Before calling upon the gentlemen around him to address the meeting, he felt it to be his duty, as Chairman, to occupy a few moments in making some brief remarks upon the important subject which had brought them together. The question of a National Training School for Music was one which had been under consideration for many years, as a deep want had been felt in this country by persons possessing good talents, of some place where those talents might be fully cultivated free, or partially free, of expense to themselves. At present there were many persons of unquestionable talents for music who were unable to afford such cultivation as was essential to the full development of their faculties, and the consequence, in too many instances, was that splendid talents were either degraded to utterly unworthy ends, or allowed to run entirely to waste. It was candidly admitted on all hands that this country possessed in abundance musical talent which was in no respect inferior to that of any Continental country; but there could be no doubt that we as a nation had incurred a grave reproach by having neglected to provide for our musical genius advantages and facilities of instruction, at least equal to those which had long been enjoyed by the musically endowed youth of other European nations. It was to clear ourselves of that reproach that the movement to establish a National Training School for Music had been inaugurated; and so successful had been the efforts of the Society of Arts and those who had wrought with it in this important work, that the country did now actually possess a school founded on the principle of free scholarships to be awarded only to those who shall have proved their fitness for them in a competitive examination. The school, which had accommodation for the instruction of 300 scholars, had been already endowed with upwards of 90 scholarships, of which 72 had been awarded to students who were now at work in the school. The remainder would be awarded as fast as competitions could be organised for them; and if the movement prospered, as the promoters had reason to hope it would prosper, when the large towns and the counties of England gave the subject that attention which it deserved, no long time would elapse before the school possessed its full complement of 300 scholars. It had been thought right to hold this meeting in Rhyl, in order to lay the subject fully before the northern counties of the Principality of Wales, that Principality, which by its annual Eisteddvods and in many other ways had so conclusively demonstrated the great love of, and the unusual capacity for music possessed by all classes of its people. Having expressed his own desire to see a strong central committee for raising free scholarships, to be competed for by the musically endowed youth of North Wales, established in that part of the country, and having stated his hope that provision might be made for carrying on the general education of the younger scholars, *pari passu*, with their musical education, his Grace called upon

The Rev. J. Richardson, who said, my Lord Duke, ladies, and gentlemen, the few words which I have to say will fall mainly under three heads, and will include a rapid narrative of what has been already done, a short statement of what is now being done, and a brief summary of what we trust, with our help, will yet be done, in respect of the establishment of the National Training School for Music upon a firm and durable basis. With regard to the first point, it is not generally known that the idea of founding such a school at South Kensington as a branch of the great Art Institutions established there emanated from the late lamented Prince Consort; but such is the fact. It was not, however, until the year 1854 that an opportunity of giving effect to the idea arose. But in that year the Royal Academy of Music made application to her Majesty's Commissioners of the Exhibition of 1851 for a site upon their estate at South Kensington for a school building; and an earnest attempt was then made, by those who had taken the Prince Consort's idea to heart, to convert that application into a basis for negociations which would result in turning the Royal Academy into a great musical school, which should be truly national in character. These negociations were carried on for a considerable time; but, for reasons to which I need not further allude, they were un-

successful, and the question remained in abeyance during some years. We now go on until the year 1865, when the Society of Arts appointed a Committee, consisting of 16 gentlemen, to consider and report on the state of musical education in the United Kingdom. H.R.H. the Prince of Wales accepted the Chairmanship of that Committee, and a vast amount of information, which has been embodied in two published reports, on the working and constitution of the chief English and foreign music schools and conservatoires, was then collected. The views of the musical profession on the subject were stated by Sir Sterndale Bennett, Sir Michael Costa, Sir Julius Benedict, Sir F. Gore Ouseley, Dr. Wylde, Messrs. Garcia, Godfrey, Hullah, Leslie, Lucas, Macfarren, Pauer, Goldschmidt, and Turle. Valuable evidence was also given by Sir George Clark, Sir Henry Cole, Messrs. Capes, Chester, Chorley, Le Neve Foster, and St. John B. Joule. Having concluded its inquiries and investigations, and having ascertained the principles upon, and the nature of the administration by which the general musical education of the people of this country might be systematically conducted on a scale, and with results, at least equal to those of the academies which flourish on the Continent of Europe, the Committee laid down certain conditions which they recommended for observance by any great school which might be founded. In 1873 H.R.H. the Duke of Edinburgh joined the Musical Committee of the Society of Arts, and negociations were reopened with the Royal Academy of Music, with the same views as have been already expressed. The Academy, however, preferred to retain its own premises and to continue as it was, and the negociations were consequently dropped. When it was found that there was no chance of effecting a union between the school which the Society of Arts desired to establish and the Royal Academy of Music, the Society resolved to take the initiative, and to found a school upon the principles which they had recommended—the chief feature in which was the establishment of free scholarships—by voluntary efforts, confidently trusting that a school so founded and so constituted might be eventually transferred to the responsible management of the State. To organise a scheme for carrying out this purpose, a Committee of Management comprising seven members, with H.R.H. the Duke of Edinburgh for chairman, with power to add to their numbers, was enrolled in December, 1873. It included three members appointed by the Society of Arts, two members appointed by her Majesty's Commissioners (the landlords of the school site), and two appointed by the Council of the Royal Albert Hall (who had agreed to grant accommodation in the hall). The work which this Committee had to do was of an unusually difficult, delicate, and discouraging character; work which required untiring patience, unflinching perseverance, and anxious watchfulness; work which was threatened by many and serious obstacles. But difficulties—as they are wont to do when fairly grappled — began to give way before the determined attitude of the Committee. Her Majesty's Commissioners came forward and granted a piece of ground as a site for the school. Then came an offer from Charles James Freake, Esq.—a name ever to be honoured by the promoters of musical education of England—to erect a suitable building at his own cost, thus sweeping away, by an act of patriotic munificence, one of the most formidable obstacles with which the committee had had to contend. During the time the building was being erected, the Society of Arts strenuously set itself to the work of raising scholarships—each representing £40 a-year for five years, paid to the school — and by the exertions of its members a considerable amount of interest in the school has been created throughout the country. In all parts of the United Kingdom local committees have been, or are being, formed to promote the establishment of free scholarships for five years, and the increasing number of such scholarships testifies to the public appreciation of the scheme, and affords a hopeful guarantee of speedy success. In the meantime the Committee of Management was devoting its attention to the organisation of professional and official staffs, and making preparations for opening the school. They placed themselves in communication with the leading members of the musical profession, and, acting on their advice, appointed a principal and a board of principal professors, in whom they vested power to determine the course of study, and the classification of students, and to whom is committed the duty of selecting professors to be recommended to the Committee for appointments on the regular professional staff. With respect to the lay administration of the school, the Committee, having taken counsel with eminent administrators in various departments of education and commerce, appointed a registrar, who should be charged with the direction of all details relating to the moral supervision of the students, and with all the correspondence of the school, and who should be the ordinary medium of communication between the Committee of Management and the professors and scholars. In the fulfilment of these duties the registrar has the assistance of a lady superintendent and an experienced clerk. In 1875 the school premises were completed; early in 1876 they were ready for occupation; and on the 17th May, in the same year, the school was opened for study, by R.H.H. the Duke of Edinburgh. The Committee had previously made themselves guarantors for the preliminary expenses, and for the costs of furnishing the school and supplying it with instruments and apparatus. These expenses will, of course, form a charge on the capital fund, and will be spread over the first five years of the school's existence. I now come to the second branch of my subject, viz., the present working of the school. The institution is under a governing body, which is composed of the Musical Committee of the Society of Arts, and of the Committee of Management, now comprising fourteen members. The professional work of the school is under the direction of the Principal, Arthur Sullivan, Esq., Mus. Doc. Cantab., who is assisted by a board of principal professors, and a distinguished staff of professional collaborateurs, including professors of composition, counterpoint, harmony, vocal music, solfeggio, organ, pianoforte, and violin. Every student attends the classes on harmony and solfeggio, and the lectures on the æsthetics, history, and literature of music. In addition to this, each student has two lessons weekly in the principal subject of his studies, whether this may happen to be vocal or instrumental, and one lesson weekly on some second subject, *e.g.*, those whose principal subject is vocal music take, as a rule, the piano or organ for their second subject; while those whose principal subject is piano or violin, may take singing for their second subject, or organ, or some other instrument. Those, again, who are sufficiently advanced in harmony, attend also the counterpoint and composition classes, and so on. There are now 72 scholars receiving instruction in the school, viz., 18 males and 54 females. Of these 41 are making the piano their principal subject of study; 22, singing; 7, violin; and 2, the organ. The academical year consists of three terms of about thirteen weeks each, and there are vacations at Christmas, and Easter, and after Midsummer. And now, my Lord Duke, ladies, and gentlemen, I shall briefly state what it is that the founders and officials connected with the institution hope to be able to accomplish. Gentlemen, our aim and hope is to found for England such a school of music as already exists in many of the principal Continental countries; a school which shall take rank with the Conservatoires of Milan, Paris, Vienna, Leipsig, Brussels, and Berlin; a school which shall do for the musical youth of Great Britain what those schools are doing for the talented youth of Italy, Austria, France, Germany, and Belgium. We desire to found, upon a firm and lasting basis, an institution where the musical talent of this country may be fostered and developed

without the necessity and expense of driving it into foreign schools—an institution where our God-born musicians may regularly graduate in all the branches of both the art and science of music; where their studies shall be pursued under the direction of eminent and responsible professors; where they may have opportunities of acquainting themselves thoroughly with the works of the great masters, by hearing them properly performed, by learning them, and by analysing them, under the eye of watchful and competent directors. And last, though not least, we are desirous of having a school whence shall be drawn a large proportion of the artists and the teachers to whom the nation must look for its musical gratifications and for the instruction of its young. We appeal with confidence to the nation to help us to carry out our designs; for, as it has been well observed, "music has now become a recognised element in English life, and its culture is regarded not only as a source of profound and lasting pleasures, but a powerful and ennobling instrument for refining the mind; as a divine gift designed for the cultivation of all that is best within us." We appeal to this Principality with confidence also, because it cannot possibly be that any movement which has the cultivation of the highest musical aptitude in the country for its object, could be regarded as truly national in its character while the people of Wales held aloof from it. Nor could any school which does not include among its alumni a large number of Welsh youths be truly styled a National Training School for Music. Bards whose influence upon our early history and poetry was incalculable may be said to be almost indigeneous to the Principality of Wales; and their minstrelsy is said to have been regulated by a king of Britain as early as the sixth century.

The Dean of Bangor said he had to move the first resolution, which was worded as follows:—"Considering that the Principality of Wales has stood pre-eminent in the United Kingdom from the remotest period of history for its musical genius, it is desirable that it should maintain this pre-eminence, and take advantage of the National Training School for Music, and establish Free Scholarships in connection with the School." He felt great pleasure in moving the resolution, for it was an acknowledged fact that Welshmen had been gifted with great musical abilities. But although they possessed this natural gift, to be of much service to the possessors it must be cultivated. Having had two letters of invitation from Mr. Richardson, he thought it his duty to attend that meeting, and show the interest he felt in the movement. He lived in a district of Wales remarkable for the extent to which the love of music prevailed in it. The stone or slate hidden in the Carnarvonshire mountains, when brought to the surface, was capable of being shaped into beautiful forms, and could receive the highest polish when subjected to the skill of workmanship and art; but so long as it lay hidden it was of no use. So also with the natural powers of the Welsh, if their musical talent and ability, which was capable of receiving the highest cultivation and polish, lay hidden among the mountains of Carnarvonshire, it was comparatively useless. Music tended greatly to benefit, to beautify, and to enrich our social life, and he had no doubt if the movement before them was brought to Carnarvonshire, it would receive every encouragement and support. The best way would be to endeavour to form working-men's committees at Llanllechid, Llanberis, Llandinorwic, Bethesda, and similar places. If the matter was properly brought before the inhabitants of those places, they would exert themselves to provide scholarships; as the quarrymen possessed not only talent and taste, but they had sufficient self-reliance and public spirit to take the matter up. Besides which, many of them earned large wages, and they were at the same time generous enough to contribute and to take part in the establishment of scholarships. Having made further suggestions of this kind, he (the Dean) said that a movement initiated in this way would find Lord Penrhyn always willing and ready to assist, and indeed he had been led to understand that his Lordship had already intimated his intention to give the movement his warm and cordial support. It was not necessary for him to enlarge further, and he would merely say that it gave him, as a Welshmen and as a clergyman, great pleasure to be present. Having shown how that music elevated mankind, and that its object might be said to be to endeavour to reproduce the eternal harmonies in the universe, he added that the clergy could not use any influence more likely to promote the moral welfare of mankind than by inciting in them a taste for good music. They might depend upon it that every hour spent in the cultivation of this taste was an hour spent in weaning them from many temptations of the world. He might add, as a clergyman, that music tended in the highest degree to elevate the mind, and to help the clergy in the great work they were engaged in; that musical ability would eventually have an effect upon that service which they specially used to the glory of God.

Sir Henry Cole, K.C.B., &c., in seconding the resolution, observed that none were more proud of themselves, and very jnstly so, than were the people of Wales. He believed there was in the traditions of Wales one curious fact which put them at the head of the whole empire. Centuries ago there was a place called Caerleon—at present a small place with a little railway station. Here King Arthur, who was no myth, is said to have reigned. That place was then bigger than London, and naturally enough it was the Cambrian head and centre of music. They could find that at this place in the sixth century Christmastide was celebrated in a merry manner, from which the town obtained the name of "merry Caerleon." Some infidel Northman, a Dane or something of that sort, had turned this into "merry Carlisle," and said that King Arthur was a Scotchman. He (Sir Henry) was talking gospel when he said that they at this Caerleon held an Eisteddvod in the 6th century—he was not able to give the precise date, but it was a noted Eisteddvod, and the account of it had been handed down to them. He defied any other country in the world to produce an account of any such meeting held in their country twelve centuries ago. Respecting this Eisteddvod they had got a programme of the meeting, and were informed therein that "Prince Llywarth" sang "The Brilliancy of Winter;" Merlyn sang "Merlyn's Apple Tree;" and Murin sang "Massacre of the Britons." There were single songs, duetts, choruses, dialogues, penillion singing, &c. All these were to be found in Wales in the sixth century. Wales had gone on in the same direction ever since then. He then spoke of the advisability of endeavouring to make the Eisteddvodau instrumental in carrying out the great objects of the old bardic meetings (promoting the love of music) by providing scholarships for Wales in connection with this training school. He understood that next year a bardic meeting would be held at Carnarvon, and that they expected the Prince of Wales would be present (he hoped they might get him), and it would be well if it were possible to bring forward the question of scholarships at this school in connection with that great gathering. Some humorous remarks about the "Gorsedd," of which Sir Henry confessed total ignorance, as he was not clear whether it meant a man or a stone, were made; the speaker wishing, as that was tho rule, to commence by propitiating the Gorsedd in regard to this scholarship movement. He (Sir Henry) had another reason for commending this movement to the support of the people of the Principality. The Dean had referred to the moral and religious influence of music. He (the speaker) felt that he also had a mission, and that was to preach recreation and instructive amusement as a powerful antidote to drunkenness. He supposed Welshmen drank no more than other people; still there might be some who went too far in their potations here as in other

places. He had always looked upon the question of temperance as one which could not be successfully promoted without providing the people with recreations as counter-attractions; and what could be found more likely to suit the people of this country than the cultivation of their musical abilities? It would be good for the bodies and souls of Welshmen, and have good effect upon their morals and manners. He would heartily second the resolution.

The resolution was put and carried.

Mr. Ellis Eyton, M.P., moved the next resolution, which was as follows:—"That it is desirable that local committees be formed in the principal cities and towns of North Wales, for the purpose of establishing free scholarships and organising competitions for them." He expressed the great pleasure he felt in proposing this resolution, and in adding his mite in support of so worthy a movement. The object in providing Welsh scholarships in connection with the National Training School for Music was one, he thought, in which everybody would agree. He closed his remarks with the lines commencing "Music hath charms to soothe the savage breast," &c.

Mr. Townshend Mainwaring said he could not add to the interest of the meeting by quoting poetry, nor by referring his hearers to the musical records of the sixth century; but he could go back as far as the beginning of the present century, and he heartily responded by way of seconding the resolution. Having referred to the example given by Major Cornwallis West, of supporting the object of the meeting by a liberal subscription, an example which he himself should gladly follow, he spoke of the music of the present day, as compared with what it was in his younger days, and said that he found it miserably dull; and he confessed that there was very little pleasure to his mind to be gained from many of the musical performances of the present day. He referred in very complimentary terms to two lady acquaintances of his, the late Misses Williams, of Aberpergwmn, who were both musical and rich, and who had spent much of their time amongst the mountain peasantry picking up some of the old melodies. No country in Europe had a richer musical genius than Wales; and he gave some historical anecdotes to show that some of the finest pieces of music sung at our operas were taken from the melodies to be found in the old mountains of Wales. He instanced that "Y 'Deryn Pur," "Gwenith Gwyn," "Llwyn Onn," as being amongst those which had been adapted in this way, with slight modifications. He was glad to second the resolution which had been placed in his hands, as he thought that the National Training School for Music afforded Welshmen a favourable opportunity of properly developing the musical gifts with which they had been so richly endowed.

The resolution having been put and carried,

The Rev. W. Hicks Owen said it gave him infinite pleasure to move the next resolution, viz.:—"That a central committee for North Wales be formed to meet in different centres were Eisteddvods are held; and that the following noblemen and gentlemen be requested to allow their names to be placed on such central committee—The Duke of Westminster, K.G.; Lord Penrhyn, Lord Clarence Paget, K.C.B.; the Lord Bishop of Bangor, the Lord Bishop of St. Asaph, the Lord Bishop of St. David's, the Dean of Chester, the Dean of Bangor, Sir Watkin Williams Wynn, Major W. Cornwallis West, &c., with power to add to their number; and that the central committee will assist in establishing local committees and act in concert with them, and through their hon. secretary will correspond with the Secretary of the Society of Arts." He remarked that the most barbarous and degraded nations were those without music. So it was in Africa, where the tom-tom was the only music they had. He replied to the argument of some, that music made men effeminate, by referring to the conduct of the most musical people in the world, the Germans, during the late war, in which that nation had surprised the world. The Bible taught them to love and cultivate all that was beautiful and of good report, and what could be more beautiful than music and harmony; it strengthened us to meet, like Christian men and women, the trials and difficulties of this life. He closed his remarks with a comparison between the barbarous countries of the earth, and those countries where music was cultivated, and sat down amid much applause.

Mr. Churton said that Mr. Hicks Owen had spoken so well on the subject that he would content himself with merely seconding the resolution. The motion was put and carried.

The Rev. Canon Morgan, in proposing the next resolution, "That the thanks of this meeting be given to his Grace the Duke of Westminster, K.G., for his kindness in presiding," said that it would ill become him to say anything in his Grace's presence, even were it needed, but it was not necessary to say anything on the subject of the unvarying kindness and courteous dignity which were so characteristic of his Grace, and which the meeting had that day witnessed for themselves in Rhyl. With respect to the object of the meeting, as far as he (Canon Morgan) could, he would do all in his power to promote it. He explained that for what Sir Henry had said about the "Gorsedd" he (Canon Morgan) was responsible: he had thought it well to make known to Sir Henry that any application to be made to the Eisteddvod ought, he understood, to be made through the Gorsedd. The Eisteddvod was becomming an annual power in the country; and one had been held in Rhyl some years ago, which had left a surplus of £160, and this sum had been lying idle in the bank for ten years, during which time the number of the committee had been so much reduced by death, and by others leaving the place, that no one could tell who would come into the reversion of the principal and interest. The money might be put to a far better use by establishing scholarships for a district of, say, ten or twelve miles round Rhyl.

Col. Humberstone, in seconding the resolution, spoke of the fine and harmonious music he had once heard from people from the neighbourhood of Llanllechid, and expressed his opinion that a better field than Wales for finding persons with the capacity for music, which ought to be carefully cultivated, could not be found. Music often became a snare unless the talent was well cultivated; to sing before an ignorant audience had spoiled many a bright talent.

The Duke of Westminster having expressed his thanks in a few words, the meeting was brought to a close.

THE ACCLIMATISATION OF USEFUL PLANTS IN INDIA.

Since the establishment of the cinchonas in India, in which Dr. King took an active part, the Royal Botanical Gardens at Calcutta have been the centre from which has been distributed other useful plants. Thus, following upon the cinchonas came the ipecacuanha, a very limited number of plants being first sent from this country for propagation at the Calcutta gardens, and subsequent distribution in the plantations, and succeeding the ipecacuanha have been other plants of commercial value, so that the annual reports on the progress of the Royal Botanical Gardens have of late years contained much interesting matter on the all-important subject of acclimatisation. The present report is dated in June last, and shows what has been done in the above respect as well as in the gardens generally during the year 1875-76.

As is well-known, the introduction of caoutchouc, or

rubber yielding plants, into India, has attracted much attention of late, and has been brought prominently before the members of the Society of Arts; following upon this, the recent despatch from the Royal Gardens at Kew of a large number of wardian cases, filled with young plants of the Para rubber (*Hevea brasiliensis*) which had been raised from seed at Kew, and which were consigned to India, gave indications that ere long we should hear of well-stocked rubber plantations. Suitable sites will have to be carefully selected for these plants, for Dr. King thinks it is only in certain parts of India that the plants will succeed at all, as will be gathered from what he says on the subject of india-rubber generally, which is as follows:—"During the current year it has become more apparent than ever that neither the *Hevea* nor the Madagascar rubber plant can be grown for commercial purposes in the climate of Bengal. Both have alike failed in this garden and in the warm tropical valleys of the Sikkim Himalayas, and in my opinion a home will not be found for them further north than Tenasserim, Ceylon, or perhaps Malabar. The appliances existing in this garden probably render it the most suitable place in India for raising seedlings of these plants for transport to places possessing a suitable climate for their growth to maturity. It was with much regret, therefore, that I had to report to Government the utterly hopeless condition of a large consignment of *Hevea* seed sent out by the India-office during September, 1875. This consignment was packed in large barrels, a singularly unfortunate arrangement for such oily and perishable seeds as those of Hevea. The india-rubber experiment cannot, therefore, be said to have progressed during the year." With regard to the cultivation of the chief indigenous rubber tree of India—the *Ficus elastica* — the Forest Department, it seems, are making some experiments. Dr. King alludes to the fallacy that this tree cannot be grown from seeds as an entire mistake; for, if the seeds be carefully collected and properly sown, they germinate freely in soil. Whether vanilla will ever prove a satisfactory crop for cultivation in India, is a question that present experience does not throw much light upon. Two years ago, it seems, a number of plants were put out in the Calcutta garden under sheds similar to those in which the pepper vine is grown. These plants, it appears, have not made satisfactory growth, which is attributed to the probability of over shading, consequently many of them have been recently planted under the shade of mango trees, the results of which, it is hoped, will be more satisfactory. The experience of Dr. King leads him to believe that vanilla will never become an established product of Bengal. Very satisfactory accounts are given as to the distribution of the ipecacuanha, numbers of plants of which have been sent to Ceylon and to the Neilgherris, as well as to Burmah. The propagation being no longer a difficulty, plants in any quantity can be raised and sent out, and further than this, it is highly satisfactory to know that the medicinal quality of the root itself is equal to that of Brazilian growth.

Most encouraging is the report on the growth and distribution of that valuable timber, the mahogany (*Swietenia mahagoni*). On this point, Dr. King writes:—"The demand for seedlings of this timber tree is far greater than I can meet. This is not at all to be wondered at, as the tree has been proved to thrive admirably in Bengal, to grow faster than the two best Indian timbers, teak (*Tectona grandis*), or Sâl (*Shorea robusta*), and to produce wood equal in quality to the best Honduras grown logs. The difficulty in extending mahogany-planting in Bengal lies solely in the scarcity of seed. The species, though thriving well in the climate of Bengal is very shy in seeding; hardly a pod is yielded by the large trees that remain in the Calcutta garden, and I am dependent for my supplies of Indian grown seed on a few trees on the grand trunk road near Barrackpore. Last year, from all sources I was able only to collect 3,717 seeds. I have already proposed that special efforts should be made to get good seed from Honduras and Jamaica." It is to be hoped that by the dissemination of this report, residents in Jamaica and other mahogany-growing countries will be induced to send seed of this invaluable timber tree to the Calcutta Botanic Gardens, so that plants may be abundantly raised and planted out in India.

The question of the manufacture of paper from the young shoots of the bamboo has been taken up in India. Dr. King justly remarks that the utilisation of the immense amount of bamboo which annually goes to waste in Indian forests, is so important, that any proposal with this end in view must naturally receive much consideration. There seems some doubt, however, whether the process of reducing the shoots to paper stock in their own country, suitable for transport to England, can ever be remunerative, as the out-turn must be very low in price; it is necessary for success that a factory turn out a large quantity per annum. This, of course, involves a large supply of raw material. If old bamboos would answer the purpose, or if young shoots could be produced all the year round, a fine revenue from bamboo would be in prospect for the Indian Forest Department. But old bamboos will not answer, and young shoots are produced in India during a period not exceeding four months in the year; and, moreover, they are too heavy to float, and there is no margin for the payment of land carriage. The only hope, therefore, of the success of the scheme is either to fit up (as has been proposed) the necessary machinery on a river steamer, and keep it moving along some river in a good bamboo district during the few months when young shoots are to be had, or to discover a means by which the bamboo may be induced to yield a crop of young tender shoots with regularity and rapidity, irrespective of season, and in spite of its natural tendency to yield shoots only during the rainy season. With the latter object some clumps of bamboo have been cut down in the way suggested by the patentee of the bamboo paper stock, and treatment is to be instituted to secure, if possible, the desiderated regular crop of shoots.

CORRESPONDENCE.

THE SOFTENING AND PURIFYING OF WATER BY THE PORTER-CLARK PROCESS.

Sir,—Mr. Jarmain, in one of his lectures recently published in the *Journal*, chiefly devotes his time to the consideration of the importance of soft water in certain manufactures. Not necessarily water of the softness of rain water, which may be taken as having one degree of "hardness," but water not exceeding 7° of hardness.

The river waters with which London is supplied have 14° to 15° of hardness, and the water of the wells in the chalk, south and west of London, about 21° or 22° of hardness. Mr. Jarmain explains what is known as "Clark's process," by which the hardness of waters may be reduced. This process is, however, slow in its action—the actual softening is very rapid, but the clearing of the water by slow precipitation of the infinitely minute particles of chalk is an affair of hours—accordingly, where large quantities of water are required, very large vessels as reservoirs are necessary, not only for the mixing, but for a supply of cleared water for use while successive operations are in progress. Now, in many cases, space for these cannot be had; and where space exists, the importance of the subject has not been recognised as sufficient to outweigh the cost of constructing them. In short, the invaluable process of Dr. Clark has, for all purposes of our national industries, been ignored. Messrs. Homersham, Bateman, Quick, and other civil engineers of eminence, have adopted it on a large scale in certain waterworks drawing their supplies from the

chalk formations, and with the happiest results, reducing to $2\frac{1}{2}°$ or 3°, in some cases, water having 18° to 21° of hardness; but what has been wanting hitherto has been a convenient, and not too costly, method of applying this process in private establishments having their own independent sources of supply.

I should like to be allowed to draw attention to an arrangement, recently introduced by myself, for meeting this want; it was first tested at Lavenham, in Suffolk, where the water from the wells has 28° of hardness; and, subsequently, under the inspection of Mr. Bramwell, the consulting engineer to the visiting justices, at the new Lunatic Asylum at Banstead, where, from 17°, the water is reduced to 3°. Let us assume that it is desired to soften 5,000 gallons of water per hour, or 60,000 gallons in 12 hours.

To do this there might be required 6,000 gallons of clear saturated lime-water, as explained in the lecture by Mr. Jarmain, and it would be desirable to provide for the preparing and storing of this, three tanks, each capable of holding 2,000 gallons. They would occupy a space, say of 23 feet by $7\frac{1}{2}$ feet, and of $7\frac{1}{2}$ feet in height.

We now come to what I term the "Porter-Clark" process. I provide a pair of tanks of the capacity of 1,700 gallons each, or of one-third of the quantity to be softened per hour, for my filtering apparatus will clear the contents of one tank in twenty minutes, and less than twenty minutes is sufficient for filling the other with the dose of lime-water and the water to be softened, and for effecting the conversion of the bi-carbonate into carbonate of lime or chalk.

Thus, these two "mixing" vessels, of about $7\frac{1}{4}$ ft. diameter and 7 ft. in depth, used alternately, give a continuous supply of the "milky" or chalky water at the rate of 60,000 gallons per day of 12 hours. They are placed at an elevation of about 10 ft. above the filtering apparatus, of which, for this quantity of water, it would be convenient to have three, each occupying a space of $5\frac{1}{2}$ ft. × $2\frac{1}{2}$ ft., and of $3\frac{1}{2}$ ft. in height.

Each filtering apparatus is sub-divided into a dozen narrow vertical filtering chambers, having about an inch in space between them; and into these intermediate spaces, the water, rendered chalky by the "Clark's process," is admitted by a circular aperture through each compartment, that forms, when they are all in close contact, one tube or channel common to all, and supplying each of the water spaces alternating with the filtering chambers.

Each filtering chamber consists of a cast-iron frame, of about $1\frac{1}{2}$ in. in thickness, fitted into and flush with the sides of which are a pair of perforated plates of metal, and in front of each of these is a cloth of suitable texture; and when, by means of a pair of powerful screws, worked by a hand wheel, these dozen compartments, with their cloths, and the intervening frames that give the water spaces, are squeezed tightly together, their edges are watertight.

The water, clouded with particles of chalk, entering the waterspaces by the apertures referred to, encounters the ever-increasing precipitate of carbonate of lime arrested by the cloths; through this it passes (under pressure from the 10 feet of "head" above mentioned), leaving its own addition to this, the filtering medium, and escapes by way of the perforated plates, between each pair of which it issues through small apertures in the bottom of each chamber into a trough common to them all. It continues thus without intermission to flow out, soft and beautifully clear, at the rate of 20,000 gallons per day, for each filtering apparatus, until the accumulation of the precipitate by degrees obstructs its passage. When that takes place, a quarter of an hour suffices for relaxing the pressure of the screws, separating the several compartments sufficiently for withdrawing the cloths surcharged with precipitate, and substituting fresh ones; the operations can then be resumed.

With the pure but hard waters from the chalk, as at Lavenham and Banstead, this change of cloths will not be necessary within the twelve hours; but with waters from other sources, it will depend upon the amount of organic or other impurities; it is, however, a most important feature in this plan of mine, that I can successfully treat waters to which the process of Dr. Clark has not hitherto been applied with success. The waterworks at which the Clark's process has been introduced all draw their supplies from wells; at least, I am not aware of any instance in which river water is treated. There is not the same "hardness" in river waters, but the slowness of the precipitation in presence of organic matters has been the obstruction, where the purification by precipitation as well as the softening would have been of value.

By my plan of causing the water to pass, under a very moderate pressure, through the ever-increasing deposit of carbonate of lime, the organic and other impurities (iron included) are thereby and therewith arrested.

I believe I may count upon the permission of the visiting justices, to show my process in action at Banstead to any of your members who may take a serious interest in it; and at the sugar works of Mr. Duncan, near the Victoria-docks, I shall be able to show it dealing with water chemically and organically impure. In these two case, the main object is to remove the cause of the calcareous incrustation in the boiler, pipes, and valves, and to economise fuel. At Mr. Duncan's works, twenty steam boilers working night and day, consume on an average 400 tons of coal per week. And it is estimated that an average saving of 40 tons per week may be effected by using the softened water. About £10 per week is now the average cost there of removing the incrustation and deposit from the boilers; the loss occasioned by these deposits in the pipes and valves is not so readily ascertained, but is very great.

At Banstead, there are five large boilers, and about five miles of hot-water pipes, for warming the many buildings of the establishment.—I am, &c.,

John H. Porter,
Assoc. Inst. C.E.

Lavenham, Suffolk, 23rd Oct., 1876.

P.S.—I should, perhaps, say that my patent is dated the 21st April, 1876, and is not yet published.

GENERAL NOTES.

Female Labour in Germany.—The German Government has lately published the results of an investigation by various States of the empire with regard to the employment of women in manufacture. From the returns, it appears that about 226,000 women, above 16 years of age, are so employed in the empire. Of that number, 24 per cent. are between 16 and 18, 42 per cent. between 19 and 25, 34 per cent. above 25. About one-fourth of the whole are married. Comparing the working women with the whole female population, it appears that in Prussia they form only 1 per cent. of the whole, in Bavaria, three-quarters per cent., in Saxony, more than 3 per cent., and in Wurtemberg, a little more than 1 per cent. If they are divided into groups according to age, it is found that in Prussia there are 690,000 girls between 16 and 18, of whom 4 per cent. are engaged in manufacture; in Bavaria there are 125,000, of whom $2\frac{1}{2}$ per cent. are employed in factories; in Saxony, 14 per cent. out of 75,000; and in Wurtemburg, 5 per cent. out of 44,500. In Prussia, $3\frac{1}{2}$ per cent., between 19 and 20, out of 1,529,000, work in manufacture; in Bavaria, 2 per cent., out of 290,500; in Saxony, 11 per cent., out of 166,500; and in Wurtemberg, 3 per cent. out of 111,000. More than half (128,500) the total number of workers are employed in textile industry, 34,000 in the manufacture of cigars, and the rest in various branches of industry. The duration of work is from ten to eleven hours a day, and never exceeds thirteen hours. The usual wages are 5s. to 8s. a week. If some get less, others get as much as 19s. to 24s. a week.

JOURNAL OF THE SOCIETY OF ARTS.

No. 1,250. Vol. XXIV.

FRIDAY, NOVEMBER 3, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NOTICE TO MEMBERS.

The 123rd session of the Society will commence on Wednesday, November 15th, when the opening address will be delivered by Lord Alfred S. Churchill, Chairman of the Council.

Candidates proposed for election as members are privileged to attend on this occasion.

Evening Meetings of the Society will be held on the following dates, subject to any alterations which may be found necessary:—

The Annual General Meeting will be held on June 27th, 1877, at four o'clock.

Ordinary Meetings.

The following arrangements for the Wednesday evenings before Christmas have been made:—

November 15.—Opening Address, by Lord Alfred S. Churchill, Chairman of the Council.

November 22.—"Collapsible Boats; their Peculiarities and Advantages," by the Rev. E. L. Berthon.

November 29.—"The Construction of House Drains," by Major-General F. C. Cotton, C.S.I.

December 6.—"Street Tramways," by Captain Douglas Galton, R.E., C.B., F.R.S.

December 13.—"A New Process of Printing a Number of Colours at One Impression," by E. Meyerstein, Esq.

December 20.—"The Philadelphia Exhibition," by Professor Archer.

Cantor Lectures.

Courses of Cantor Lectures will be given on Monday evenings at eight o'clock, and the First Course will be on "The History of the Art of Coach Building," by George A. Thrupp, Esq., as follows:—

Lecture I.—November 20.

Carriages of the ancient world; Egypt, Syria, Greece, and Rome, and native carriages of Hindustan.

	Cantor Lectures.				African Meetings.				Ordinary Meetings.					Chemical Meetings.				Indian Meetings.			
1876.	Mondays.				Tuesdays.				Wednesdays.					Thursdays.				Fridays.			
November........	—	—	20	27	—	—	—	—	—	—	15	22	29	—	—	—	—	—	—	—	—
December........	4	11	18	—	—	—	—	—	—	6	13	20	—	—	—	—	—	—	—	—	—
1877.																					
January	—	—	—	—	—	—	23	—	—	—	17	24	31	—	—	—	—	—	—	—	—
February........	—	—	—	—	—	13	—	—	—	7	14	21	28	8	—	22	—	2	—	16	—
March	5	12	19	26	—	13	—	—	—	7	14	21	—	8	—	—	—	2	—	16	—
April............	—	16	23	30	10	—	24	—	—	4	11	18	25	—	12	—	26	—	—	20	—
May	7	14	—	—	8	—	—	—	2	9	16	23	30	—	10	—	—	4	—	—	—

The Chair will be taken at Eight o'clock at each of the above Meetings.

Lecture II.—November 27.

Carriages of the Middle Ages, and introduction of coaches into England, France, Italy, and Germany. State coaches of the time of Louis XV.

Lecture III.—December 4.

Carriages from 1770 to the present time.

Lecture IV.—December 11.

Ancient and modern travelling, and public carriages of Europe.

Lecture V.—December 18.

Rules of coach building and theories applicable to the carriages of the future.

The Second Course will be on "The Chemistry of Gas Manufacture," by A. Vernon Harcourt, Esq., F.R.S., and the Third Course on "The Connection of Greek and Roman Art with the Teaching of the Classics," by Sidney Colvin, Esq., M.A., Slade Professor of Fine Art at the University of Cambridge.

The First and Second Courses have been arranged with special reference to the Society's Technological Examinations.

African Section.

Meetings of this Section will be held on Tuesday evenings at eight o'clock.

Chemical Section.

Meetings of this Section will be held on Thursday evenings at eight o'clock.

Indian Section.

Meetings of this Section will be held on Friday evenings at eight o'clock.

Papers to be read in the above Sections, will be announced in the *Journal.*

Juvenile Lectures.

This Course will consist of Two Lectures, by R. A. Proctor, Esq., F.R.A.S.

Lecture I.—January 3rd.

"The Sun and his Family."

Lecture II.—January 10th.

"Comets, Meteors, and the Stars."

Special tickets will be issued for these lectures.

Admission to Meetings.

Members have the right of attending the above meetings and lectures. They require no tickets (except for the Juvenile Lectures), but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose are now in course of issue to the Members, but admission can also be obtained on the personal introduction of a Member.

NATIONAL TRAINING SCHOOL FOR MUSIC.

Sir William G. Anderson, K.C.B., has kindly expressed his intention to defray the costs of enlarging the new organ, which has been recently erected in the school.

CANTOR LECTURES.

The sixth and last lecture of the third course of Cantor Lectures for the past Session, on "Wool Dyeing," by Mr. George Jarmain, was delivered on Monday evening, May 1st, as follows:—

Lecture VI.

During recent years chemists have devoted themselves very much to the utilisation of waste products, that is, to the elimination of valuable materials from substances either worthless or positively noxious. Among the achievements of the chemists in this line I may mention, as examples, the extraction of phosphorus from bones, oleine and stearine from soap-scouring liquors, indigo from indigo-dyed rags, copperas from pyrites, sulphate of ammonia and ammonia from gas liquor; but, among the whole range of chemical industry, there has been no conquest over matter so great as in the production of these marvellous colours from coal-tar.

The time at my disposal will not allow me to enter lengthily into the history of the discovery of these colours, interesting though it may be.

In 1834, Runge extracted a substance from coal-tar which gave him a blue colour when mixed with a solution of chloride of lime. He gave to this substance the name "Kyanol," derived from a word which signifies blue. Kyanol was afterwards proved by Hoffman to be identical with crystalline, which had been discovered in 1826 by Unverdorben, among the products of the destructive distillation of indigo, with aniline, discovered by Fritzche in 1840, when distilling indigo with caustic potash, and with benzidam, prepared by Zinin in 1842, by the action of sulphide of ammonium upon nitro-benzol. This substance, which is now known in commerce by the name of aniline, from *anil*, the Portuguese name for indigo, remained a mere laboratory curiosity until 1856, that is, twenty years ago, when Mr. Perkin took out a patent for the production of a violet, or mauve; and from that time to this there has been a constant succession of coloured products derived from the same source to which many chemists have contributed. Hofmann, Medlock, Nicholson, Girard and De Laire, Poirrier, and others, stand in the front rank of discoverers.

Aniline.

We have seen that aniline, originally known under various names, can be obtained from various sources. Indigo is out of the question, as it would prove too dear from that source. Coal-tar contains only very small quantities of it, about $\frac{1}{2}$ per cent. being the average quantity, and the separation and purification of it are tedious operations.

The aniline employed in the production of colours is obtained by converting another coal-tar product, benzol, into nitro-benzol, and then that into aniline.

Benzol is largely contained in coal-tar naphtha, the first product of distillation of tar. The naphtha is redistilled, and the first portions taken.

The composition of benzol is represented by the symbol

$$C_6\,H_6$$

It is therefore a hydrocarbon. It is, however, a hydride of a compound radical, called phenyl. It may, therefore, be represented by the symbol

$$C_6\,H_5.\,H$$

or, more shortly, by Ph H., in which Ph represents the radical phenyl.

Benzol is converted into nitro-benzol, by treatment with strong nitric acid mixed with sulphuric acid. The following equation shows the reaction:—

$$\underset{\text{Benzol.}}{C_6\,H_5.\,H} + \underset{\text{Nitric-acid.}}{H\,NO_3} = \underset{\text{Nitro-benzol.}}{C_6\,H_5\,NO_2} + \underset{\text{Water.}}{OH_2}$$

Lastly, nitro-benzol is submitted to the reducing action of nascent hydrogen, whereby its oxygen is entirely removed, and it becomes hydrogenised thus—

$$\underset{\text{Nitro-benzol.}}{C_6\,H_5\,NO_2} + \underset{\text{Hydrogen.}}{3\,H_2} = \underset{\text{Aniline.}}{C_6\,H_7\,N} + \underset{\text{Water.}}{2\,OH_2}$$

Aniline is a basic substance like ammonia; it forms crystalline salts by combining with acids. It was on account of this property that Unverdorben gave it the name of crystallin.

Its constitution is best understood by regarding it as an ammonia substitution, in which one atom of the hydrogen in ammonia is replaced by the phenyl radical, thus—

$$\text{Ammonia } NH_3 \quad \text{Aniline } N\,(C_6\,H_5)'\,H_2 \text{ or } N\,Ph'\,H_2$$

The manufacture of aniline from nitro-benzol is now carried out on an immense scale; the nascent hydrogen produced by the action of iron borings on acetic acid is found to be the best adapted for the purpose of reducing the nitro-benzol. This is Béchamp's method.

Toluidine.

The aniline of commerce is not pure aniline, but contains an admixture of another member of the same series of bodies called toluidine, the presence of which, we shall see, is essential in the production of magenta, which is the starting point in the manufacture of a great number of the aniline colours. Toluidine is derived from toluol, which is contained in coal-tar naphtha along with benzol, by processes analogous to those which are employed to convert the benzol first into nitro-benzol and then into aniline. The toluol, $C_7\,H_8$, is con-

verted by nitric acid into nitro-toluol, $C_7 H_7 NO_2$, which by the action of nascent hydrogen becomes toluidine, $C_7 H_9 N$, or $N (C_7 H_7) H_2$.

Magenta.

This dye, as previously stated, is the starting point in the manufacture of the greatest number of the so-called aniline colours. It will be convenient, therefore, to describe it first, although it was not the first discovered.

In 1866, Natanson noticed that a red colour was produced when aniline was treated with Dutch liquid; Hofmann got a similar re-action in 1858, by treating aniline with tetrachloride of carbon; but Verguin, in 1859, was the first to manufacture magenta for the dyer, taking out a patent for it in conjunction with Renard Fréres. Verguin obtained the colour by the action of tetrachloride of tin on aniline. Then again, in 1859, came Gerber Keller's process, which consisted in the use of nitrate of mercury as the active agent; but the process which is now almost universally employed for the production of magenta on the large scale was invented by Mr. Medlock, and patented by him in January, 1860; the patent-right was subsequently sold to the firm of Messrs. Simpson, Maule, and Nicholson. In May, 1860, the same process was patented by Messrs. Girard and De Laire. The agent employed by Medlock for the conversion of aniline into magenta is arsenic acid. Arsenic acid is made by treating arsenious acid (white arsenic) with nitric acid.

The manufacture of magenta has now arrived at a state of great perfection; but as the dyer is more concerned with the mode of using this and the other aniline colours as dyes, and their special properties, than with the details of their preparation, I do not deem it necessary to enter further into its manufacture.

Magenta is the salt of a base, called rosaniline by Hofmann, who investigated it. Rosaniline, sometimes also called "magenta base," is formed by the removal of six hydrogen atoms from one molecule of aniline and two molecules of toluidine, thus—

$$\underset{\text{Aniline.}}{C_6 H_7 N} + \underset{\text{Toluidine.}}{2 C_7 H_9 N} = \underset{\text{Rosaniline.}}{C_{20} H_{19} N_3} + \underset{\text{Hydrogen.}}{3 H_2}$$

Hofmann discovered this fact by observing that magenta could not be formed when pure aniline alone or pure toluidine alone was acted on, and only when the two are mixed. The base rosaniline, when perfectly pure, is colourless, but the colour called magenta is instantly developed when it combines with an acid.

The magenta of commerce is either the acetate of rosaniline or the hydrochlorate—

Acetate .... $C_{20} H_{19} N_3, C_2 H_4 O_2$.
Hydrochlorate .. $C_{20} H_{19} N_3, HCl$.

The acetate is freely soluble in water, and is on that account preferred by the dyer. Its crystals have a fine golden green iridescent appearance. It is often called roseine. The hydrochlorate is but sparingly soluble in water, but freely in alcohol.

DYEING OPERATIONS WITH ANILINE COLOURS.

Wool has such a powerful affinity for the aniline colours, that the chief difficulty in dyeing with them is to obtain even work. This is accomplished in a variety of ways :—

1. The goods are introduced quickly at a temperature much below the boil, the bath is then heated up very gradually for half an hour, the goods being kept in constant motion all the time.

2. Where the goods can be entirely removed from the bath, it is found advantageous to introduce the whole amount of colour at two or three separate times.

3. Evenness may frequently be obtained, by the addition to a large bath of a few buckets full of crystals of sulphate of soda.

4. The goods must be well scoured, and free from every trace of grease, and soft water should be used. Wool requires no mordants for the aniline colours; the so-called mordants required in dyeing with some of them merely act the part of a modifier, and are in no sense mordants in the proper meaning of the term.

Aniline colours, therefore, behave to wool as substantive colours.

The aniline colours are neither mill-fast nor sun and weather proof; I cannot, therefore, classify these among the fast and permanent colours which I have already described; they, however, vary very much in fastness and permanency; some of the blues will withstand a good deal of severe treatment. They serve an important purpose exceedingly well, in furnishing bright and brilliant colours, of every conceivable shade, for goods which are not required to be exposed to deteriorating influences; but they far surpass the fast colours in beauty. It is not surprising, therefore, that the gentler portion of humanity should delight themselves and us, by adorning themselves with these glorious colours, which rival the tints of the rainbow, the rosy hue of morning, and the beautiful colours of the winged tribes of the sunny south.

Roseine, or the acetate, is prepared for dyeing operations by dissolving it in boiling water, and filtering the solution through flannel, so that no undissolved small particles of the dye can come in contact with the goods to be dyed; the solution is then added to the bath as required.

Magenta, or the hydrochlorate, is got into solution by dissolving it in boiling water, in the proportion of two gallons of water to every ounce of the dye, but a concentrated solution may be made by dissolving the colour in methylated spirit, and then adding boiling water. If the crystals be worked up into a paste with glycerine, before treatment with water, a very perfect solution is obtained.

Ponceau.

Ponceau is another aniline red, which may be classed with magenta and roseine. It is, however, a more pure red than either, and is considered a faster colour. The process of its manufacture has not been made public. Its solution is prepared and used by the dyer in the same manner as that of roseine.

There is also an aniline scarlet, but it does not produce a scarlet on wool equal to what can be got by other means.

Aniline Crimson.

This is a crude, common magenta, often called claret-paste, which is exceedingly useful for dyeing clarets, maroons, and any composite colour containing magenta. The colour is prepared for

dyeing by dissolving it in hydrochloric acid, then adding boiling water, and filtering. Any excess of acid may be corrected in the dye-bath by an alkali.

Aniline Violet.

Mr. Perkin's violet, or mauve, as already stated, was the first colour made from aniline which was converted to practical purposes. It may not be out of place if I repeat a few of the words which Mr. Perkin made use of, when he gave an account of his discovery to the Society of Arts, soon after he made it. He said:—

"Chemists have always been desirous of producing natural organic bodies artificially, and have in many instances been successful. It was whilst trying to solve one of these questions that I discovered the mauve. I was endeavouring to convert an artificial base into the natural alkaloid quinine; but my experiment, instead of yielding me the colourless quinine, gave a reddish powder. With a desire to understand this peculiar result, a different base of more simple construction was selected, namely, aniline, and in this case I obtained a perfectly black product. This was purified and dried, and, when digested with spirits of wine, gave the mauve dye."

Such was the experiment which eventually led to the formation of an entirely new industry, and the utilisation of an offensive bye-product in the manufacture of coal gas.

For some time after its discovery mauve was a very fashionable colour, but it has been to a great extent superseded, by the introduction of violets of greater beauty.

The discovery of the constitution of rosaniline by Hoffman was followed up by him, and he elicited the important fact that some of the hydrogen atoms in rosaniline are replaceable by radicals such as ethyl and methyl, and that different shades of violets can be obtained by replacing one, two, or three atoms of hydrogen by these radicals. Thus we have—

Monomethyl rosaniline ..$C_{20}\,H_{18}\,(CH_3)\,N_3$
Dimethyl rosaniline ....$C_{20}\,H_{17}\,(CH_3)_2\,N_3$
Trimethyl rosaniline ....$C_{20}\,H_{16}\,(CH_3)_3\,N_3$

The salts of these substitution compounds are violet, passing from a red shade in the monomethyl derivative to a blue shade in the trimethyl one. The numerous intermediate shades are, no doubt, mixtures of varying proportions of the three. They are produced by heating under pressure, in enamelled iron vessels, a mixture of the base rosaniline, an alcoholic solution of caustic potash or soda, and iodide of methyl or ethyl, or a mixture of the two, according to the shade required.

The colours are now well known to the dyer as Hofmann's violets; since their discovery they have been well patronised by the public, and are much esteemed for the beautiful and bright colours which they give to wool.

These violets are manufactured by the firm of Messrs. Brooke, Simpson, and Spiller, to whom I am indebted for the colours I now exhibit.

Another set of violets, called Paris violets, having the same composition as Hofmann's violets, were obtained by a process discovered by Lauth, but the process was much improved by Poirrier, of St. Denis, who now manufactures these violets, and to whom I am indebted for the samples I now place before you.

In the manufacture of the Paris violets, the substituting radical is introduced into the aniline and not into the rosaniline, as is the case in Hofmann's violets. The methyl aniline, $C_6\,H_6\,(CH_3)\,N$, and methyl toluidine, $C_7\,H_8\,(CH_3)\,N$, formed at the same time from commercial aniline, are then treated with tetrachloride of tin, which converts them into the methyl rosaniline thus—

$$\underbrace{C_6\,H_6\,(CH_3)\,N}_{\text{Methyl aniline.}} + 2\,\underbrace{C_7\,H_8\,(CH_3)\,N}_{\text{Methyl toluidine.}} = \underbrace{C_{20}\,H_{16}\,(CH_3)_3\,N}_{\text{Trimethyl rosaniline.}} + 3H_2$$

Many other aniline violets are in the market, but the two kinds which I have described above are most generally used by dyers.

Woollen goods are dyed with these in the same manner as with the aniline reds. The well-cleansed goods are entered at about 130° F., and well handled; the bath is gradually heated up to near the boiling point. The colour is introduced at two or three times. For the bluer shades of violets it is found to be advantageous to make the bath slightly acid with sulphuric acid, which has a tendency to develop the blue colour.

The violets are the acetates or hydrochlorates of the methyl or ethyl rosanilines, and are consequently ordinary salts. They are substantive colours to wool, requiring no mordant of any kind; their affinity for wool is very great, but it has not the permanent character of a fast colour.

For dyeing the heavier shades it is found advantageous to add to the bath, for 100 lbs. of woollen material, 4 lbs. of alum, and 10 lbs. of sulphate of soda, to prevent too rapid dyeing.

Aniline Blues.

These fine colours are also substitution products of rosaniline, the substituting radical being phenyl. They are for the most part salts of triphenyl rosaniline—

$$C_{20}\,H_{16}\,(C_6\,H_5)_3\,N_3$$

They are made by heating together magenta and aniline; the crude product is then purified. These blues require to be dissolved in spirit, which is an inconvenience.

In 1862, Mr. Nicholson made use of sulphuric acid in the preparation of these blues, in a similar manner to that used in the preparation of sulphindigotic acid. The dye known as Nicholson's blue is the sodium salt of one of these acids; the sodium salt is soluble in water, the acid is insoluble. The sodium salt is the triphenyl rosaniline monosulphonate. It is exceedingly well adapted for the use of the woollen dyer, and the colours are fairly fast and permanent.

The dyeing of wool is performed in the following manner:—

A solution of the colour in boiling water is made and added to the dye bath, made alkaline with silicate of soda or borax. The goods are then washed out and passed into a bath of water acidulated with sulphuric acid. The acid converts the soluble sodium salt, which is of a bluish grey tint, into the insoluble acid, which is blue. If the goods are required to be dyed up to pattern, portions of the piece are torn off from time to time, washed, and then put into the acid bath, and more colour is added

to the alkaline bath if necessary, and the dyeing operation continued.

Aniline Greens.

There are several greens in use by the dyer. The colour called iodine green is, however, I think, preferred. It is a dimethyliodide of the violet base trimethyl rosaniline.

$$C_{20}H_{16}(CH_3)_3N_3, (CH_3I)_2 + OH_2$$

The dyeing with iodine green is done in a bath of silicate of soda, as with the alkali blues; the colour is afterwards developed in acid, or, better still, in tin spirit, which gives a faster colour.

The proper shade of green is often arrived at by the addition to the bath of the necessary quantity of picric acid.

Aniline Yellow and Picric Acid.

The aniline yellow is a bye-product in the manufacture of magenta. It is the salt of a base called chrysaniline. The colour is often called phosphine. There are also other yellows in the market. There is nothing difficult in the dyeing operations. The addition of tartaric acid or tartar to the bath is an improvement with some of the yellow colours.

Picric acid is obtained by acting on carbolic acid, or phenol, with strong nitric acid. It is a substitution product, in which the group or radical NO_2 takes the place of hydrogen. Its formation is explained by the following equation:—

$$\underset{\text{Phenol.}}{C_6H_5,HO} + \underset{\text{Nitric acid.}}{3HNO_3} = \underset{\text{Picric acid.}}{C_6H_2(NO_2)_3,HO} + 3OH_2$$

Picric acid dyes wool a bright yellow, with a slight green tinge, which is rather objectionable. It is much employed to produce greens along with extracts of indigo, and to modify the shades of reds and browns; in fact, it serves the same purpose with the aniline colours that the yellow woods do with the red woods, in modifying their shades.

The dyeing of wool with picric acid presents no difficulty. The dye is freely soluble in water. It is advantageous to make the bath acid with sulphuric acid.

Aniline Browns.—Bismark Brown.

These are an extremely useful class of colours. They dye wool easily, and their shades are readily modified to the red side by the use of magenta; to the yellow side by picric acid, Persian berries, or turmeric acid; and to the blue by extract of indigo.

There are several modes of preparing these browns; one of the most commonly used colours is prepared by acting on dinitro-benzol with granulated tin and hydrochloric acid, which produces phenylene diamine, which is then acted on by an alkaline nitrite.

The solution of the colour is prepared for the dyeing operations by dissolving it in hydrochloric acid, and diluting with hot water. The dye is then ready for use.

Aniline Black.

By the employment of very powerful oxidising agents, such as potassic chlorate associated with a copper or vanadium salt, the salts of aniline are converted into an intensely black colour, which has been applied successfully in the printing of calicos, but as yet, I believe, it has not been successfully applied to the dyeing of wool, for which it seems to have less affinity than for vegetable matter. The colour is unaffected by soap, acid or alkali, and is consequently very well suited for certain purposes in the woollen trade, such as its use in certain mixtures of cotton and wool, in which it is indispensable that the cotton dye shall be a fast one and not run in the scouring. Aniline black seems to fulfil these conditions perfectly. It has been ascertained, chiefly through the researches of Mr. Samuel Mellor, of Patricroft, that the difficulties experienced in using aniline black as a cotton dye may in a great measure be overcome by using the following proportions of substances, and drying with a dry heat of 140 degrees:—

16 oz. Hydrochlorate of aniline.
8 oz. Chlorate of soda.
16 grs. Chloride of vanadium.

The whole is dissolved in water and made up to 1 gallon. Chloride of copper may be used instead of the vanadium salt. but a much larger quantity will be required. The cotton is steeped in this mixture for one hour, wrung out, and dried as above.

The difficulties to be overcome in the use of aniline black as a dye are, the liability of the colour to become green, and the liability of the fabric to become tender.

Unlike all the other aniline colours, the affinity of aniline black for wool is very slight; it therefore does not seem likely that it will find use as a woollen dye.

The Dyeing of Mixed Fabrics of Cotton and Wool.

Blues.

Dye the wool or worsted first with an alkaline blue, in the ordinary way, with silicate of soda, taking care that the wool is dyed a little lighter in shade than the pattern, as in dyeing the cotton, afterwards the wool takes up a little additional colour. After dyeing the wool, wash out and develop in acid, and wash again; then dye the cotton with cotton blue up to shade, adding the colour until the proper shade is obtained. A solution of alum should be used along with the cotton dye. The cotton is dyed in a cold bath.

With the other aniline colours, after the wool or worsted has been dyed in the ordinary way, with the precaution of leaving it a little under shade, for the reason stated under blues, the cotton is prepared for receiving the dye by washing it out from the wood dye bath, then steeping the goods in sumac liquor, and afterwards in a solution of oxymuriate of tin, of about 3° Twaddell, for an hour. The cotton so prepared may be dyed up to shade in the cold with the same dye as that used for the wool. In this manner magenta, the Hofmann and Paris violets, and the iodine greens, may be dyed on mixed fabrics.

The aniline colours are frequently employed as a topping to other colours which, though fast and solid, lack brilliancy.

Time forbids me to enter more lengthily into the industrial application of these extraordinary colours which, since their introduction just 20 years ago,

have completely revolutionised the dyer's art in one branch of his work. They form a separate series of tinctorial substances, which enable the dyer to obtain every shade of colour previously obtained by other agents, and though wanting in solidity and permanency, they supply such abundant opportunity for the dyer to produce colours much in demand, they will always find a place in the dye-house.

I cannot bring these lectures to a conclusion without expressing regret that the principles of the dyer's art should have been so much neglected in this country, and that our woollen manufacturers should have so long submitted to have such a very important branch of their manufactures carried out by men who for the most part work by purely rule of thumb processes. When I say this, I do not wish to imply that the dyer is not a skilful workman, for, considering his opportunities, he has brought his art to a wonderful state of perfection. But where such large interests are involved as they are in the woollen manufactures of the United Kingdom, it seems strange that the manufacturers have not yet opened their eyes to the fact that, in this scientific age, we can no more hope to compete with those who work out their processes on scientific principles, than we could hope to overcome an enemy armed with modern weapons of precision if our soldiers were dependent upon the old "Brown Bess" of former times. So far as I know, the Society of Arts' scheme of offering prizes to students in dyeing, after examination, is the first attempt which has been made in this country to induce young dyers to study their art; but it is a deplorable fact that, throughout the length and breadth of this land last year, there was found only one student who ventured to offer himself for examination in wool dyeing. If our manufacturers studied their best interests, they would at once set about offering inducements to their young dyers to make themselves better acquainted with the principles of their art, by providing a library of the best standard works on dyeing for their dyehouse, by furnishing a small laboratory for their works, by encouraging their young men to study chemistry, by encouraging the formation of dyers' societies in their district, and by uniting to endow chairs in colleges now in existence devoted to technical education. By such means, or others of a similar character, we might hope in time to have a class of working dyers proud of their art, skilful in the practice of it, and able to compete with the dyers of any other nation.

My best thanks are due to several woollen manufacturers and dyers in West Yorkshire who have given me the privilege of visiting their dye-houses, and have explained their processes to me. I have no permission, however, to mention their names.

It was stated on Monday from Paris that the work of sounding for the projected Channel tunnel is advancing rapidly. On the 1st of September the depth of the shaft at Sangatte reached 107 metres; on the 1st inst. it had increased to 119, and on the 9th inst. to 122 metres. The boring of this shaft, which is to be sunk to a depth of 130 metres, will probably be completed towards the end of the present month. The soundings of the Strait were taken some time back. The result of these operations appears—the telegram says—entirely to confirm the expectations of the geologists.

MISCELLANEOUS.

THE LOAN COLLECTION OF SCIENTIFIC INSTRUMENTS.

Lighthouses and Lighthouse Apparatus.

By J. N. Douglass.

The subject of lighthouses is one of particular interest in this great maritime country, for to every part of the globe where civilisation and commerce have spread has the advance been marked and facilitated by coast lights.

The class of lighthouses which are the subject of this paper are those erected upon tidal rocks, at some distance from the coast, and thus exposed to the full fury of wind and waves. The first of these lighthouses erected in this country was that upon the far-famed Eddystone, by Winstanley, in 1696. This was a timber structure, ill adapted to resist the heavy seas to which it was exposed, for, during a furious storm in November, 1703, it was completely swept away, together with its builder, who had gone off to effect some necessary repairs. The second lighthouse, designed and erected by John Rudyard, was a combination of wood and stone, and a considerable improvement, as regards form and stability, over its predecessor. This work was commenced in 1706, and was first lighted on the 28th July, 1708. It successfully resisted the heavy seas to which it was exposed for forty-seven years, when, about two o'clock on the morning of the 2nd December, 1755, the lightkeeper on duty, going into the lantern to snuff the candles, found it full of smoke. The lighthouse was on fire, and in a few minutes the fabric was in a blaze; fortunately, the lightkeepers were rescued, but Rudyard's lighthouse was completely destroyed. The third and present lighthouse on the Eddystone is the noble work of that eminent father of civil engineers, John Smeaton, who gave the subject the most careful investigation. Smeaton carefully examined the plans and models of the two former lighthouses, by which he sought to ascertain their defects, with a view to their avoidance in the intended new structure. In the course of the inquiry he became convinced that a great defect in the late building had been its want of weight, through which it had rocked about in heavy storms, so that it would probably have been washed away before long if it had not been burnt; and he came to the conclusion that, if the lighthouse was to be contrived so as not to give way to the sea, it should then be made so strong that the sea must be compelled to give way to the building. He also had regard to durability as an important point in its re-erection. To quote his own words:—"In contemplating the use and benefit of such a structure as this, my ideas of what its duration and continued existence ought to be were not confined within the boundary of one age or two, but extended themselves to look towards a possible perpetuity." Smeaton had thus arrived at the firm conviction that the new lighthouse must be of stone, and, with regard to form, the idea of the trunk of a large spreading oak tree suggested itself to his mind as the natural model of a column presenting possibly the greatest stability. Another point, which he long and carefully studied, was the best mode of binding and dovetailing the blocks of stone to the rock and to each other, in such a way that not only every individual piece, but the whole fabric, should be rendered proof against the external forces to which it must be subjected. Smeaton commenced his work in the spring of 1756, and on the 16th October, 1759, the light was first exhibited, and the column still stands, after nearly a century and a quarter, a lasting monument to its architect and builder. The illuminating apparatus of Smeaton consisted, as did its predecessors, of tallow candles, weighing two-fifths of a pound each; these were mounted on a chandelier, with no optical agent for directing their light to the sea surface; consequently, only a small portion of the available

light was utilised for the benefit of the mariner, the remainder being wasted upon the sky and the roof of the lantern. This is not surprising when it is remembered that at that date nearly all our coast lights consisted of coal fires, and the science of lighthouse illumination was just dawning. From experiments I have made with tallow candles of the dimensions of those used at the Eddystone, I find that their illuminating power was about two and four-fifths standard sperm candles, or English units of light; this would give, as the aggregate power of the beam from the 24 candles, 67 standard candles or units. The consumption of tallow I find to have been about three and three-eights lbs. per hour. At the Trinity House may be seen a reflector which was one of the earliest used in lighthouses. It was invented by William Hutchinson, and was first used at Liverpool about 1763, and afterwards at Lowestoft and other lighthouses on the English coast. The surface of the reflector is approximately paraboloidal in form, and is covered with small facets of silvered glass. The reflector is furnished with a rude oil lamp, having a flat wick about one and one-eighth inch wide. I have measured the maximum intensity of the beam of light emitted by this reflector, and find it to be about 81 standard candles; probably when the reflector was new the intensity might have reached 100 candles, or about 36 times the intensity of the flame.

In the year 1810, the Trinity House substituted twenty-four sperm oil lamps and paraboloidal reflectors of silvered copper for the candle-light at the Eddystone. The reflectors were constructed from a formula proposed by Captain Joseph Huddart, F.R.S., an Elder Brother of the Trinity House. They are still used in some of our lighthouses, and are known as Huddart's reflectors. By this improvement the intensity of the light at the Eddystone was raised to about 1,125 standard candles, or about $16\frac{3}{4}$ times that of the candle light. In 1845, the Trinity-house further improved this light, installing a second order dioptric apparatus of the system of Fresnel, thus increasing the intensity of the beam to about 3,216 standard candles; and in 1872, an improved lamp of larger dimensions was introduced, thus increasing the intensity of the light to about 7,325 standard candles, or about 109 times the power of the original candle-light. This large increase in power, due to the aid of scientific instruments, is obtained at about one-third the former annual cost for candles. Smeaton's success with the Eddystone led to the erection of several similar works on the coast, by the Trinity House and Commissioners of Northern Lighthouses; among the earliest of these may be mentioned the Bell Rock and Skerryvone, designed and erected by the Stephensons, father and sons, who have done so much for lighthouse illumination; and among the most recent and difficult are the Bishop and Wolf, off the west coast of England, and Du-Heartach off the north-west coast of Scotland.

The Great and Little Basses reefs, the lighthouse for the last of which was shown at South Kensington, are situated off the south-east coast of Ceylon. These are respectively about 80 and 100 miles eastward of Point de Galle, and about 7 miles from land. The Great Basses rock is about 220 feet long, 75 feet wide, and about 6 feet above ocean sea level; the rise of tide averages 2 to 3 feet. The Little Basses reef is only awash at low water. Both reefs are composed of a hard red sandstone, and the surface is very rugged. These reefs are exposed to both the north-east and south-west monsoons, consequently the days available for working on them during a year are but very few. If they had been situated about 50 miles nearer to or farther from Galle, the number of days on which a landing could have been effected would probably have been doubled. The only suitable season for working is during the north-east monsoon, which commences in November and terminates in April, and the best months of the monsoon are the first and two last. During part of December, the whole of January, and part of February, the wind blows strongly from north-east, especially about 2 p.m., when a short quick sea, on reaching the shallow water near the surf, breaks heavily on it, rendering it dangerous to approach in a boat. During November, March, and April the wind is variable; light breezes prevail frequently off the shore in the morning and on the shore in the evening, with a calm at mid-day. The current sets westward during the north-east monsoon, and westward during the south-west monsoon; the rate is very irregular, sometimes varying from half a knot to four knots per hour during the same day. The usual direction of the current is parallel with the coast. Towards the close of the monsoon the current is weak, and occasionally flows freely in opposite directions during the same day. It attains its highest velocity to the westward in December, January, and the early part of February. The coast for many miles on both sides of the Basses is almost continually exposed to a heavy surf from south or south-west. It is very thinly populated, and is without secure shelter for shipping. It was therefore necessary to establish at Galle the depôt from which the operations at the Basses were carried out.

The rapid increase in the shipping trade passing this portion of the coast of Ceylon, and the number of wrecks occuring, have for many years rendered necessary the lighting of these dangers to navigation. In 1855, the late Mr. Alexander Gordon, C.E., was instructed by the Board of Trade to propose plans and estimates for a lighthouse for the Great Basses. The design submitted by him was approved. It consisted of a cylindrical tower of cast-iron, supported within an enlarged base of granite. The illuminating apparatus consisted of eighteen paraboloidal reflectors, twenty-one inches diameter, arranged in six groups of three each, thus giving six beams of light to the circle for a revolving light, the intensity of each beam being about 3,375 standard candles. The estimate for the work was £33,946. Early in 1856 operations were commenced in Ceylon. In the meantime the lighthouse and its illuminating apparatus were prepared in England and despatched to Galle. After three years only a few landings on the rock had been effected and nothing had been accomplished beyond the erection of a beacon mast, and the marking out of the site of the proposed lighthouse. It was found, in fact, that the difficulties to be encountered had not been fully appreciated before the work was commenced, and consequently the arrangements for meeting them proved insufficient. About £40,000 had been expended, and it was estimated that £20,000 per annum, for five years, would be required to complete the lighthouse. The authorities, unwilling to incur so large an expenditure, upon what seemed, from past experience, a doubtful chance of success, suffered the work to lie in abeyance.

In the year 1863 a light-vessel was moored off the Little Basses, from which a white revolving light has since been exhibited.

Various schemes were subsequently submitted to the Board of Trade for the erection of a lighthouse on the Great Basses, and in 1867 the whole question as to practicability, probable cost, and reasonable chance of success, together with the various proposals for its construction, was referred to the Elder Brethren of the Trinity House, which resulted in the adoption of the design submitted by me, as their engineer. This design was for a granite structure, in which the granite base of the Gordon Lighthouse, the only portion of the original work which could be made available, was proposed to be utilised. The scheme further included a lantern and dioptric revolving light of the first order, also a light-vessel to be moored off the rock, for exhibiting a red revolving light regularly every night from the commencement to the completion of the work, and to serve as a barrack for the executive engineer and working staff. The total estimated cost of the work was £64,661.

Mr. William Douglass, C.E., who had erected the Hanois and Wolf-rock lighthouses in this country, was selected by the Trinity House as executive engineer for the work. The lighthouse consists of a cylindrical base of granite, 32 feet diameter and 30 feet high. On this is a tower, 23 feet in diameter at the base, and 67 feet 5 inches high. The thickness of the wall at the base is 5 feet, and at the top 2 feet. The accommodation for the lightkeepers consists of six rooms, 13 feet diameter, and one at the base for water and coals, 12 feet diameter. The lighthouse contains about 2,768 tons of granite. The stones forming the walls and floors of the tower are dovetailed together, both horizontally and vertically, on an improved system devised by Mr. Nicholas Douglass, and first adopted at the Hanois-rock Lighthouse, Guernsey, in 1859. On the upper bed and on one end-joint of each stone, is a raised dovetailed band, and on the under bed and at the other end-joint is a corresponding dovetailed indentation. The indentation is made just large enough for the projection to enter it freely, with a coating of Portland cement. When the latter has hardened, the blocks cannot be separated without breaking the solid stone. The whole tower is thus rendered literally one solid mass of granite. The step-ladders for ascending from floor to floor are of cast-iron. The entrance-door and storm-shutters to the windows are of gun metal. The use of wood has been avoided in the internal fittings as far as practicable, so that the building is completely fireproof. The lantern is cylindrical, 14 feet in diameter, of the Trinity House pattern. The one for the Little Basses Lighthouse was to be seen in the Loan Exhibition, and was lighted there at evening. The cylindrical lantern has the following important advantages over previous forms of lanterns with facets of flat glass. 1st, it is more perfect optically, the light from the central apparatus always falling nearly normally upon the surface of the glazing, and thus avoiding surface reflections, which not only involve loss of light, but are often mischievous; 2nd, less resistance is offered to storms; 3rd, the curved glass has been found by experiment to be 58 per cent. stronger for resisting external pressure than flat glass; and 4th, the helically curved framing has a maximum rigidity for the support of the glass, and offers a minimum obstruction to the light emitted by the illuminating apparatus. To that eminent man of science, Faraday, who was for many years the scientific adviser of the Trinity House, is due the perfection of the ventilation of these lanterns. The requirements are a perfectly uniform, and plentiful supply of air to the large central lamp, and the prevention of condensed vapour upon the internal surface of the glazing. To meet these requirements the external air is admitted at the ventilating windows of the service room under the lantern, then it ascends into the latter through an iron grating which surrounds the lantern floor, and upwards over the surface of the glazing, through an aperture surrounding the ceiling, to a space between the latter and the roof, and thence through the shaft, from whence it is discharged by the revolving cowl, the ascending current being invigorated by the heat of the funnel of the large central lamp. Hit or miss ventilating valves are placed round the pedestal, for admitting an additional supply of air in very calm weather. The large lamp is provided with a chimney, which delivers the products of combustion into the shaft of the cowl; this chimney is provided with a regulating damper, and one of Faraday's cones for dispersing any down draught that may possibly occur, and would otherwise impair the steady burning of the lamp. The dioptric apparatus is octagonal, having 8 panels of refractors, with panels of totally reflecting prisms, above and below them. Flashes of red light are emitted from the apparatus at intervals of 45 seconds, the duration of each flash being about 7 seconds, and that of each eclipse about 38 seconds. The light is coloured by a chimney of ruby glass on the large central lamp. The intensity of the flashes from this apparatus, with the improved lamp of the first order of the Trinity House, having 6 wicks, if white light is about 125,977 candles, or about 37 times the intensity of the catoptric light originally proposed, but in colouring about 70 per cent. of the power is lost; the intensity of the red flashes is thus about 37,793 candles. Adverting to these improved lamps, although at the Great Basses it is consuming the local cocoa-nut oil, which is found to be nearly equal in illuminating power to the best colza or mineral oil, the lamp is capable, with a very simple adjustment, of burning efficiently all the oils used as lighthouse illuminants, whether animal, vegetable, or mineral. Improvements lately made with this lamp have increased the illuminating power 22 per cent., at the same time the consumption of oil has been reduced 17 per cent. Within the last five years the power of the first order Trinity House lamp has been raised from 280 to 722 standard candles. By a simple device the lamp is made to burn at half or full power without any alteration in the form or dimensions of the flame, but with a corresponding consumption of oil and intensity of light; the half power is adopted when the atmosphere is perfectly clear, and the full power whenever the transparency of the atmosphere is impaired by mist, rain, snow, or fog. It is found that with this system, and given a certain quantity of oil to be consumed annually, about 64 per cent. more light is available for the mariner when the transparency of the atmosphere is impaired than if the lamp were burned regularly at a uniform power.

A fog bell, weighing seven cwt., for a signal during foggy weather, is fixed on the outside of the tower, and sounded by machinery fixed in the lantern.

At the erection of the Eddystone lighthouse, small sailing vessels were used by Smeaton to convey the material from the workyard to the rock, a distance of fourteen miles, and land it thereat; and in the case of recent structures, the material has been conveyed in barges towed by a steam tug. It is evident, however, that with works like the Basses, at distances of 80 and 100 miles from the workyard, such methods of transport would be neither certain nor safe. Two iron twin-screw steamers were designed and constructed for the purpose, each capable of carrying 120 tons of cargo. For the purpose of landing and hoisting the material of the lighthouse rapidly at the rock with a minimum number of workmen, the steamers were each fitted with two steam winches, by which the blocks of stone were hoisted on board, stowed away, hoisted again to the deck, and from thence to the rock.

On the 27th of February, 1870, the first of the steam vessels, the *Arrow*, arrived at Galle, *via* the Suez Canal, and on the 7th March following the first landing was effected on the Great Basses. On the 17th of the same month the light-vessel arrived at Galle from London, *via* the Cape, and on the 30th she was moored off the Great Basses, and at sunset the light was exhibited. The workmen were now quartered on board the light-vessel, and the *Arrow* was available for obtaining supplies from Galle without delaying the work. The working season ended on the 3rd of May, when 36 landings had been effected, and 220 hours worked on the rock. In this time a dam had been built round the site for the tower, for the protection of the workmen, the foundation pit had been nearly completed, and part of the landing platform had been built with the stone excavated.

On the 19th October, 1870, the second steamer, the *Hercules*, arrived at Galle from London to co-operate with the *Arrow* in conveying material from Galle to the rock. The first landing for the season was effected on the 28th November, and the last on the 28th of the following April; 84 landings were effected, and 651 hours worked. The first stone was laid on the 28th December, after which both vessels were used alternately in conveying the material from Galle to the rock. During the monsoon the foundation pit had been completed and the work raised to the 21st course.

For landing the stones at the rock a strong mast,

forty-five feet long, was stepped into the rock and further supported by chain guys; from the mast was suspended a strong derrick, which was traversed towards the tower by a winch and chain guy. The steamer was moored with one anchor ahead, and a warp to the mooring for veering into position. Two large coir hawsers were abreast to the mooring buoys, and two to the rock. The holds of the steamers were fitted with two tiers of rollers, on which the stones were placed; they were brought speedily under the hatchway, when an iron cage, working in slides, was fitted for conveying them to the level of the deck. One barrel of the forward steam winch lifted the stone to the deck, and deposited it on rollers in readiness to go out of the gangway. The shore purchase consisted of three parts of half inch chain, one end of which was attached to a barrel of the aft winch; from thence it passed through a leading block at the gangway, thence through another leading block at the foot of the shore derrick, thence through another block at the head of the derrick, thence through a block attached to the stone to be landed, and thence to the head of the derrick, where the end was made fast. A strong chain was also attached to the stone and No. 2 barrel of the forward winch, on which was a powerful brake. To land a stone the aft steam winch was put in motion, and as the stone went over the side the guy chain was eased away until the stone entered the water; it was then gradually checked and "paid" away at about the same speed as the aft winch worked the stone ashore. When the stone reached the rock and was high enough, the derrick was swung towards the tower by means of the small winch on shore, and the stone lowered. This is the first known instance of a vessel landing heavy material in a seaway by her own steam power, excepting where the load could be deposited by her own derrick. Although necessary, owing to the shallow water, to moor the steamers at a distance of 30 fathoms from the rock, stones, weighing on an average 2½ tons, were hoisted out of the hold, landed, and deposited 28 feet above the surface of the rock, at the rate of 10 per hour. As soon as the cylindrical base of the building was completed, a steam winch was fixed upon the rock for hoisting the stones to the top of the work.

On the 16th November the first landing of the third season was effected; the last was effected on the 2nd of the following May. During the season 74 landings were effected, and 679 hours worked. The number of working days of 10 hours from the first landing on the rock to the end of this season was 153 days 3 hours, and from laying the first stone of the tower to setting the last stone only 110 days. The light was exhibited on the 10th March, 1873, and has been continued with regularity every night from sunset to sunrise. There are two European and four native light-keepers attached to the lighthouse, who are relieved monthly, or as near it as practicable. One European and three native keepers are always at the lighthouse, while one European and one native are on leave.

This important work has been executed in a tropical climate, at a distance of nearly 7,000 miles from this country, by a small band of trained Europeans, aided by natives, and under exceptional difficulties, without loss of life or limb to any person employed. The total cost of the work, including all incidental expenses, was about £62,000, being within the estimate for the work. It might fairly be assumed that such a work as that now on the Great Basses, fitted with all the modern improvements in engineering and optical science, would have proved exceptionally costly compared with similar works in this country, but such is not the case. When it is stated that per cubic foot the work has been executed at less than half the cost of the Eddystone, I think that no better proof could be afforded of the advantages now derived by a judicious application of scientific improvements to constructive works.

The success which attended the execution of this work encouraged the Board of Trade to order the erection of a similar lighthouse on the Little Basses. This work is of even greater difficulty than that at the Great Basses, the reef being 20 miles further from Galle, and awash at low water. Mr. William Douglass, who erected the Great Basses Lighthouse, has been entrusted by the Trinity House with the work, which was commenced in November, 1873. On the 28th February last, the first stone of the lighthouse was laid; the solid portion of the tower is now completed, and it is expected that the light will be exhibited in another year. The tower is of Dalbeattie granite. It has, like that for the Great Basses, been prepared and fitted together in this country and delivered at Galle. The tower is 33 feet 3 inches in diameter at the base, and 16 feet 6 inches in diameter at the top under the gallery. The shaft is a concave elliptic frustrum, the generating curve of which has a major axis of 148·6 feet and a minor axis of 28 feet. It contains about 1,720 tons of granite. The internal arrangements and fittings are very similar to those in the Great Basses.

With two rock lighthouses so near each other, it was not only necessary that there should be a clear and unmistakable distinction between the two lights, but also that the two lighthouses should be quite distinctive by day. To effect this, the lantern of the Little Basses was provided with a domed roof, the roof of the Little Basses being conical; and further, the Little Basses has a second gallery 10 feet below the lantern gallery.

A light of a novel and very distinctive character has been adopted for this lighthouse. It belongs to a class of lights called "group flashing," which have for some time received the attention of the Trinity House. The system consists in giving two or more flashes in quick succession at intervals of (say) quarter, half, or one minute intervals, instead of a single flash at the same intervals. The first light established on this system was a floating catoptric light at the Royal Sovereign Shoal, near Beachy Head. This light gives three flashes in quick succession at intervals of one minute; and it has been found to be very distinctive and efficient. The first order dioptric light for the Little Basses has been designed by Dr. Hopkinson, and manufactured by Messrs. Chance Bros. and Co. It is intended to give two flashes in quick succession at intervals of one minute. This is accomplished by cutting away a portion from the opposite side of each pair of lenses, so as to bring their axes closer together, and to the required angle in azimuth for the short eclipse between the flashes. The maximum intensity of this light with a six-wick improved lamp in focus, is about 88,900 candles, being about 1,234 times the intensity of the beam originally emitted from the Eddystone. There is at the Trinity House one of the first lenses used in an English lighthouse, this was at the Portland Lower Light in 1786, being 33 years before the invention by that eminent Frenchman, Augustin Fresnel, of his lenticular lighthouse system. In 1836, at the Start Point Lighthouse, on the coast of South Devon, the Trinity House installed the first dioptric apparatus on Fresnel's system in an English lighthouse. One of these lenses was in the Exhibition. There were eight lenses to the circle, with fixed silvered mirrors above them. The intensity of the flashes of this light, with its concentric four-wick lamp, was about 49,392 candles. This apparatus was manufactured by Messrs. Cookson and Co., of Newcastle-on-Tyne. It is exceedingly interesting and instructive to compare the imperfect material and workmanship of these instruments with the excellent apparatus now manufactured. The illuminating apparatus at the Start Lighthouse, and that of the South Stack Lighthouse, near Holyhead, have lately been replaced by dioptric apparatus, having six lenses to the circle; these apparatus have been manufactured by Messrs. Chance Bros. and Co. The intensity of their flashes, with their six wick-lamp in focus, is about 169,360 candles, or about twice the power of the light

for the Little Basses. These two lights are at present the most powerful oil lights in the world.

Before concluding, it may be well to make a few remarks on the two other sources of lighthouse illumination adopted, viz., coal gas and the electric light. The latter we owe to the discovery of Faraday, and the ingenuity and inventive genius of Holmes. Neither of these illuminants is applicable to the class of lighthouses which are the subjects of our paper, owing to the want of space for the requisite apparatus and fuel. Both systems are, however, on their trial in this country, and at present their extra cost appears to be the only barrier to their more general adoption for shore stations.

At the Haisboro' lighthouses, on the coast of Norfolk, coal gas on the system of Mr. Wigham, of Dublin, has been under trial about four years, with satisfactory results. Several of these lights have been established on the coast of Ireland by the Commissioners of Irish Lights.

The electric light has been under trial in this country nearly 18 years. It was first tried at the South Foreland Lighthouse in 1858. There are now two electric fixed lights at the South Foreland, and an electric revolving light has been exhibited at the Souter Point Lighthouse, on the coast of Durham, for the last five and a half years. The flash of this light has an intensity of about 392,000 candles, or about two and a quarter times the intensity of the oil lamps at the Start and South Stack. With the improved electric machines of Gramme or Siemens, which were to be seen at the Loan Exhibition, this enormous intensity of light would probably be increased five to six times; indeed, there appears to be no practical limit to the power available for the service of the mariner by this marvellous source of illumination.

Unfortunately, such fogs occasionally occur as to eclipse even the sun; consequently the most powerful artificial light must be unable to cope with them. Recent investigations of the Trinity House, aided by their scientific adviser, Dr. Tyndall, whose researches on fog are so well known, are leading to the development of powerful sound signals as aids to the mariner at such times as light is no longer serviceable. Some of these instruments were shown by the Trinity House, in the Lighthouse Section of the Loan Exhibition.

GENERAL NOTES.

The Laws of Health.—The Council of the Trades' Guild of Learning, in conjunction with the Committee of the National Health Society, have organised a course of twenty lectures on the Laws of Health, which will be delivered by Professessor W. H. Corfield, in he large room of the Society by permission of the Council. The plan pursued will be the same as that adopted at Birmingham by Dr. Corfield, the charge for admission being merely nominal, and the lectures being supplemented by examination papers, to which answers are requested. The lectures are intended for the industrial classes, their object being to diffuse among the working people of London a better knowledge of the fundamental laws of health. The subject is divided into two parts, "Anatomy and Physiology," and "Hygiene Proper." For further information application should be made to the Secretary of the National Health Society, 44, Berners-street, or the Secretary of the Trades' Guild of Learning, 13, Beaufort-buildings, Strand

Telegraphs in America.—The Asiatic Telegraph Company, chartered by Congress, propose to complete the last link in telegraph communication round the world by laying a submarine cable in the Pacific Ocean to communicate with Asiatic and American lines. The company is required to begin to lay the line within three years from August 15, 1876. The terms of the Act, the written acceptance of which has already been filed with the Secretary of State at Washington, exact equal privileges with foreign Governments and citizens,

Block Telegraphs for Single Lines of Railway.—The want of an indicator in connection with the block instruments of single lines has been long felt, such as would enable the signalman to see at once the correct position of the train, either on the section or clear of it. To meet this requirement, the following apparatus has been devised by Mr. Harper. There is a locking plate on the front of the block instrument, which alternately locks one or the other of the plungers for raising or lowering the miniature semaphore arms on the dial face of the instrument; under the locking plate is fitted a screen piece with the words "Train on line" engraved on it, which is brought in and out of action as follows:—For giving permission for a train to approach, the locking plate must be raised before the bottom plunger can be depressed; this plate, by a stud connection, raises the screen piece also, but upon restoring the locking plate back to its normal position, the screen piece is left behind, showing the words "Train on line" while the train is approaching. Upon the arrival of the train, the screen piece is turned by the signalman behind the locking plate by a button, the screen at the same time uncovering a fixed engraved face with the words "Train clear." By this means the signalman is always able at a glance to ascertain the state of the section of line he has to deal with. The instruments by another arrangement are also interlocked with each other, so that in the event of permission being obtained for a train, it cannot be given for a meeting train, showing that such collisions as that at Radstock are easily preventable. In connection with the block telegraphs mentioned, is an apparatus for controlling the position of the out-door semaphore. A compound lever, actuated by an electro-magnet, serves to connect or disconnect the hand lever of the out-door signal, so that in the event of the block instruments being at the position of danger, the hand lever has no control over the semaphore. Should the block instrument and the semaphore be at clear, and the hand lever have control of the semaphore, the signalman at the distant station would place the semaphore to danger by merely pressing the plunger of the "Train on line" portion of the instrument.

Tonnage of Railways in the United States.—The tonnage of all the railroads in the United States for the past year is given as 200,000,000 tons, having increased forty-fold in the past twenty-five years. At 50 dols. per ton the value would be 10,000,000,000 dols. The canals of the country transported not less than 10,000,000 tons, worth 500,000,000 dols. The tonnage of vessels employed in the domestic trade of the United States is 4,000,000 tons. The tonnage moved in this way may be estimated at 15,000,000 tons per annum, worth 750,000,000 dols. This gives a grand total of 11,250,000,000 dols. per annum as the volume of the internal commerce of the United States.

NOTICES.

MEETINGS FOR THE ENSUING WEEK.

Mon. ...Farmers' Club, Caledonian Hotel, Adelphi, W.C., 5½ p m, Mr. R. Masfen, "Fashion in Breeding."
Society of Engineers, 6, Westminster-chambers, 7½ p.m. Mr. Charles E. Hall, "The Conversion of Peat into Fuel and Charcoal."
British Architects, 9, Conduit-street, W., 8 p.m.
Medical, 11, Chandos-street, W., 8 30 p m. General Meeting

Tues....Women's Education Union (at the House of the Society of Arts), 8 p.m.

Wed. ...Society for the Development of the Science of Education (at the House of the Society of Arts). 8 p.m. Rev. Barham Zincke will deliver the opening Presidential Address.
Geological, Burlington House, W., 8 p.m.

Thur....South London Photographic (at the House of the Society of Arts), 8 p.m.
Royal Historical, 11, Chandos-street, W., 8 p.m. Annual Meeting. 1. Mr. Hyde Clarke, "The Destruction of the Empire of the Khita." 2. Mr. George Harris, "Domestic Everyday Life and Manners and Customs in this Country, from the earliest period to the end of the last century." (Part II.)

Fri.......Quekett Club, University College, W.C., 8 p.m.

Sat.......National Health Society (at the House of the Society of Arts), 8 p.m. Prof. W. H. Corfield, "The Laws of Health." Introductory.

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FRIDAY, NOVEMBER 10, 1876.

All communications for the Society should be addressed to the Secretary, John-street, Adelphi, London, W.C.

PROCEEDINGS OF THE SOCIETY.

NOTICE TO MEMBERS.

The 123rd session of the Society will commence on Wednesday, November 15th, when the opening address will be delivered by Lord ALFRED S. CHURCHILL, Chairman of the Council.

Candidates proposed for election as members are privileged to attend on this occasion.

Evening Meetings of the Society will be held on the following dates, subject to any alterations which may be found necessary :—

The Annual General Meeting will be held on June 27th, 1877, at four o'clock.

ORDINARY MEETINGS.

The following arrangements for the Wednesday evenings before Christmas have been made :—

NOVEMBER 15.—Opening Address, by Lord ALFRED S. CHURCHILL, Chairman of the Council. Presentation of Medals and Prizes awarded, Session 1875-6.

NOVEMBER 22.—"Collapsible Boats; their Peculiarities and Advantages," by the Rev. E. L. BERTHON. On this evening Lord ALFRED CHURCHILL will preside.

NOVEMBER 29.—"The Construction of House Drains," by Major-General F. C. COTTON, C.S.I.

DECEMBER 6.—"Street Tramways," by Captain DOUGLAS GALTON, R.E., C.B., F.R.S.

DECEMBER 13.—"A New Process of Printing a Number of Colours at One Impression," by E. MEYERSTEIN, Esq.

DECEMBER 20.—"The Philadelphia Exhibition," by Professor ARCHER.

CANTOR LECTURES.

Courses of Cantor Lectures will be given on Monday evenings at eight o'clock, and the First Course will be on "The History of the Art of Coach Building," by GEORGE A. THRUPP, Esq., as follows :—

	CANTOR LECTURES.	AFRICAN MEETINGS.	ORDINARY MEETINGS.	CHEMICAL MEETINGS.	INDIAN MEETINGS.
	Mondays.	Tuesdays.	Wednesdays.	Thursdays.	Fridays.
1876.					
NOVEMBER	— — 20 27	— — — —	— — 15 22 29	— — — —	— — — —
DECEMBER	4 11 18 —	— — — —	— 6 13 20 —	— — — —	— — — —
1877.					
JANUARY	— — — —	— — 23 —	— — 17 24 31	— — — —	— — — —
FEBRUARY	— — — —	— 13 — —	— 7 14 21 28	8 — 22 —	2 — 16 —
MARCH	5 12 19 26	— 13 — —	— 7 14 21 —	8 — — —	2 — 16 —
APRIL	— 16 23 30	10 — 24 —	— 4 11 18 25	— 12 — 26	— — 20 —
MAY	7 14 — —	8 — — —	2 9 16 23 30	— 10 — —	4 — — —

THE CHAIR WILL BE TAKEN AT EIGHT O'CLOCK AT EACH OF THE ABOVE MEETINGS.

LECTURE I.—NOVEMBER 20.

Carriages of the ancient world; Egypt, Syria, Greece, and Rome, and native carriages of Hindustan.

LECTURE II.—NOVEMBER 27.

Carriages of the Middle Ages, and introduction of coaches into England, France, Italy, and Germany. State coaches of the time of Louis XV.

LECTURE III.—DECEMBER 4.

Carriages from 1770 to the present time.

LECTURE IV.—DECEMBER 11.

Ancient and modern travelling, and public carriages of Europe.

LECTURE V.—DECEMBER 18.

Rules of coach building and theories applicable to the carriages of the future.

The Second Course will be on "The Chemistry of Gas Manufacture," by A. VERNON HARCOURT, Esq., F.R.S., and the Third Course on "The Connection of Greek and Roman Art with the Teaching of the Classics," by SIDNEY COLVIN, Esq., M.A., Slade Professor of Fine Art at the University of Cambridge.

The First and Second Courses have been arranged with special reference to the Society's Technological Examinations.

AFRICAN SECTION.

Meetings of this Section will be held on Tuesday evenings at eight o'clock.

CHEMICAL SECTION.

Meetings of this Section will be held on Thursday evenings at eight o'clock.

INDIAN SECTION.

Meetings of this Section will be held on Friday evenings at eight o'clock.

Papers to be read in the above Sections, will be announced in the *Journal*.

Juvenile Lectures.

This Course will consist of Two Lectures, by R. A. Proctor, Esq., F.R.A.S.

Lecture I.—January 3rd.

"The Sun and his Family."

Lecture II.—January 10th.

"Comets, Meteors, and the Stars."

Special tickets will be issued for these lectures.

Admission to Meetings.

Members have the right of attending the above meetings and lectures. They require no tickets (except for the Juvenile Lectures), but are admitted on signing their names. Every Member can admit *two* friends to the Ordinary and Sectional Meetings, and *one* friend to the Cantor Lectures. Books of tickets for the purpose are now in course of issue to the Members, but admission can also be obtained on the personal introduction of a Member.

SPECIAL GENERAL MEETING.

The Council hereby give notice that on the conclusion of the first Ordinary meeting of the session, to be held Wednesday, November 15th, the meeting will be made special, when a resolution approving the proceedings of the Council, in electing their Majesties the King of the Belgians and the King of Sweden Royal Honorary Members of the Society, will be proposed for adoption by the meeting.

By Order,

P. Le Neve Foster, Secretary.

7th November, 1876.

MISCELLANEOUS.

MEETING OF SANITARY ENGINEERS AT KIDDERMINSTER.

The Association of Municipal and Sanitary Engineers and Surveyors held a meeting at Kidderminster on November 3. **Mr. J. Leman** (Southampton) presided. Mr. Pritchard (Warwick), hon. secretary for the Midland district, and others were present.

The President, in opening the proceedings, said of the districts into which the association was formed that one in the Midlands was the most important. The objects of the association were to promote an interchange of that species of knowledge and practice falling within the department of sanitary engineers and surveyors.

Mr. Comber, borough surveyor at Kidderminster, read a paper descriptive of the sanitary works at Kidderminster which were carried out by Mr. Fairbank, of London. The area drained was 1,100 acres, and the population contributing sewage 20,000. The whole of the surface water was conveyed into the sewers through cast-iron gullies, all of which were trapped. The ventilation was effected by means of open gratings in the centre of the streets. These originally had boxes filled with charcoal placed in the shafts, and so long as these existed great complaints were made of the smells arising from the drains. The whole were removed, and the working of the ventilation was now satisfactory. The flushing was effected by means of hose from the water mains, but he had, during the last three months, constructed a self-acting flushing apparatus, which discharged a sudden flush of from 50 to 100 gallons of water twice in twenty-four hours, or oftener if required. These he proposed to place at the dead ends of all branch sewers. The sewage was collected into two tanks, each 100ft. by 27ft., and each containing about 130,000 gallons. These were provided with straining gates, to intercept yarn waste and other extraneous matter likely to choke the pumps. After flowing through these tanks the sewage entered the engine wells, from whence it was pumped through an 18in. main to a height of 98ft. on to the sewage farm, four miles distant. The ordinary dry weather flow of sewage was about 1,120,000 gallons in twenty-four hours, and in wet weather about 1,900,000 gallons. In heavy thunderstorms it was sometimes as much as 600,000 gallons per hour. Each engine was capable of raising 1,400,000 gallons in twenty-four hours. The storm pumps were capable of raising 5,000 gallons per minute each. The detritus and sludge which precipitated in the tanks had to be removed by manual labour, and this cost about £80 per year. It was sold to the neighbouring farmers at 1s. per cart-load. The cost of pumping, cleansing, and maintaining sewers was about £700 per annum. The sewage farm was at Stourport, and comprised 172 acres. The soil was a light sand, five to six feet deep, on a bed of gravel. The natural drainage through the gravel was so good that the effluent reached the main drain without difficulty, was conveyed into the river or canal at pleasure, and passed off perfectly colourless. The farm was originally carried on by the Corporation, but, finding it to be an annual loss, it was let, in October of last year, for fourteen years, at £3 per acre, or a total of £500; so that the actual cost of disposing of the sewage was £200 per year (this, of course was not taking into consideration interest on outlay). The total cost of the construction of the whole of the sewage work was £74,754, including £17,999 for purchase and laying out of sewage farm. The waterworks were constructed about the same time as the sewerage works. The well would yield about 1 million gallons in twenty-four hours, and the present consumption was 250,000 gallons in that time; this was steadily increasing. The cost of constructing the works, including the laying of mains, was £24,765, making a total of £99,519 expended in sanitary works since 1869.

Mr. G. Cole gave a sketch of the sanitary arrangements of Hereford. That city and its suburbs contained a population of nearly 20,000, but there were not more than 10,000 or 12,000 within the district of the sewerage and water supply. The works were carried out under the direction of Mr. T. Curley, C.E., in 1854, but had been considerably extended since, under his (Mr. Cole's) direction. There was scarcely a house in the city which was not connected with the sewers, all had their water-closets, and nearly all were supplied with the sanitary syphon and trap system, with self-closing valves, and were supplied with water direct from the mains. The surface water was conveyed into the sewers, and when running full flushed them effectually after heavy storms. At other times they were flushed weekly by flush wells, at the end of every street. The sewers were all well ventilated by open gratings in the centre of the street, varying from 50 to 100 yards apart, and no complaints had ever been made of bad smells from these openings. The sewers were further ventilated by rain-water pipes when these were not near windows, and in some instances by special 6-inch pipes. The cesspools were for the most part filled up. It had often been his lot to find two or three at gentlemen's houses, and Mr. Cole commented on the danger arising when the imprisoned gases escaped into a house. All sewers and drains should be ventilated as much as possible, and no

drain in connection with a sewer should be allowed to enter a house without there being carried up from it a perfectly jointed ventilator. Water-closets should be made outside the external walls of a house, or at any rate adjoining them, so as to admit of free ventilation, not only from the closets themselves, but from the soil-pipes below the traps. The water-closets in many instances in Hereford were not properly ventilated, and Mr. Cole remarked that the better class of society ran more danger from this source than the poor. Earth closets had been used, but not found successful—it might be through mismanagement. The inspector had been compelled to report them as nuisances, and had caused them to be made into water-closets. The great drawback to the Hereford sewerage was that it was made to empty itself into the Wye, and polluted the stream for a considerable distance. The commercial value of sewage was, he thought, generally much over-estimated, but in an agricultural district, if anywhere, it ought to be utilised. The water supply of Hereford was pumped from the Wye, passed through filter beds, and delivered in the usual way. Mr. Cole commented on the waste of water which occurred, and the great unnecessary expense this entailed on the ratepayers. With the object of checking it at Hereford, he had recommended the Town Council to make the use of water meters compulsory as far as possible. Mr. Cole tested for a week the quantity of water passing through the meter at the waterworks in each of the four hours ending at four a.m., and the average was:—One o'clock, 19,805 gallons; two o'clock, 18,000; three o'clock, 17,571; four o'clock, 17,500. It was obvious that the legitimate use of water at these hours would be very small, and as he had no evidence as to material leakage from the pipes, he was bound to conclude a considerable number of taps were left open, and waste caused, from which no one derived benefit. Many persons thought they flushed their drains by so doing, but a drain could only be effectually flushed by pouring a quantity of water suddenly into it.

Mr. Lobley (Hanley) said it was a common notion that leaving the water taps running flushed the drains, but he quite concurred with Mr. Cole that it was perfectly valueless, and only caused waste of water. With regard to putting a water meter to every house or few houses, that would require great consideration. It would be very unsatisfactory to cause poor people to use as little water as possible. Waste of water could be checked by the system carried out by Mr. Deacon, at Liverpool. District meters were provided, which showed in what part waste was going on, and this being known, inspectors were able to trace it out and stop it. By this means the waste had been so checked in Liverpool, that under the constant service less water was now used than under the former intermittent system. He was surprised to hear that in a city like Hereford, surrounded by agricultural land, the sewage was not utilised.

Mr. Pritchard said that he was glad to find that at Kidderminster and Hereford the sewers were ventilated by open gratings in the streets, that being, he believed, the best mode of ventilating them. There seemed to be [illegible] in nearly every town of a waste of water. He [illegible] with the use of meters, but not in a way to prevent [illegible] having a proper supply of water. The quantity [illegible] used varied very greatly, ranging from fifty [illegible] per head per day down to seven and nine gallons. [illegible] the cost at 6d. per 1,000 gallons, great waste [illegible] great loss to the ratepayers.

Councillor Dixon said he was much interested in what Mr. Cole had said regarding the ventilation of drains. There was a great prejudice against the open gratings in the streets at Kidderminster, and he believed people went and put their noses over the gratings, and, if they detected a smell, made a great complaint about it. The great difficulty had been to prevent people stopping the gratings up, and nothing would convince them it would be detrimental to do so. He was glad that representative meeting confirmed the opinion he held as to the greatest possible ventilation of sewers.

The President said when he went to Southampton first he found all the ventilators of the sewers stopped up, and he had great difficulty in getting the prejudice on the point removed. Smells arose, not from the gratings, but rather from the want of them; and at Leeds 14,000 ventilators had been put into the sewers. It was better to have smells in the streets than in the houses. His experience of the waste of water agreed with that of other speakers, and he knew no better plan of detecting it than that of Mr. Deacon, of Liverpool. Local governing bodies ought not to neglect this question of reducing the waste of water. With regard to the value of sewage, the notion that money could be made by it was exploded. If they could even make a sewage farm pay its expenses they were doing a great deal.

Mr. Cole, in replying to criticisms upon his paper, supported his plea for the general use of water meters. Years ago the same objections were made to the general use of gas meters as were now made to water meters; but at the present time gas meters were used by all consumers. He hoped something would be done to teach people the value of water, and nothing would tend more to this than the adoption of the meter system.

The engineers then proceeded to inspect the sewage works, irrigation farm, and waterworks, which occupied them between two and three hours. On their return a discussion took place. The utility of the large covered receiving tanks was questioned, and an opinion expressed that the sewage should be pumped direct to the farm and dealt with. It was urged that decomposition was allowed to set in, and the sewage lost part of its fertilising value before being removed to the farm, and at the same time an intolerable nuisance was caused. Surprise was expressed that the midden system was allowed to exist in the town, now there was sewerage and a sewage farm; and also that so many of the inhabitants still took their water supply from old wells, and not from the mains.

VILLAGE COOKERY.

Mr. C. B. Clayton is a vigorous missionary on behalf of cookery, not merely on his own estate at Carrigbyrne, in Ireland—but at Cheltenham and other places in England, where he has lighted up a desire for instruction in the art. The *Wexford Independent* gives an account of the Irish School at Carrigbyrne, which shows the progress which has been made there in the teaching of cookery.

"The division of time in each week is admirable. Mondays and Thursdays, cooking; Tuesdays, washing; Wednesdays, baking; Fridays, ironing; Saturdays, cleaning up, and a half holiday. The individual girls learning during the week we have before us were 18, and these appear to have been divided over a pretty large district, for we see some from Clongeen and Templenacrow, some from Raheen, the majority, of course, being from Carrigbyrne. The first question invariably asked of us is—What is done with the provisions cooked? Well this is answered by the return also, for we see therein set down 50 free meals to the girls learning, we see other free meals to the poor and sickly of the surrounding district, and we see 32 paid for meals—20 of these being school boys, whose dinner only cost 2½d. each—for this they pay 1d. each. We see 10 parties who came from a distance for medical advice to the Carrigbyrne Dispensary, as having got 10 meals at a cost of 3s. 3d.; and we see some one or two gentlemen who were travelling and called in for their bowl of soup or omelette, which is served, done to a turn, by one of these neat handed little Philisses learning. We see some of the dishes are not at all expensive, but are just what poor people can have every day at home. We

have here Irish stews, stuffed hearts, sheep's-head soup, suet puddings, tripe, macaroni, vegetable soup, rice puddings, potato pies, cottage pies, small mutton pies made up of bits and scraps, &c. Now these are the very dishes which poor people can have, and should have. But we hear some one objecting that these dishes require seasoning, and everyone can't have their thyme and their onions, their parsnips and their carrots, their sage and their celery, their leek and their parsley. We answer that we believe everyone in the country can, and we know that every little girl attending this Industrial School, and every boy of competent age attending the National School there, has his or her little garden at home in which every one of these vegetables are cultivated. These cottage gardens were introduced there last season, and Mr. Brown Clayton now pays them an annual visit and awards them a number of prizes. We ask of others, would not a few shillings spent this way, and an annual visit of this kind, repay the expense and trouble a hundred-fold? But these are not the only dishes cooked, for we see veal pies, batter puddings, beefsteak pies, applo pies, sweet omelettes; and in the baking line we have drop cakes, luncheon cakes, sugar cakes, ginger cakes, sponge cakes, custard puddings, &c., so that their training is neglected in no department of the art of cooking. Thus these girls get a training which never leaves them in after life. Some of them may go as servants, but the majority of them will make the effects of their training felt in their own homes, and thus many a family will be benefited down to future generations, for we all know that good mothers make good daughters."

EDUCATION IN INDIA.

The report for the year 1874-75, upon the progress of India, states with regard to education, that in Bengal tho great majority of youths resort to two professions, the public service and the law, with the consequence that many cannot obtain employment, to their great discontent. With a view to open out other lines of employment, the Government is endeavouring to establish technical industrial schools of a superior kind in many places. Funds are being raised among the natives themselves for two such institutions, one at Calcutta, and one at or near Patna. The civil engineering branch at the Presidency College has not been very successful, but the School of Art at Calcutta is attracting pupils. Among the natives of Bengal, Sir R. Temple discerns a healthy ambition to raise themselves by education; an increasing pride finds expression among them in respect to the achievements of the Hindoo mind; in fact, there is "a sort of intellectual restlessness and mental fermentation" going on, which it is most important should be guided into a right direction. The number of young men who visit England to complete their education, or to study for a profession, is gradually increasing. Almost every Bengalee youth who can afford the means aspires to English education as one of the main objects of his life; and there is a desire for learning English even among tho poorer classes. One satisfactory result of the visit of the Prince of Wales has been that the wealthier natives of all classes are raising subscriptions to commemorate the event by founding educational institutions.

The schools in Madras, in connection with the Education Department, increased during the year by 936, and the number of scholars by 24,917. The number of lower schools was 8,306, showing an increase of 881, accompanied by an increased attendance of 22,106. In Bombay, the number of schools connected in any way with the Government, increased by 181, and the scholars by 10,125; the numbers being 4,334 and 238,686 respectively. Education made continued satisfactory progress in the Punjab. The number of institutions increased during the year by 100, and the scholars by 9,876. The development of education in the frontier district of Hazara has been very striking. In 1872 there were only three ill-attended schools in the district, and the authorities considered there was no desire for education, and that it would be long before anything like progress would be made. There are now about 25 schools, attended by 1,098 scholars, among whom are the sons of Atta Mohammed Khan and the other local chiefs, and some children from independent territory across the border. A similar change in the feelings of the people towards education is reported from the district of Peshawur. Notwithstanding the above encouraging features, the fact remains, that of children of a school-going age in the Punjab, about 70 per cent. are receiving no instruction. In the North-West Provinces the schools increased from 4,017 to 4,184, and scholars from 155,819 to 159,419.

The "hulkabundee," or schools of a lower class, increased by 161, and the pupils by 3,346. In Oude there was an increase of 47 Government schools, whilst private schools increased by two. There were 1,059 village schools, of which all except five were supported and managed by the State. In the northern Garo hills education is entirely conducted by the American missionaries. Of 20 village schools five were closed during the year, but the falling off will, it is hoped, be only temporary. The year in Ajmere was, on the whole, marked by satisfactory progress in educational matters. Although the number of schools in the Central Provinces decreased by 30, the average daily attendance increased by 4,051, and this in spite of the prevalence of small-pox, which interfered with the attendance of the scholars. In Berar special attention has been directed to the diffusion of primary instruction among the lower classes of the community. Six middle-class schools were reduced to the lower grade, and 22 lower-grade schools were added to the number previously existing, making the total number of 380. In Burmah the remarkable progress recorded in former reports was continued, and large numbers of the indigenous schools of the country were brought into co-operation with the Government. The number of children whose education is in some manner under supervision, was 33,027, only 1·2 per cent. of the population; but this is no indication of the extent to which education is carried on, as there are numerous monastic schools throughout the country which firmly resent Government interference. There is reported to be an earnest desire among the Burman youths to acquire a knowledge, however superficial, of English.

With regard to the readiness of the Mohammedan population to avail themselves of the educational advantages thus offered, the report states that in Bengal, of a total of 436,098 pupils in Government institutions, 87,917 were of that faith. In the central division of the Bombay Presidency, the number of male pupils shows a considerable falling off from the previous year. In the northern division, on the other hand, the Urdu schools increased from 31 to 38, and the results showed marked improvement. In the southern division there are Mussulman masters and assistants in some of the ordinary Canarese schools, and many Mussulman pupils learning with the Hindoos. An indication of the growing appreciation of education by the Mohammedans in the Punjab, is the circumstance that of 1,026 boys attending the Lahore district school and its branches, 554 were of that religion. The Mohammedans in Oude are, in proportion to their numbers, far more ready than the Hindoos to accept the offer of State education. This fact is apparent in English as well as vernacular schools.

Female education in Bengal, though not making as rapid advance as might be desired, is yet marked by steady progress. One of the most promising features of the new "patshala" system, is the extension of primary female instruction in the mixed schools. Zenana education is believed to be making decided progress

among the higher classes of society, but it is conducted quite privately, and it is doubtful whether it goes beyond reading and writing. The attempts to establish normal schools for female teachers have scarcely succeeded. In Madras the total number of girls' schools increased from 237 to 269, and the pupils from 11,193 to 11,906. The number under instruction rose from 17,113 to 19,582. Among this number, Hindoo girls increased by 780, while the number of Mohammedan girls more than doubled itself. In Bombay there was a net decrease in girls' schools of 12, and in pupils of 150. Except in the Poona sub-division, the schools are generally promising. In the Punjab the number of Government female schools rose from 101 to 128, and of pupils from 2,599 to 3,318. The aided female schools, however, decreased from 223 to 218, and the scholars from 6,444 to 6,284. Female education in Burmah progresses satisfactorily, principally at missionary institutions. The social freedom which Burmese women enjoy gives them a great advantage in this respect. But there is a difficulty in obtaining thoroughly suitable teachers, combining a knowledge of English and of the vernacular.

The Bengalese literature chiefly excels in fiction, but an aptitude is shown for history, and many books of this character have been prepared, which are sound and good as far as they go. There are also ethical and didactic works of some merit, and rudimentary books on science, derived from European sources, are beginning to be written. A steady improvement is observed in the native press. The circulation of the 20 principal papers is believed to amount to about 200,000 copies. The general towns are decidedly loyal and favourable to British rule. The confidence felt in the good intentions of the Government, and the gratitude of the natives for external security, religious freedom, material prosperity, and English education, are frequently expressed with the greatest warmth and impressiveness. At the same time there is often much matter of a controversial character; a disposition is sometimes manifested to find fault with everything that is done or omitted, and an increasing jealousy is evinced regarding the bearing of British people towards the natives.

CORRESPONDENCE.

COFFEE-LEAF TEA.

Sir,—It is a remarkable fact that throughout the whole Eastern Archipelago, the natives prefer the infusion from the coffee leaf to that from the berry. We here, on the other hand, are acquainted only with the latter, and have had no opportunity of determining for ourselves which is the best. Various travellers, both in the West and in the East, have tried it and have spoken very favourably, not only of the flavour, but also of its strengthening qualities, and generally their opinion confirms that of the natives. From the last number of the *Queenslander* (August 26th) I take the following paragraph, which alludes to one of the many things which were displayed at the exhibition lately opened at Brisbane:—"Mr. Alexander, of Redbank, showed some coffee-tea prepared from the leaves of coffee trees growing at Redbank. Mr. Alexander says that the beverage prepared from this article is most delicious, and is preferable to the decoction from the berry." From this it will be seen that it is very highly spoken of. It therefore appears to me a matter of importance to give it a fair trial, if only for the sake of having another agreeable beverage in addition to the very few we possess. At present, owing to the high price of good coffee berries, adulteration with chicory, beans, burnt bread crumbs, &c., is carried on to a large extent, and mainly, I believe, to bring it within the reach of the million, who otherwise could not afford the luxury(?) From another paper I learn that matè, the national beverage in the southern part of South America, has lately been introduced at two of the cafés in Vienna and with increasing favour. From personal experience of it, I believe it would also be appreciated here, and more especially if it were gathered and prepared in a better manner. The varieties which I have used betray both a woody and an earthy substance. At present an expedition is made to the forests, and there, hurriedly, twigs and leaves are indiscriminately broken off, are dried, and thence pulverised by means of a most primitively constructed stamping mill. But were the leaves only gathered, and care was taken that no earth or dust was incorporated with the pulverised leaves, I believe it would become a great favourite with many persons here. In the Spanish South American Republics the inhabitants are passionately fond of it, and unlike tea, no nervous disorders arise from its inordinate use.

Chinese tea, also, is not what it used to be. As the woollen industry here is now largely indebted to shoddy, so all is not choice unused tea which comes from China. The various qualities of the exports from that country may be compared to the horizontal sections of a pyramid. At one extreme, at the top, we have a small quantity of really good and choice tea, but which commands a very high price; at the other extreme we have an immense quantity of stuff which is but one remove from pure rubbish, which, nevertheless, is readily marketable, for much of it and a little of Indian tea (which, being genuine, is very strong), when mixed together, appears to exactly suit the palates of the millions. All things appear to have their rise and fall—their flood tide and their ebb tide. Chinese tea in England commenced with a small packet, and now many large cargoes are annually imported. Indian tea struck the first blow at his supremacy in the estimation of Europeans, and extensive practices of various sorts, but all coming under the head of adulteration, denote that it has past its culuminating point in estimation, and the commencement of the ebb tide, whose rapidity would depend on the extension of accurate knowledge of its intrinsic value. If, then, the destiny of Chinese tea is to retreat at the same rate that it advanced, I am of opinion that the next most suitable invader to fill up the vacuum would be coffee-leaf tea, for according to the opinions of all those who have tried it, the infusion is pleasant, very grateful, and invigorating; which is very much more than can be said for the vast bulk of the teas from China, or for matè as it is gathered and made at present.

If found superior, it would lead to a change in the cultivation of the coffee tree in the plantations abroad, for at present the pruning knife is freely used, so as to obtain as large a crop of berry per acre as possible (in the quickest time, and at the least expenditure of labour in gathering), and unlike the tea shrub with which a large crop of leaf is aimed at. It might happen that it would be more profitable to cultivate the coffee tree for its leaf than for its berry, or it might enable the planter to secure first the berry, and thence a crop of leaves, which greater yield would enable him to sell both as cheap as the crop of berry alone.

In various conservatories here, the coffee tree is cultivated as an ornamental one, and I should think that there would be no great difficulty for connoisseurs to obtain a quantity of leaves, and give the infusion a fair trial. In the hope that the matter may be found worthy the attention of the Society,—I am, &c.,

J. F. D.

London, 7th Nov., 1876.

As mentioned in last week's *Journal*, a course of lectures on the Laws of Health will be commenced by Professor Corfield to-morrow, Saturday, the 11th inst. Professor Huxley will take the chair at the first lecture. The lectures are given under the auspices of the Trades Guild of Learning, in the Large Room of the Society. They are intended for all classes.

NOTICES.

MEETINGS FOR THE ENSUING WEEK.

MON. ...Institute of Surveyors, 12, Great George-street, S.W., 8 p.m. Opening Address by the President, Mr. Edmund James Smith.
Royal Geographical, 1, Savile-row, W., 8½ p.m. 1. The President's Opening Address. 2. Sir J. Douglas Forsyth, "The Buried Cities of the Gobi Desert, Eastern Turkistan."
Medical, 11, Chandos-street, W., 8 p m.

TUES....Civil Engineers, 25, Great George-street, Westminster, S.W., 8 p.m. Mr. R. Henry Brunton, "The Japan Lights."
Women's Education Union (at the HOUSE OF THE SOCIETY OF ARTS), 6 p.m. Mons. Edmund Audrade, "The Galin-Paris-Chevé Method of Teaching Music." (Lecture I.)
Photographic, 9, Conduit-street, W., 8 p m.
Royal Colonial Institute (at the Pall-mall Restaurant), 8 p.m. Mr. J. D. Wood, "The Benefits to the Colonies of being Members of the British Empire."

WED. ...SOCIETY OF ARTS, John-street, Adelphi, W.C., 8p.m. Opening Address by the Chairman, Lord Alfred Churchill.
Meteorological, 25, Great George-street, S.W., 7 p.m. 1. Mr. William Marriott, "Results of Meteorological Observations made at Rossinière, Canton Vaud, Switzerland, during 1874 and 1875." 2. Mr. H. C. Russell, "Notes on some Remarkable Errors in Thermometers recorded at Sydney Observatory."

THUR....Linnean, Burlington House, W., 8 p m. 1. Mr. R. Bowdler Sharpe, "The Birds Collected by Professor Steere in the Philippine Archipelago." 2. Mr. H. N. Moseley, "The Flora of Marion Island."
Chemical, Burlington House, W., 8 p.m. 1. "Barwood," by the late Dr. Anderson. 2. Mr. G. S. Johnstone, "Potassium Tricodide." 3. Mr. J. S. D. Humpidge, "The Coal Gas of the Metropolis." 4. Mr. J. B. Hannay, "Calcium Sulphate."
Pyschological, 11, Chandos-street, W., 8.30 p m.

SAT.......Trades' Guild of Learning and National Health Society (at the HOUSE OF THE SOCIETY OF ARTS). 8.30 p.m. Prof. W. H. Corfield, "The Laws of Health." Part I. Lecture I.

CONTRIBUTIONS TO THE READING-ROOM.

The Council beg leave to acknowledge, with thanks to the Proprietors, the regular receipt of the following Transactions of Societies and Periodicals during the year:—

WEEKLY.

Agricultural Gazette.
American Journal of Gas Lighting.
Architect.
Athenæum.
Bombay Gazette, Overland Summary.
British Architect.
British Journal of Photography.
Builder.
Building News.
Builders' Weekly Reporter.
Capital and Labour.
Ceylon Times, Weekly Summary.
Chamber of Agriculture Journal.
Chemical News.
Colliery Guardian.
Colonies, The.
Cosmopolitan.
Draper.
Engineer.
Engineering.
Engineering and Building Times.
English Mechanic.
European Mail.
Farmer.
Gardeners' Chronicle.
Gas Lighting, Journal of.
Herapath's Railway Journal
India, Times of.
Indian Public Opinion.
Irish Builder.
Iron.
Land and Water.
Local Government Times.
Medical Examiner.
Metropolitan.
Mining Journal.
Mondes, Les.
Moniteur des Arts.
Musical Standard.
Musical World.
Nature.
Papermakers' Circular.
Pharmaceutical Journal.
Photographic News.
Photographic Society, Journal of the.
Produce Markets' Review.
Queen.
Railway Service Gazette.
Revue Scientifique.
Sanitary Record.
School Board Chronicle.
Schoolmaster.
Social Science Association, Sessional Proceedings of the.
South African Dominion Budget.
Staffordshire Sentinel.
Temperance Record.
Warehousemen & Drapers' Journal.
Workmen's Club Journal.

FORTNIGHTLY.

Jeweller & Metal Worker.
Publishers' Circular.

MONTHLY.

American Artizan.
Annales du Génie Civil.
Applied Science, Journal of.
Atlantic Monthly.
Bayerisches Industrie- und Gewerbe-Blatt.
Bookseller.
British Mail.
British Mercantile Gazette.
Chemical Society, Journal of the.
Chemist and Druggist.
Education, Journal of.
Educational Times.
Franklin Inst., Journal of the.
Geographical Magazine.
Horological Journal.
Horticultural Society, Journal of the.
Industrie Nationale, Bulletin de la Société d'Encouragement.
Leather Trades' Circular.
London, Edinburgh, and Dublin Philosophical Magazine.
Monatsschrift für den Orient.
Moniteur Scientifique.
Musée de l'Industrie, Bulletin du.
National Education League.
National Life Boat Institution, Journal of the.
Nautical Magazine.
Pharmaceutical Society, Journal of the.
Practical Magazine.
Printing Times and Lithographer.
Presse Scientifique des Deux Mondes
Quekett Microscopical Club, Journal of the.
Revue Maritime et Coloniale
Société Imperiale, Zoologique d'Acclimatation, Bulletin.
Sugar Cane.
Symons' Meteorological Magazine.
Telegraphic Journal and Electrical Review.

QUARTERLY.

Asiatic Society, Journal of the.
East India Association, Journal of the.
Geological Society, Journal of the.
Geologists' Association, Proceedings of the.
Linnæan Society, Journal and Transactions of the.
Mental Science, Journal of.
Meteorological Society, Journal of.
Naval Science.
Royal Agricultural Society, Journal of.
Royal Geographical Society, Proceedings and Journal of the.
Royal Society, Proceedings of the.
Royal United Service Institution, Journal of the.
Statistical Society, Journal of the.
Victoria Inst., Journal of the
Zoological Society, Proceedings and Transactions of the.

ANNUALLY.

Archæologia (Transactions of the Society of Antiquaries).
British Association for the Advancement of Science, Report of the.
Civil Engineers, Minutes of the Proceedings of the Institution of.
Engineers in Scotland, Transactions of the Institution of.
Gas Managers, Report of the Proceedings of the British Association of.
Iron and Steel Inst., Journal of the.
Naval Architects, Transactions of the Institution of.
Philosophical Transactions.
Royal Colonial Institute, Proceedings of the.
St. James's Magazine.
Society of Engineers, Transactions of the.

INDEX TO VOL. XXIV.

A.

Abbott, Mr., *disc*, spring propulsion for street trams, 607
Addy, Mr., *disc*., sewage grounds, 151
Ador's meat preserving process (see "Food")
Africa, Portuguese possessions on east coast of, 824
——, proposed inland sea for, 883
African (north-west) expedition, 511
——, (south) exhibition (see "Exhibitions.")
AFRICAN SECTION:—Chairman's address, 9; annual report on, 789; committee (see "Committees.")
1st Meeting:—1. Opening address, by Vice-Admiral Erasmus Ommanney, 162. 2. "Some notes on the origin and character of the Dutch republics of South Africa," by Dr. Mann, 165
2nd Meeting:—"Progress and prospects of ostrich farming in the Cape Colony, and the trade in ostrich feathers," by P. L. Simmonds, 225
3rd Meeting:—"The diamond fields of Griqualand, and their probable influence on the native races of South Africa," by John B. Currey, 372
4th Meeting:—"Industrial progress of the natives of South Africa," by T. B. Glanville, 448
5th Meeting:—"The commerce of the Gaboon; its history and future prospects," by R. B. N. Walker, 585
6th Meeting:—"The Development of Central Africa," by E. Hutchinson, 689
Agricultural engineers' association, resolutions of, 31
Agriculture in India, *letter*, W. R. Robertson, 46
———— of Labuan, 913
Airy, Sir G. B., award of Albert medal to, 791
Albert medal (see "Medals")
Alcock, Mr., *disc*., sewage (see "Sewage Conference")
Alizarine, artificial, in powder, 573
AMERICA:—
Centennial exhibition (see "Exhibitions")
Fires in New York, 47
Fresh meat from (see "Food")
Oil for lighting purposes, use of in United States, 139
Oysters from, 136
Replanting of timber in Canada, 944
Soda in United States, 904
Telegraphs in, 1,030
Tonnage of railways in, 1,030
Trade and manufacture in United States, 909
Trade marks in, 842
Angell, L., *disc*., sewage (see "Sewage Conference")
Annual educational conference (see "Education")
———— general meeting, 787
Aquaria, their construction, management, utility, *paper* by W. Saville Kent, 292; *letters*, W. A. Lloyd, 427, 483; R. Howden, 432
Arnold, Mr., *disc*., sewage (see "Sewage Conference")
Arntz, R. R., *disc*., public meeting of sewage committee, 1010
Astronomical instruments at loan exhibition, 850, 915, 925
Australian silk, 879, 934; *paper*, Mrs. Neill, 538

B.

Badger, Dr., *disc*., development of Central Africa, 704
Bailey, Mr., *disc*., caoutchouc-yielding trees in India, 482
Baker, W. H., *disc*., education (see "Educational Conference")
Ballot, Dr. C. H. D. Buys, elected honorary life member, 681
Bamboo paper, 300
Bancroft, Mr., *disc*., improvements in railway couplings, 426
Bangor, Dean of, speech at Rhyl, on training school for music, 1017
Bank, national penny, 485, 868
Barff, Prof., *letter*, dangers in use of white lead, 984
Barnett, F., *paper*, bridge for traffic below London-bridge, 382
Barrow, Mr., *disc*., sole leather tanning, 223
Bartleet, Mr., *disc*., health, &c., in the house, 73
Bartlett, Dr., *paper*, condensed beer, 178
Baruchson, A., *disc*., Suez canal, 281; model dwellings for the rich, 465
Beattie, Dr., *disc*., caoutchouc-yielding trees in India, 475
Beer, condensed, *paper*, Dr. Bartlett, 178
—— from essence of malt and hops, *letter*, Admiral Sir E. Belcher, 47
Beer, H., presentation of Prince Consort's prize to, 14
Belcher, Admiral Sir E., *letter*, beer from essence of malt and hops, 47
Belgium, science congress in, 833, 922
Belleville, Mr., *disc*., diamond fields of Griqualand, 380
Berthon's collapsible boat, 124
Billing, Dr., *chair*., Mexican onyx-marble deposits, 503
Birdwood, Dr. George, *paper*, competition and its effects on education, with special reference to the Indian Civil Service, 681
Birmingham, trade of, 244
Bischoff, Mr., *disc*., recent metallurgical processes, 290
Bissett, Lieut.-Gen., *chair*., industrial progress of natives of South Africa, 448; *disc*., diamond fields of Griqualand, 379
Blackie, Mr., *disc*., spring propulsion for street trams, 607
Blashfield, Mr., *disc*., china clay, 570
Blashill, Thomas, *paper*, health, comfort, and cleanliness in the house, 66
Blunt, R., *letter*, health in the house, 109
Boat, collapsible, 124
Bolton, Mr., *disc*., sewage (see "Sewage Conference")
Bond, Dr., *paper*, importance of knowledge of laws of health (see "Educational Conference")
BOOKS, NOTICES OF:—
Amateur house carpenter, 736
Bi-metallic money and its bearings on the monetary crises in Germany, France, England, and the United States, 485
Dyeing and calico printing, 128
Introduction to experimental physics, 77
Manual of house painting, 501
A manual of qualitative chemical analysis, 735
The octopus, or the "devil fish" of fiction and of fact, 110
Official catalogue of British section of the Philadelphia exhibition, 517
The old days of Price's Patent Candle Company, 914
Primer of the phonic method of teaching reading and writing, 110
Science made easy, 501
Silk industry in America, 984
Specifications as bases of patents, 63
Borthwick, Lord, *chair*., fall in the price of silver, 306
Bosdet, Mr., *disc*., dextrine maltose, 413
Botly, W., *disc*., sewage grounds, 42; health in the house, 73; cultivation of hardy fruits, 203; contagious diseases of animals, 270; *letter*, health in the house, 110; sewage (see "Sewage Conference")
Boulton, W., *disc*., sewage (see "Sewage Conference")
Bourne, Mr., *disc*., sugar duties, 60
Box (paper) making machinery, 516
Boycott, Dr., *disc*., sanitary progress in India, 534
Brady, Sir Antonio, *disc*., opening address, 14; pure charcoal steel from the ore, 92; silk growing, 540
Brakes, continuous, 736
Bramwell, F. J., presentation of medal to, 14; *paper*, railway safety appliances, 646, 674, *disc*., condensed beer, 185; caoutchouc-yielding trees in India, 482
Branson, Mr., *disc*., condensed beer, 184; combustion of coal gas, 242
Brazil, industries of, 923
Brewer, Richard, *paper*, sewage, and *disc*., (see "Sewage Conference")
Bridge for traffic below London-bridge, *paper* by F. Barnett, 382
Briggs, T., *letter* to Chancellor of the Exchequer on malt tax, 250; *disc*., irrigation works in India, 583; *letter*, 584
British Association, Glasgow, 1876, officers, 884; *paper* on patent-law reform, by Mr. Day, 953
Britton, Dr. *disc*., sewage (see "Sewage Conference")
Brock, Mr., *disc*., manufacture of salt-cake, 645
Brockelbank, T. A., *paper*, improvements in railway couplings, 415; *letter*, 483; notice of his couplings, 786
Brocklehurst, W. C., *disc*., silk growing, 541 *letter*, silk culture in Australia, 879
Bronzes, imitation of Chinese and Japanese, 495
Brussels, city of, notes on, 894
———, exhibition (see "Exhibitions")
———, hygienic life-saving congress, 866, 971, 982, 997

Bryan, Mr., *disc.*, sewage (see "Sewage Conference")
Buckland, Frank, *disc.*, aquaria, 299
Buckmaster, J. C., *disc.*, education (see "Educational Conference")
Burgess, Alderman, *disc.*, sewage (see "Sewage Conference")
Burn, Dr., *disc.*, Suez canal, 261, 282; land revenue of India, 447; sanitary progress in India, 535; competition for Indian Civil Service, 688
Buxton, Sir Fowell, *disc.*, development of Central Africa, 703
Bye-laws, alteration of, 487

C.

Calcium chloride for watering streets, 984
Cameron, Lieut., elected hon. life member, 653
Campbell, Sir George, *chair.*, land revenue of India, 435; *disc.*, Suez canal, 279
Campin, F. W., *disc.*, trade marks, 28; bridge below London-bridge, 388
Cannon, Mr., *disc.*, cultivation of hardy fruits, 203
Cantor Lectures:—Opening address, 11; annual report, 790
1st Course:—Dr. J. L. W. Thudichum "On the discoveries and philosophy of Liebig, with especial reference to their influence upon the advancement of arts, manufactures, and commerce," *syllabus*, 16; *lectures*, 80, 95, 111, 125, 141
2nd Course:—"On iron and steel manufacture," by W. Mattieu Williams; *syllabus*, 140; *lectures*, 827, 843, 860, 869, 885, 895
3rd Course:—"On wool dyeing," by G. Jarmain; *syllabus*, 276; *lectures*, 955, 965, 975, 985, 1003, 1022
Caoutchouc-yielding trees, cultivation of, in British India, *paper* by C. R. Markham, 475
Carbon from shale, 678
Carpenter, Dr. A., *disc.*, sewage grounds, 41; *paper*, sewage, *disc.* and *letter* (see "Sewage Conference")
———, Dr. W. B., *lectures* on the wonders of the microscope (see "Juvenile Lectures")
Cask making machinery, 822
Cassels, A., *chair.*, adjourned *disc.* on Suez Canal, 278; irrigation works in India, 575; competition and its effects on education, with especial reference to the Indian Civil Service, 681; *disc.*, sanitary progress in India, 535
Cattle food, new plant for, 498
——— truck (Murray's), description of, 271
Celluloid, explosion of, 48
Chadwick, D., M.P., *disc.*, annual meeting, 793
———, Edwin, C.B., *chair.*, sanitary progress in India, 519; spring propulsion for street trams, 598; *letter* on Chairman's address, 15; on physical training and national education, 134; Suez canal, 341; model dwellings for the rich, 463; *disc.*, irrigation works in India, 583; sewage (see "Sewage Conference")
Channel passage, opening address, 11; Foreign-office report on correspondence on, 137; reports on, 901; traffic from 1866-1875, 485
Chapman, I., *disc.*, hall marking, 340
Charlesworth, Mr., *disc.*, onyx-marble deposits near Mexico, 510
Charpentier's underground irrigation, 106
Chemical Section:—Opening address, 10; annual report, 789
1st Meeting:—"Sole-leather tanning, with some remarks on the import of hides and cattle," by Sparke Evans, 214
2nd Meeting:—"Some recent metallurgical processes," by J. A. Phillips, 284
3rd Meeting:—"On the manufacture of citric and tartaric acid," by Robert Warington, 366
4th Meeting:—"The preparation of dextrine-maltose (malt sugar) and its use in brewing," by W. G. Valentin, F.R.S., 404
5th Meeting:—"Some methods of estimating the illuminating power and purity of coal gas," by A. Vernon Harcourt, 468
6th Meeting:—"On the manufacture of salt-cake," by John Morrison, 639
China clay and china stone of Devon and Cornwall, *paper* by J. H. Collins, 565
——— opium in, 107
Chinchona cultivation in India, 914
Chinese bronzes, imitation of, 495
Churchill, Lord Alfred, *chair.*, opening meeting, 4; adjourned discussion on the fall in the price of silver, 353; model dwellings for the rich, 456; railway safety appliances, 674; sewage conference, 709, 732, 749; annual general meeting, 787; public meeting of executive committee on health and sewage, 1008; *address* at opening meeting, 4; *disc.*, trade marks, 53; silk growing, 541.
Citric and tartaric acid manufacture, *paper* by R. Warington, 366
Clarke, Hyde, *chair.*, adjourned discussion on fall in price of silver, 345; *disc.*, ostrich farming in Cape Colony, 234; Suez canal, 280; model dwellings for the rich, 464
Coal gas, combustion of, *paper* by J. Wallace, 235; *letter*, T. M. Gisborne, 302
Coffee disease in Dominica, 248
——— leaf tea, *letter*, 1035
Coghlan, Mr., *disc.*, sewage (see "Sewage Conference")
Cole, Alan S., *paper*, teaching of music (see "Educational Conference"); election as Soane trustee, 792
———, Sir H., *paper*, adult education (see "Educational Conference"); *chair.*, sewage conference, 717, and *disc.* (see "Sewage Conference"); educational conference, 794; *disc.*, annual meeting, 794; public meeting of sewage committee, 1008; *speech* at deputation on sewage gases in houses, 860; at Liverpool Institute, 101; at Rhyl on training school for music, 1017; *letter* to Kensington Vestry, 904; reply, 945; on use of national works of fine art, 997
Collins, H. H., *disc.*, health, &c., in the house, 73
———, J. H., *paper*, china clay and china stone of Devon and Cornwall, 565
Comfrey, prickly, 498
Committees:—
African, 125
Drill, 17
Education, 738
Fires in Ships, extinction of, 435, 468
Food, 253, 306, 403, 738, 943; annual report, 790
Indian, 141, 161
Railway Lamps, 17
Revolution Indicator, 435, 487, 653
Sewage, opening address, 13; resolutions of, 214; members of, 403; public meeting, 1008
Trade Marks, 53, 79
Competition and its effect on education, with special reference to the Indian Civil Service, *paper* by Dr. George Birdwood, 681
Contagious diseases of animals, *paper* by G. Fleming, 262
Conversazione, 809
Conybeare, Mr., *disc.*, fall in the price of silver, 356; land revenue of India, 447
Cook, Mr., *disc.*, sewage (see "Sewage Conference")
Cooke, C., *disc.*, trade marks, 52; health in the house, 73; railway safety appliances, 677; competition for Indian Civil Service, 688
Cookery instruction, grants for, notice of motion by E. J. Reed, 760
———, National School of, rules for admission for Society's scholarships, 141; examination of candidates, 197; deputation to the Lord President, 401; annual meeting of, 819; annual report of, 835
——— school at Charlton Kings, 498; at Carrigbyrne, 1033
——— school at Leamington, 251
———, village, *Saturday Review* on, 837
Cotton, Sir Arthur, *disc.*, irrigation works in India, 581
———, General F., *chair.*, aquaria, their construction and management, 292; hall marking, 334; sewage conference, 756; *disc.*, irrigation works in India, 582; public meeting of sewage committee, 1010
Council, election of, 793
———, report of, 787
Craigie, Captain, *disc.*, contagious diseases of animals, 269
Cresswell, C. N., *disc.*, sewage (see "Sewage Conference")
Crisp, Mr., *disc.*, leather tanning, 223
Critchett, C., report on examinations (see "Educational Conference")
Crookes, Mr., *disc.*, sewage (see "Sewage Conference")
Currey, John B., *paper*, diamond fields of Griqualand, 372
Curzon, F., *disc.*, education (see "Educational Conference")

D.

Danvers, Mr., *disc.*, competition for Indian Civil Service, 688
Davenport, S. T., *obituary* notice, 125, 139; subscription for family of, 161, 177, 197, 213, 253, 277, 503
Davidson, E. A., *disc.*, education (see "Educational Conference")
Dennis's fire extinguisher, 677
Denton, J. Bailey, *paper*, sewage (see "Sewage Conference")
Dextrine-maltose, and its use in brewing, *paper* by W. G. Valentin, 404; *letters*, W. A. Lyttle, 484, 573; *letter*, 501; F. Faulkner, 516
Diamond fields of Griqualand, *paper* by J. B. Currey, 372
Disinfectants for general use, 63
Dod, Rev. C. W., *disc.*, sewage (see "Sewage Conference")
Dominica, coffee disease in, 248
Drawing, models for teaching, 819
Drew, F., presentation of medal to, 14
Drewry, Dr., *disc.*, condensed beer, 184
Drill committee (see "Committees")
——— in schools, annual report on, 788; inspection of School Board boys, 859
Duncan, P. M., *chair.*, china clay and china stone of Devon and Cornwall, 565
Dutch republic of South Africa, *paper*, Dr. Mann, 165
Dynamite, experiments in manufacture of, 944

E.

Earley, Mr., *disc.*, cultivation of hardy fruits, 203
Earthenware glaze, innocuous, 680
Eassie, W., *paper*, so-called deposits of onyx near Mexico, 503
Ebden, Mr., *disc.*, diamond fields of Griqualand, 380
Education, cost in elementary day schools, 512
———, elementary, *letter*, R. Hamilton, 193
——— in India, 1034
———, secondary, Duke of Richmond on, 893
———, technological, Plasterers' Company's report, 32
Educational Conference:—
Papers read:—
1. "Aid to adult education given by the Education Department," by J. G. Fitch, 763
2. "University external adult education," by James Stuart, M.A., 765
3. "The extension of university teaching in London," by Walter Leaf, 768
4. "Aid obtainable from the surplus of the Exhibition of 1851, held by the Commissioners," 771
5. "The importance of a knowledge of the laws of health," by Thomas Bond, M.B., 71
6. "The importance of a practical knowledge of clothing," by Mary Willis, 773
7. "On instruction in cookery," by Edith Nicolls, 774
8. "The teaching of music," by Alan S. Cole, 774
9. "On technical education," by George Howell, 775
Programme of, 721
Report of, 763, 794
Report of Educational Officer, 777
Eggar, Mr., *disc.*, sewage grounds, 43
Elcock, G., *paper*, sewage, and *disc.* (see "Sewage Conference")
Electric pen, Edison's, 652

Electrical apparatus at the loan exhibition, 875
Electricity exhibition at Paris (see "France")
———, lighting gas by, at the National Assembly, 496; *letter*, W. Ladd, 573
Elkington, Mr., *disc.*, public meeting of sewage committee, 1012
Emmott, W. T., *letter*, newspaper post, 735
Endless rails, experiments with, 894
Epirus, resources of, 513
Etheridge, Mr., *disc.*, onyx-marble deposits of Mexico, 509
Evans, Sparke, *paper*, sole leather tanning, 214
———, W., *disc.*, sole leather tanning, 224
Examinations:—Report of educational officer on, 777; annual report on, 792; programme for 1877, 915
——— ———, commercial, opening address, 6; results of in 1876, 739, 812
——— ———, domestic economy, opening address, 7; correspondence with Education Department, 213; results of in 1876, 739
——— ———, fine arts applied to industry, opening address, 7
——— ———, technological, opening address, 7; results of for 1876, 1003
Exhibition of 1851, proposed application of surplus of, 721; newspapers on, 734, 979; House of Commons on, 809
———, Brussels international, 211; description of, 810, 813, 905 (see also "Brussels congress")
———, Paris of 1878, 512, 833
———, Paris electrical, 497
———, Philadelphia, art museum for, 16; judges at, 43; general description of, 43; England at, *Engineering* on, 75; prospects for opening, 513; dimensions of, 782; buildings for, 919, 942
———, scientific apparatus (loan), 16, 831, 850, 876, 915, 925, 980, 989, 1026
———, South African international, 924
Eyton, Ellis, M.P., speech at Rhyl on training school for music, 1,018

F.

Faulkner, F., *letter*, dextrine-maltose, 516
Female labour in Germany, 1,020
Fereday, W. W., *paper*, sewage (see "Sewage Conference")
Fewtrell, Mr., *disc.*, estimating illuminating power and purity of coal gas, 474
Fibre, new (*Lavatera*), 139
Field, Cyrus, elected hon. life member, 653
———, Rogers, *disc.*, sewage (see "Sewage Conference")
Figgis, Samuel, *disc.*, ostrich farming in Cape Colony, 234
Filters, typhoid germs and, 835
Financial statement, 761
Fine art, use of national works of, Sir H. Cole on, 997
Fire extinguisher, Dennis's, 677
Fireproof towns, 841
Fires in New York, 47
——— theatres, means for extinguishing, 944
———, prevention of, opening address, 11
Fitch, J. G., *paper*, adult education, and *disc.* (see "Educational Conference")
Fitzgerald, W. F. Vesey, *disc.*, Suez canal, 282
Flames, the structure of, *paper*, J. Wallace, 235
Flax, New Zealand, 138
——— trade in Russia, 78
Fleming, G., presentation of medal to, 14; *paper*, contagious diseases of animals, 262
———, Mr., *disc.*, Suez canal, 280
Flooring, parquet, 251
Flower, Capt., *paper*, sewage (see "Sewage Conference")
Food:—
Committee (see "Committees")
Meat imported fresh from America, 275, 914; *letter*, G. Kent. 484
Meat preservation, M. Ador's process, 77; Mr. Mort's process, 102; M. Reynoso's process, 251
Preservation, Massié's process, 842
Supply, opening address, 13
Fordred, J., *disc.*, condensed beer, 185; dextrine-maltose, 412
Forli sulphur mines, 840
Forrest, Mr., *disc.*, competition for Indian Civil Service, 688
Fortescue, Hon. Dudley F., *chair.*, cultivation of hardy fruits, 198; *disc.*, sewage (see "Sewage Conference")
Foster, Dr. C. Le Neve, *disc.*, recent metallurgical processes, 290
Fowler, A. M., *disc.*, sewage (see "Sewage Conference")
France, demolition of buildings in Paris, 63
———, exhibition of electricity at Paris, 497
——— ——— of 1878 (see "Exhibitions")
———, laboratory of school of mines, 934
———, lightning conductors in Paris, 736
———, market gardening near Paris, 485
———, utilisation of urine in, 812
———, weather forecasts in, 826
Freeland, H. W., *disc.*, silk growing, 541
Fruits (hardy), cultivation of, *paper* by Shirley Hibberd, 198
Fryer, C., award of medal to, 791
Fuel, economy of, *letter*, G. N. Shore, 500
Fuller, E. H., *disc.*, sewage (see "Sewage Conference")
Furnivall, F. J., *letter*, offering copies of work from New Shakespeare Society to Institutions, 47

G.

Gaboon, commerce of, *paper*, R. B. N. Walker, 585; *letter*, 651
Galloway, G. B., *disc.*, sewage grounds, 154; spring propulsion for street trams, 606; sewage (see "Sewage Conference")
Galt, W., *chair.*, improvements in railway couplings, 414
Galton, Capt. Douglas, *paper*, sanitary progress in India, 519; *disc*, sewage (see "Sewage Conference"); public meeting of sewage committee, 1014; *chair.*, sewage conference, 728, 754; *letter* to *Times*, manufactures in America, 909
———, Francis, F.R.S., *disc.*, ostrich farming in the Cape Colony, 225
Galvanic batteries, simplification in, 823; new, 893
Gardner, Mr., *disc.*, aquaria, 298
Gas (coal) combustion of to produce heat, *paper* by J. Wallace, 235; *letter*, T. M. Gisborne, 302
——— ———, methods of estimating the illuminating power and purity of, *paper* by A. Vernon Harcourt, 468
General meeting, 787
Genevan Society of Arts, centennial medal, 721
Germany, female labour in, 1020
———, trade classification, 103
Gibbs, Mr., *disc.*, education (see "Educational Conference")
Gill, Dr., *disc.*, sewage (see "Sewage Conference")
Girton College, 48
Gisborne, T. M., *letter*, combustion of coal gas, 302
Gladstone, Right Hon. W. E., on industrial art, 14
Glanville, T. B., *paper*, industrial progress of natives of South Africa, 448
Glass refining, 273
——— tempering, improvements in, 944
———, writing on with common ink, 826
Graham, Dr., *disc.*, dextrine-maltose, 413
Grant, Col., *disc.*, development of Central Africa, 703
Grant-Duff, Mr. E., M.P., *chair.*, commercial aspects of Suez canal, 253
Grantham, Mrs., presentation of Howard prize to, 14
Grazebrook, Mr., *disc.*, condensed beer, 185
Gresham College, resolution of managing committee, 243
Grey, Mrs., *disc.*, education (see "Educational Conference")
Grindle, T. W., *disc.*, sewage (see "Sewage Conference")
Griqualand, diamond fields of, *paper* by J. B. Currey, 372
Grosjean, Mr., *disc.*, citric acid, 372
Grosvenor-house gallery, public exhibition of, 869
Gruneisen, Mr., *disc.*, model dwellings for the rich, 464

H.

Hale, Mr., *disc.*, health, &c., in the house, 73; steel manufacture, 94; railway safety appliances, 677; annual meeting, 792
Hall, Mr., *disc.*, trade marks, 52; health, &c., in the house, 74; sewage (see "Sewage Conference")
Hall-marking of jewellery, *paper* by A. Lutschaunig, 334; *letter*, 483
Hamilton, Rowland, *letter*, elementary education, 194; *disc.*, land revenue of India, 445
Hampton, Lord, *chair.*, sugar duties, 54
Hancock, Mr., *disc.*, caoutchouc-yielding trees in India, 481; spring propulsion for street trams, 607
Hanson, Mr., *disc.*, sewage (see "Sewage Conference")
Harcourt, A. Vernon, *paper*, methods of estimating illuminating power and purity of coal gas, 468
Harescough, Mr., *disc.*, sewage (see "Sewage Conference")
Hartley, F. W., *disc.*, combustion of coal gas, 241; estimating illuminating power and purity of coal gas, 474
Haviland, A., *disc.*, sewage (see "Sewage Conference")
Hay, Sir Hector, *disc.*, fall in the price of silver, 351
Healey, C., *disc.*, trade marks, 28
Health and sewage of towns (see "Sewage")
———, &c., in the house, *paper* by Thomas Blashill, 66; *letters*, R. G. Blunt, 109; W. Botly, 110
Hearson, T. A., award of prize for revolution indicator, 653
Heinemann, Dr., *disc.*, competition for Indian Civil Service, 688
Hemp, Japanese, 679
Hendriks, F., *disc.*, fall in the price of silver, 348
Henry, Prof. J., elected hon. life member, 681
Hepburn, J. G., *chair.*, sole leather tanning, 214
Hibberd, Shirley, *paper*, cultivation of hardy fruits, 198
Hill, Mr., *disc.*, contagious diseases of animals, 270
———, Rowley, M.P., *disc.*, sewage (see "Sewage Conference")
Hilton, Mr., *disc.*, annual meeting, 793
Holland, abolition of patents in, 821
———, export trade of, 823
Honorary life members elected 1876-7, 791
Hope, Lieut.-Col., *letter*, sewage grounds, 41; *disc.*, 153; *paper*, sewage (see "Sewage Conference")
Horn, Mr., *disc.*, spring propulsion of street trams, 606
House drains, *Lancet* on, 874, 891, 911; *letter*, T. P. Teale, 911
Howard, David, *chair.*, manufacture of citric and tartaric acid, 366
Howden, R., *letter*, acquaria, 432
Howell, G., *paper*, technical education and *disc.* (see "Educational Conference")
Hughes, Mr., *disc.*, recent metallurgical processes, 291
Humphreys, Mr., *disc.*, sewage (see "Sewage Conference")
Humphris, D. J., *paper*, sewage, and *disc.* (see "Sewage Conference")
Hunting, Mr., *disc.*, contagious diseases of animals, 268
Hutchinson, E., *paper*, development of Central Africa, 689; award of medal, 791
Hygeia, city of, company to establish, 914
Hygiene, industrial (see "Prizes")
Hygienic congress in Brussels, 865, 971, 982, 997

I.

Iceland, its scenery and volcanic rocks, *paper*, by W. L. Watts, 169
India, acclimatisation of useful plants in 1018
———, chinchona cultivation in, 914
———, caoutchouc-yielding trees in, *paper* by C. R. Markham, 475
———, cultivation of useful plants in, 105
———, education in, 1034
Indian agriculture, *letter*, W. R. Robertson, 46
Indian Section:—Opening address, 8; annual report on, 789; committee (see "Committees")
1st Meeting:—"Commercial aspects of the Suez canal," by C. Magniac, 253
2nd meeting:—Adjourned discussion on "The commercial aspects of the Suez canal," 277

3rd Meeting:—"The fall in the price of silver, its consequences, and their possible avoidance," by Ernest Seyd, 306
4th Meeting:—Adjourned discussion on Mr. Seyd's paper on the "Fall in the price of silver," 345
5th Meeting:—Adjourned discussion on Mr. Seyd's paper on the "Fall in the price of silver," 353
6th Meeting:—The land revenue of India," by Major-Gen. Marriott, 435
7th Meeting:—"Sanitary progress in India," by Capt. Douglas Galton, 519
8th Meeting:—"Irrigation works in India, with especial reference to their remunerativeness," by W. T. Thornton, C.B, 575
9th Meeting.—"Competition and its effects on education, with especial reference to the Indian Civil Service," by Dr. George Birdwood, 681
Industrial hygiene (see "Prizes")
Ingram, Mr., *disc.*, caoutchouc-yielding trees in India, 481
Ink (printing) from gas tar, 77
Inks, permanent, patent for, 124
Institutions admitted into union:—
Auckland (New Zealand) model training school, 435
Cardiff free library, 435
Christchurch working man's, 79
Islington Youths', 79
Monnow-road science and art classes, 49
St. Bernard's evening classes, 39, King Henry's-hill, N.W., 435
Saltaire club and institute, 213
———, union of, Council's report, 792
Iron amalgamation, 880
—— (cast), conversion of, *letters*, Sir F. C. Knowles, 46, 63, 76
—— and steel manufacture, *lectures* on, by W. Mattieu Williams (see "Cantor Lectures")
Irons, Rev. Dr., *disc.*, education (see "Educational Conference")
Irrigation, underground, Charpentier's system, 106
———, in India, 575
Italy, silkworms' eggs in, 515

J.

Jackson, H. M., Q.C., M.P., *chair.*, registration of trade marks, 49
Jacob, Dr., *disc.*, sewage (see "Sewage Conference")
Japan, patent right in, 884
———, uses of quicksilver in, 497
Japanese bronzes, imitations of, 495
——— hemp, 679
——— lacquer ware, 249
Jarmain, George, *lectures* on wool dyeing, (see "Cantor Lectures")
Johnson, Edmund, *disc.*, trade marks, 50
———, Rev. Mr. *disc.*, development of Central Africa, 703
Johnston, Mr. Campbell, *disc.*, diamond fields of Griqualand, 380; industrial progress of natives of South Africa, 455
Jones, C. *disc.*, sewage grounds, 153 (see also "Sewage Conference")
———, John, *disc.*, bridge below London-bridge, 388
———, Lieut.-Col., *disc.*, sewage (see "Sewage Conference")
———, T. E., M.D., *disc.*, sewage (see "Sewage Conference")
Joseph, Dr., *disc.*, sewage (see "Sewage Conference")
Journal issued unstitched, 4
Juvenile lectures, the wonders of the microscope, by Dr. W. B. Carpenter, C.B., F.R.S., 123, 134

K.

Keith, W., *paper*, sewage (see "Sewage Conference")
Kensington, typhoid fever in, *letter* by Sir H. Cole to Vestry, 904; *reply*, 945; *Lancet* on, 874, 891, 911
Kennelly, Mr., *disc.*, recent metallurgical processes, 290
Kent, G., *letter*, preservation of meat, 484
Kent, W. Saville, *paper*, aquaria, their construction, management, and utility, 292
Kenyon, Dr. *disc.*, sewage (see "Sewage Conference")
Kerr, Prof., *disc.*, model dwellings for the rich, 464
Kew gardens, report on, 892
Kidd, Howard, *disc.*, sewage (see "Sewage Conference")
Kinematic models at loan exhibition, 989
Kloes, T. A. van der, *paper*, sewage (see "Sewage Conference")
Knight, J. M., *disc.*, onyx-marble deposits of Mexico, 509
Knowles, Sir F. C., conversion of cast-iron to iron or steel, 46, 63, 76; *chair.*, pure charcoal steel direct from the ore, 86; combustion of coal gas to produce heat, 235
Kock, Mr. *disc.*, recent metallurgical processes, 291

L.

Labuan agriculture, 913
Lack, H. Reader, *chair.*, bridge for traffic below London-bridge, 381
Lacquer ware (Japanese), 249
Ladd, W., *letter*, electricity for lighting the National Assembly, 573
Lamps, railway, prizes for (see "Committees")
Latham, Baldwin, *disc.*, sewage grounds, 154 (see also "Sewage Conference")
Larkin, Henry, *paper*, on the production of pure charcoal steel direct from the ore, 86
Larkins, Mr., *disc.*, sewage (see "Sewage Conference")
Law, Henry, *disc.*, aquaria, 299
Lawrence, E., *disc.*, model dwellings for the rich, 463
Lead poisoning, antidote for, 826
Leaf, W., *paper*, university teaching in London, and *disc.* (see "Educational Conference")
Leak stopper, self-adjusting, 64
Leather (sole) tanning *paper*, Sparke Evans, 214
Lebanon silk, 841
Lechmere, Sir E. A. H., *letter*, Order of St. John of Jerusalem, 868
Leigh, Evan, *obituary*, 433
Lemon, T., *disc.*, sewage (see "Sewage Conference")
Leschemacher, Mr., *disc.*, citric and tartaric acid, 372
Letheby, Dr., *chair.*, legislation for regulation of sewage grounds, 33, 152; *obituary*, 484
Leveaux, Edward H., *paper*, spring propulsion for street trams, 598
Levi, Prof., *paper*, mode of levying sugar duties in France, and its influence on the sugar duties of great Britain, 54; *disc.*, trade marks, 50
Lewis, Mrs. Amelia B., *disc.*, sole leather tanning, 223
Library, additions to, 78, 486, 786, 934, 1036
Liddle, Dr., *disc.*, public meeting of sewage committee, 1011
Liebig, discoveries and philosophy of, *lectures* by Dr. Thudichum (see "Cantor Lectures")
Liernur, Capt., *paper*, sewage (see "Sewage Conference")
Life saving congress in Brussels, 866
——, at sea, 868
Liggins, H., *disc.*, sugar duties, 62; condensed beer, 185; spring propulsion for street trams, 607
Lighthouse apparatus at loan exhibition, 1026
Lighthouses, illumination of, 823
Lightning conductors, 736, 822
Livesey, Mr., *disc.*, estimating illuminating power and purity of coal gas, 473
Lloyd, W. A., *letter*, aquaria, 427, 483
Locke, G., *obituary*, 275
Lockwood, Mr., *disc.*, condensed beer, 185
Logie, Dr., *letter*, railway accidents, 302
Long, Dr., *disc.*, competition for Indian Civil Service, 688
——, Rev. J., presentation of medal to, 14
Lovell, J., *disc.*, public meeting of sewage committee, 1013
Lutschaunig, Alfred, *paper*, hall marking of jewellery, 334
Lyttelton, Lord, *obituary*, 545
Lyttle, W. A., *letters*, patent-law reform, 301; dextrine-maltose, 484, 573

M.

Macomber, Mr., *disc.*, sugar duties, 62; contagious diseases of animals, 270; spring propulsion for street trams, 608
Magniac, C., *paper*, commercial aspects of Suez canal, 253
Mainwaring, T., speech at Rhyl on training school for music, 1018
Maitland, Mr. *disc.*, Suez canal, 262, 278; *letter*, 302; fall in the price of silver, 345
Malt-tax, *letter* to Chancellor of Exchequer on, by T. Biggs, 250
Manchester, Duke of, *chair.*, silk growing, 538
Manchester, street directory lamps in, 884
Manico, Mr, *disc*, improvements in railway couplings, 426
Mann, Dr., *paper*, notes on origin and character of the Dutch republics of South Africa, 165; *disc.*, ostrich farming in Cape Colony, 233; diamond fields of Griqualand, 380; industrial progress of natives of South Africa, 455; commerce of the Gaboon, 597
Manuel, R, *disc.*, improvements in railway couplings, 426; model dwellings for the rich, 465
Markham, Clements R., presentation of medal to, 14; *paper*, cultivation of caoutchouc-yielding trees in British India, 475; award of medal, 791
Marsden, Mr., *disc.*, sewage (see "Sewage Conference")
Marriott, Major-Gen., *disc.*, fall in the price of silver, 346; *paper*, land revenue of India, 435
Martineau, G., *disc.*, sugar duties, 60; *letter*, 77
Maskelyne, Prof. Nevil, *chair.*, diamond fields of Griqualand, 372
Mason, Thomas, *paper*, sewage, and *disc.* (see "Sewage Conference")
Massié's food preserving process ("See Food")
Mast, C. E., *disc.*, development of Central Africa, 704
Meat (see "Food")
Maté, 825
MEDALS:—Albert, list of recipients, 277; award to Sir G. Airy, 791
———, "Howard" gold, presented to Mrs. Grantham, 14
———, Society's gold to Mr. Hearson for his strophometer, 791 (see also "Prizes")
———, Society's silver, presented to F. J. Bramwell, G. Fleming, Clements R. Markham, F. Drew, Rev. J. Long, Hon. T. Shepstone, A. Nobel, 14; awards for papers read during session 1875-6, 791
——— of societies, *letter*, D. F. Pryce, 251
MEETINGS:—
AFRICAN (see "African Section")
ANNUAL GENERAL, 787
CHEMICAL (see "Chemical Section")
INDIAN (see "Indian Section")
ORDINARY:—
1st Meeting:—Opening address by Lord Alfred S. Churchill, 4
2nd Meeting:—"Registration of trade marks," by H. Trueman Wood, 17
3rd Meeting:—"Proposed heads of legislation for the regulation of sewage grounds," by Alfred Smee, F.R.S., 34
Extra Meeting:—Adjourned discussion on "Registration of trade marks," 49
4th Meeting:—"The mode of levying the sugar duties in France, and its influence on the sugar industries of Great Britain," by Professor Leone Levi, 54
5th Meeting:—"Health, comfort, and cleanliness in the house," by Thomas Blashill, 66
6th Meeting:—"Method of producing pure charcoal steel directly from the ore," by Henry Larkin, 86
7th Meeting:—Adjourned discussion on Mr. Alfred Smee's paper on "Regulation of sewage grounds," 152
8th Meeting:—"Iceland; its scenery and volcanic rocks," by W. L. Watts, 169
9th Meeting:—"Condensed beer," by Dr. Bartlett, 178
10th Meeting:—"The cultivation of hardy fruits, with a view to improve-

ment of quality, and insuring constant and abundant production," by Shirley Hibberd, 198
11th Meeting:—"The combustion of coal gas to produce heat, and the theory of the structure of flames," by James Wallace, 235
12th Meeting:—"Contagious diseases of animals, their influence on the wealth and health of the nation, and how they are to be combated," by George Fleming, 262
13th Meeting:—Aquaria, their construction, management, and utility," by W. Saville Kent, 292
14th Meeting:—"Hall marking of jewellery," by Alfred Lutschaunig, 334
15th Meeting:—"A new bridge for providing for the traffic across the Thames below London-bridge," by Frederic Barnett, 382
16th Meeting:—"Improvements in railway couplings as a necessity of the day," by T. A. Broekelbank, 415
17th Meeting:—"Model dwellings for the rich," by Roger T. Smith and W. H. White, 456
18th Meeting:—"The cultivation of caoutchouc-yielding trees in British India," by Clements R. Markham, C.B., F.R.S., 475
19th Meeting:—"On the so-called deposits of onyx near Mexico; their history, and their value as a decorative material," by W. Eassie, 503
20th Meeting:—"Silk growing, its prospects and its wants," by Mrs. Bladen-Neill, 538
21st Meeting:—On the china clay and china stone of Devon and Cornwall," by J. H. Collins, 565
22nd Meeting:—Spring propulsion for street trams," by Edward H Leveaux, 598
23rd Meeting:—"Railway safety appliances," by F. J. Bramwell, F.R.S., 646
24th Meeting:—Continuation of paper on "Railway safety appliances," by F. J. Bramwell, 674
Melliss, C. J., *paper*, sewage (see "Sewage Conference")
Memorial tablets affixed, list of, 613; annual report, 791
Mercer, Mr., *disc.*, trade marks, 51
Metallurgical processes, recent, *paper*, J. A. Phillips, 284; *letter*, E. Smith, 483
Methven, Mr., *disc.*, estimating illuminating power of coal gas, 474
Mexican onyx-marble deposits, *paper*, W. Eassie, 503
Microscope, wonders of the, *lectures* by Dr. Carpenter (see "Juvenile Lectures")
Mines, French school of, 934
Mirrors, silvering of, 784
Mitchell, Rev. M., *obituary*, 433
———, W. S., *disc.*, aquaria, 298
Model dwellings for the rich, *paper*, T. R. Smith and H. W. White, 456; *letters*, E. Chadwick, 463; H. C. White, 517
Monson, Capt., *disc.*, sewage grounds, 152; bridge below London bridge, 400; sewage (see "Sewage Conference")
Moodie, Mr., *disc.*, diamond fields of Griqualand, 380
Morgan, Rev. Canon, speech at Rhyl on training school for music, 1018
———, H., *disc.*, sewage (see "Sewage Conference")
Morin, General, elected hon. life member, 681
Mort's meat preserving process (see "Food")
Morrison, John, *paper*, manufacture of salt-cake, 639
Mundella, A. J., M.P., *chair.*, registration of trade marks, 17
Murray's cattle truck, description of, 271
MUSEUMS:—Opening address, 13
———, art at Philadelphia, 16
———, British, educational use of, committee of head masters of public schools upon, 110
———, Indian and Colonial, 812
——— of physical science, 907
———, public, returns of attendances at, 102, 175, 274, 427, 494, 783, 910, 1002
———, science, 818, 879
Music, national training school for, opening address, 7; Society's scholarships offered for competition, 17; rules for admission of candidates to competition, 49; meeting at Hastings, 124; professional staff, 195; examination of candidates for Society's scholarships, 197; City of London scholarships, 213; meeting at Mansion-house, 271; selected candidates for scholarships, 277, 306, 345, 403, 435, 519, 547, 613, 653, 721, 738, 843, 869, 965, 985; report of Society's examiners on competition, 305; subscription for scholarships, 345; *letter* on, 499; opening of, 613; annual report on, 787; pianos presented to, 975; meeting at Rhyl, 1015

N.

Napier, Robert, *obituary*, 826
Nash, Mr., *disc.*, dextrine-maltose, 413
Needle manufacture at Redditch, 1001
Neill, Mrs., *paper*, silk growing, its prospects, and its wants, 538; *letters* to, 879
Nettlefold screw, wire, and nail works, 933
New Caledonia, nickel ore in, 884
New York (see "America")
New Zealand pine trees, 824
———, resources of, 44
Newspaper post, correspondence between Society and Postmaster-General, 653; *letter*, W. T. Emmott, 735
Nicholson, Sir Charles, *chair.*, development of Central Africa, 689
Nickel ore in New Caledonia, 884; in Spain, 264
Nicolls, Miss E., *paper*, instruction in cookery (see "Educational Conference")
Nijni-Novogorod fair, 495
Nobel, A., presentation of medal to, 14
Noldwritt, J. S., *disc.*, education (see "Educational Conference")
Norris, G. M., *disc.*, education (see "Educational Conference")

O.

Oakum combing competition, 680
OBITUARY NOTICES:—
Davenport, S. T., 133
Leigh, Evan, 433
Letheby, Dr., 481
Locke, G., 275
Lyttelton, Lord, 545
Mitchell, Rev. Muirhead, 433
Napier, Robert, 826
Redgrave, Samuel, 433
Strange, Lieut.-Col., 433
Vignoles, C.B., F.R.S., 31
Odling, Dr., *chair.*, methods of estimating the illuminating power and purity of coal gas, 468
Oil, use of for lighting purposes in United States, 139
Olive oil, 868
Ommanney, Vice-Admiral E., opening address to African section, 162; *chair.*, cultivation of caoutchouc-yielding trees in British India, 475; commerce of the Gaboon, 585; *disc.*, development of Central Africa, 703
Onyx-marble deposits near Mexico, *paper*, W. Eassie, 503
Opium in China, 106
——— cultivation in Persia, 913
Ostrich farming in Cape Colony, *paper*, P. L. Simmonds, 225
O'Sullivan, Mr., *disc.*, dextrine-maltose, 412
Ottley, Mr., *disc.*, trade marks, 51
Owen, Rev. W. H., speech at Rhyl on training school for music, 1018
Oysters, American, 136

P.

Paper from Bamboo, 300
Paper-box making machinery, 513
Papillon, Mr., *disc.*, sewage (see "Sewage Conference")
Paris (see "France")
Parker-Rhodes, Mr., C.E., *disc.*, bridge below London-bridge, 388
Parkin, Dr., *letter*, sanitary progress in India, 611
Patent bill, 343; petition on, 611, 835
———, resolutions at meeting of mechanical engineers, 677
———, summary of, 572
——— law amendment, *petition* to House of Commons, 654
———, assimilation of, resolutions of Bremen conference, 1003
———, council's report on, 792
——— reform, paper at British association by Mr. Day, 958
———, *letter*, W. A. Lyttle 301
——— office, alterations in, 760
——— report, 934
———, retirement of B. Woodcroft, 482
——— right in Japan, 884
——— specifications, new issue of, 914
Patents, abolition of, in Holland, 821
———, applications for, in 1875, 249
Paul, W., *disc.*, cultivation of hardy fruits, 202
Payne, A., *disc.*, health, &c., in the house, 73; sewage (see "Sewage Conference"); *letter*, 720, 826
Pearsall, T. J., *disc.*, caoutchouc-yielding trees in India, 481; education (see "Educational Conference")
Pearse, J. W., *paper*, sewage, and *disc.* (see "Sewage Conference")
Penny bank (national), 868; report of 485
Persia, opium cultivation in, 913
Philadelphia centennial exhibition (see "Exhibitions")
——— museums of art (see "Museums")
Phillips, J. A., *paper*, recent metallurgical processes, 284
Phormium tenax, 138
Physical science museum, *Nature* on, 907
——— training and national education, E. Chadwick on, 134
Piacenza, industries of, 300
Pine trees in New Zealand, 824
Porter, J. H., *letter*, softening water, 1019
Portuguese possessions, east coast of Africa, 824
Postal statistics of various countries, 244
Pratt, Hodgson, *disc.*, education (see "Educational Conference")
Printing ink from gas tar, 77
PRIZES:—
Council, presented to M. E. Rudd, 14
Fires in ships, prize for prevention of (see "Committees")
Industrial hygiene, offer of prize by Benjamin Shaw, 813, 955
Medals awarded, session 1875-6, 791
Prince Consort's, presented to H. Beer, 14
Railway lamps (see "Committees")
Revolution indicator, award of, 653
Turners' Company, offer of, 502; presentation of, 988
Pryce, D. F., *letter*, medals of societies, 251
Public buildings, drainage of, 760
Pulling, Mr., *disc.*, sewage grounds, 42; *disc.*, sewage (see "Sewage Conference")
Purnell, E. A., *paper* and *disc.*, sewage (see "Sewage Conference")
Punnett, Mr., *disc.*, competition for Indian Civil Service, 688

Q.

Quicksilver, uses of, in Japan, 497

R.

Railway accidents, *letter*, Dr. Logie, 302
——— brakes, continuous, 736
——— couplings, improvements in, *paper*, T. A. Brockelbank, 415; *letter*, 483; notice, 786
——— lamps, prizes for (see "Committees")
——— safety appliances, *paper*, F. J. Bramwell, 646, 674
——— signals, Stewart's flags, 18
——— tonnage in America, 1030
Rathborne, Col., *disc.*, land revenue of India, 446
Rawlinson, Robert, C.B., *chair.*, health, &c., in the house, 65; *disc.*, model dwellings for the rich, 465; sewage (see "Sewage Conference")
Rawson, C., *paper*, sewage (see "Sewage Conference")

Read, C. S., M.P., *chair.*, contagious diseases of animals, 262
Redditch needle manufacture, 1001
Redgrave, G., *disc.*, sewage ("see "Sewage Conference")
———, Samuel, *obituary*, 433
Reed, E. J., C.B., M.P., *chair.*, Iceland, its scenery and volcanic rocks, 169
Report, annual, 787
Revolution indicator (see "Committees")
Reynoso's meat preserving process (see ("Food")
Richardson, Dr., *lectures* on unhealthy trades (see "Unhealthy Trades")
———, Rev. J., speech at Rhyl on training school for music, 1015
Riley, Mr., *disc.*, pure charcoal steel direct from the ore, 92; combustion of coal gas, 242; recent metallurgical processes, 289
Rimmel, E., *letter*, trade marks, 109
Ritchie, Capt., M.P., *disc.*, sugar duties, 61
River pollution, opening address, 13; bill on, 759, 834
Roberts, W. R., *letter*, Indian agriculture, 46
Rock, Mr., *disc.*, sewage (see "Sewage Conference")
Room, H. H., appointed cashier, 177
Roumania, wood industry of, 924
Routledge, Mr. *disc.*, caoutchouc-yielding trees in India, 481
Rudd, M. E., presentation of council prize to, 14
Rugg, Mr. *disc.*, sewage (see "Sewage Conference")
Russia, flax trade in, 78
Ryland, Arthur, *disc.*, trade marks, 39

S.

St. John of Jerusalem, order of, *letter*, Sir E. A. H. Lechmere, 868
Salaman, S., *disc.*, trade marks, 29, 51
Salt-cake, manufacture of, *paper* by John Morrison, 639
Sanders, Dr., *disc.*, sewage (see "Sewage Conference")
Sanitary engineers' meeting at Kidderminster, 1032
——— progress in India, *paper*, Capt. Douglas Galton, 519; *letter*, Dr. Parkin, 611
Saywell, Mr., *disc.*, sewage grounds, 156; bridge below London-bridge, 389; sewage (see "Sewage Conference")
Schone, I., *disc.*, sewage (see "Sewage Conference")
Science congress in Belgium, 833, 922
——— made easy, *letter*, T. Twining, 652
——— museums (see "Museums")
———, national aid to progress in, 787
——— and art votes, *Athenæum* on, 501
Scientific apparatus, loan exhibition (see "Exhibitions")
Sclater-Booth, Right. Hon. G., on river pollution bill, 759
Scott, Mr. *disc.*, recent metallurgical processes, 290
———, Adam, *papers*, sewage, and *disc.* (see "Sewage Conference")
———, Major-General, *disc.*, sewage grounds, 41; sewage (see "Sewage Conference")
Sea, experiments on life saving at, 868
Secondary education (see "Education")
Sen, Mr., *disc.*, sanitary progress in India, 535
Sessional arrangements, 1875-6, 1
———, 1876-7, 1021
Sevres museum, transfer of, 833
Sewage committee (see "Committees")
Sewage Conference:—Resolutions of committee for conduct of, 214; questions issued, 467; table of system of sewage treatment, 543; programme of proceedings, 547; summary of returns furnished to committee from various towns, 547; report of proceedings, 609, 613, 707, 722, 749; *letters*, B. Latham, 651, 679, 785; A. Payne, 720, 826; Dr. Carpenter, 760; committee's report on results of conference, 737; annual report on, 788
Papers read at:—
1. "Financial account of the Beddington sewage farm," by Alfred Carpenter, M.D., 614
2. "Notes on the Eton sewage irrigation farm," 617
3. "Intermittent downward filtration," by J. Bailey Denton, 618
"Notes on Wrexham sewage farm, 622
5. "Can sewage be utilised as well as purified?" by Lieut.-Col. W. Hope, V.C., 624
6. "The treatment of sewage, according to the processes of the General Sewage and Manure Company, limited, at Coventry, Nuneaton, and Kenilworth, in the county of Warwick," by C. J. Melliss, 628
7. "Coventry," by E. A. Purnell, 631
8. "The Phosphate Sewage Company's process," by W. Keith, 631
9. "Leeds sewage treatment," by George Tatham, 632
10. "A B C process for treating sewage. Native Guano Company," by C. Rawson, 634
11. "Sewage treatment; more especially as affecting the pollution of the river Lee," by Captain L. Flower, 636
12. "On obstacles to sanitation," by Richard Brewer, 654
13. "On the removal of the excreta and refuse of Rochdale by the Rochdale system," by Mr. Alderman Taylor, 656
14. "The Universal Charcoal and Sewage Company," by George Elcock, 659
15. "Sanitary and Economic Manure Company's closets," by J. Walter Pearse, 659
16. "The Goux absorbent system," by Thomas Mason, 661
17. "Treating human excreta of towns," by William White Fereday, C.E., 663
18. "The pan and pail system in Edinburgh," by Adam Scott, 664
19. "Edinburgh and Glasgow water-flushing systems," by Adam Scott, 664
20. "The Munich sewers, as illustrating how the subsoil and subsoil water of towns are polluted by sewage," by Captain Liernur, 665
21. "The Liernur system at Dordrecht," by T. A. Van der Kloes, 666
22. "The Liernur sewerage system at Dordrecht (Holland)," by Adam Scott, 667
23. "The Liernur system at Leyden (Holland)," by Adam Scott, 670
24. "The Liernur system at Amsterdam," by Adam Scott, 671
25. "The Liernur system in Prague, Brunn, and Olmutz," by Adam Scott, 673
26. "The Liernur system at Vienna," by Adam Scott, 674
27. "Sewage Treatment at Cheltenham," by D. J. Humphris, 704
Sewage grounds, proposed heads of legislation for the regulation of, *paper* by Alfred Smee, F.R.S., 34; adjourned *disc.* on, 152
———, house, *Lancet* on, 874, 891, 911
———, *letter* to Kensington Vestry by Sir H. Cole, 904; *reply*, 945
———, letter to newspapers, 945
——— polluted water, *Times* on, 193
——— precipitation by sulphate of alumina, 680
——— screen, rotary, 834
———, *Times* on, 963
——— of towns, deputation to Metropolitan Board of Works, 859; reply of Board, 895
Seyd, Ernest, *paper*, fall in the price of silver, 306; *disc.*, 357
Shale, carbon from, 678
Shantung, province of, 801
Sharman, Mr., *disc.*, sewage (see "Sewage Conference")
Sharpe, Mr., *disc.*, sole leather tanning, 223
Shaw, Benjamin, offer of prize for industrial hygiene, 843
Shelford, Mr., *disc.*, sewage (see "Sewage Conference")
Shepherd, W., *disc.*, sugar duties, 60
Shepstone, Hon. T., presentation of medal to, 14
Ships, Fires in (see "Committees")
Shore, G. N., *letter*, economy of fuel, 500
Shot hole stopper, self-adjusting, 64
Siemens, Dr., *chair.*, recent metallurgical processes, 284; *disc.*, pure charcoal steel direct from the ore, 93
Silk culture in Australia, *letter* on, by Mr. Brocklehurst, 879; specimens shown in Melbourne, 934
Silk growing, its prospects and its want, *paper* by Mrs. Bladen-Neill, 538
—— of Lebanon, 841
Silkworms' eggs in Italy, 515
Sillar, W. C., *disc.*, sewage (see "Sewage Conference")
Silver, Mr., *disc.*, caoutchouc yielding trees in India, 481
Silver, depreciation of, report of select committee on, 842
———, fall in the price of, *paper* by E. Seyd, 306; adjourned discussion on, 345, 353; *letters*, Col. Smith, 433; J. T. Wood, 433
——— production of the world, 517
Simmonds, P. L., *paper*, ostrich farming in Cape Colony, 225; *disc.*, trade marks, 28; commerce of the Gaboon, 597
Small arms factory at Smallheath, 974
Smartt, Mr., *disc.*, condensed beer, 186; cultivation of hardy fruits, 203
Smee, Alfred, F.R.S., *paper*, legislation for the regulation of sewage grounds, 34; adjourned *disc.*, 152
——, A., jun., *disc.*, sewage grounds, 154
Smith, Col., *disc.*, fall in the price of silver, 353; *letter*, fall in the price of silver, 433
———, E., *letter*, recent metallurgical processes, 483
———, G., *disc.*, improvements in railway couplings, 425
———, T. Roger, *paper*, model dwellings for the rich, 456
———, W., *disc.*, spring propulsion for street trams, 606; railway safety appliances, 677
Soane museum, election of A. S. Cole as Society's trustee, 792
Soda in the United States, 904
Sole-leather tanning, *paper* by Sparke Evans, 214
Soper, W. G., *disc.*, ostrich farming in Cape Colony, 234
Southby, A. G., *disc.*, combustion of coal gas, 242
———, E. R., *disc.*, condensed beer, 186
Spain, nickel ore in, 964
Spence, Peter, *disc.*, sewage (see "Sewage Conference")
Spencer, Mr., *disc.*, sewage (see "Sewage Conference")
Spring propulsion for trams, *paper*, E. H. Leveaux, 598
Stansfeld, Rt. Hon. James, M.P., *chair.* ("Sewage Conference), 609, 707, 722
Stayton, Mr., *disc.*, public meeting of sewage committee, 1011
Steel from cast iron, *letters*, Sir F. C. Knowles, 46, 63, 76
—— manufacture, *lectures* on, by W. Mattieu Williams (see "Cantor Lectures")
—— by Siemens-Martin process, 912
—— (pure charcoal) direct from the ore, *paper* by H. Larkin, 86
——, structure of, 837, 856
Stephenson, James, M.P., *disc.*, manufacture of salt-cake, 645
Stewart, Dr., *disc.*, sewage (see "Sewage Conference")
———, M. J., M.P., *disc.*, development of Central Africa, 703
Stewart's flag railway signals, 186
Stinton, Mr., *disc.*, china clay, 570
Stokes, J., *disc.*, sewage (see "Sewage Conference")
Strange, Lieut.-Col. A., *obituary*, 433
Street directory lamps in Manchester, 884
——— watering, chloride of calcium for, 984
Streeter, Mr., *disc.*, hall-marking, 339
Strong, Mr., *disc.*, model dwellings for the rich, 464
Stuart, J., *paper*, university external adult education (see "Educational Conference")
Stuart-Wortley, Col., *disc.*, aquaria, 298
Suez canal, commercial prospects of, *paper*, C. Magniac, 253; adjourned discussion on, 277; *letter*, W. Maitland, 302; E. Chadwick, 341
——— receipts, 502, 878
Sugar duties, mode of levying in France, and its influence on the sugar industries of Great Britain, *paper*, by Prof. Levi, 54; *letter*, G. Martineau, 77
Sulphur mines of Forli, 840
Sun's heat utilised for industrial purposes, 46
Swale, Mr., *disc.*, health, &c., in the house, 74
Syson, Dr. *disc.*, sewage (see "Sewage Conference")

T.

Tanning of sole leather, *paper* by Sparke Evans, 214
Tarbotton, Mr., *disc*, sewage (see "Sewage Conference")
Tartaric acid manufacture, *paper*, by R. Warington, 366
Tate, C. M., *disc.*, bridge below London-bridge, 389
Tatham, George, *paper* and *disc.*, sewage (see "Sewage Conference")
Tayler, William, *disc.*, irrigation works in India, 583; competition for Indian Civil Service, 688
Taylor, Alderman, *paper*, sewage (see "Sewage Conference")
——, Dr., *disc.*, sewage (see "Sewage Conference")
Tea from coffee leaves, 1035
——, Paraguayan, 825
Teale, T. P., *letter*, house drains, 911
Technological education (see "Education")
———— examination (see "Examinations")
Telegraph apparatus, new, 783
Telegraphs, opening address, 7
——— in America, 1030
——— for single lines, 1030
Tennant, Prof, *disc.*, diamond fields of Griqualand, 379
————, onyx-marble deposits near Mexico, 410
Teulon, S., *disc.*, annual meeting, 793
Thames, bridge for traffic below London-bridge, *paper*, F. Barnett, 382
—— water for drinking, 545
Thompson, James, *disc.*, sewage ("see Sewage Conference")
Thornton, W. T., *paper*, irrigation works in India, 575; award of medal, 791
Thorpe, Mr., *disc.*, dextrine-maltose, 414
Thudichum, Dr., lecture on the discoveries and philosophy of Liebig (see "Cantor Lectures")
Tilghman, Mr. *disc.*, model dwellings for the rich, 464
Timber, preservation of, 515
——— replanting in Canada, 944
Tomlinson, C., F.R.S., *chair.*, condensed beer, 178
————, J., *disc.*, improvements in railway couplings, 425
Towle, Mr., *disc.*, sewage (see "Sewage Conference")
Townshend, Capt., R.N., *disc.*, Suez Canal, 282; bridge below London-bridge, 400
Tracey, Mr., *disc*, trade marks, 51
Trade and manufacture in United States, 909
—— marks in America, 842
———— committee (see "Committees")
———— *Journal*, notice of, 574
————, *letter*, E. Rimmel, 109
————, registration of, *paper* by H. T. Wood, 17; adjourned discussion, 49
————— in Germany, trade classification list, 103
—————, rules for, 100
Traice, Mr., *disc.*, education (see "Educational Conference")
Trains, speed of, 518
Tram-car, M. Mékarski's, 245
Trams, spring propulsion for, *paper*, E. H. Leveaux, 598
Tramway locomotive, 245
Treasurer's annual statement, 761
Trewby, W. G., *disc.*, illuminating power of gas, 473
Trieste, trade of, 935, 946; *letter*, T. A. Welton, 964
Tripe, Dr, *disc.*, public meeting of sewage committee, 1009
Tripoli, industries of, 862
Tucker, C, *disc.*, sewage (see "Sewage Conference")
Tunis, resources of, 650
Turners' company's prizes, (see "Prizes")
Twining, T., *letter*, science made easy, 652
Type-writing machine, 75, 245
Typhoid fever in Kensington, *letter* to Vestry by Sir H. Cole, 904; *reply*, 945; *Lancet* on, 874, 890, 911

U.

Unhealthy trades, lectures on, by Dr. Richardson, F.R.S., opening address, 11; syllabus, 16; lectures, 116, 128, 145, 186, 203, 487; *letter*, T. A. Welton, 195; annual report, 791
Union of institutions, annual report on, 792
United States (see "America")
Urine, utilisation of, 812
Usill, Mr., *disc.*, bridge below London-bridge, 389

V.

Vacher, Dr., *disc*, sewage (see "Sewage Conference")
Valentin, W. G., *paper*, dextrine-maltose and its use in brewing, 404; award of medal, 791
Vanilla culture, 612
Vegetable products at loan exhibition, 980
Vignoles, C.B., F.R.S., *obituary*, 31

W.

Walford, Mr. *disc.*, sewage (see "Sewage Conference")
Walker, R. B. N., *paper*, commerce of the Gaboon, 585; *letter*, 651
————, Councillor, *disc.*, sewage (see "Sewage Conference")
Wallace, John, *paper*, combustion of coal gas to produce heat, and the theory of the structure of flames, 235
Wanklyn, Prof., *disc.*, sewage (see "Sewage Conference")
Ward, Mr., *disc.*, Suez canal, 282
Warington, Robert, *paper*, manufacture of citric and tartaric acid, 366
Water, softening of, by Porter-Clark process, *letter*, J. H. Porter, 1019
—— supply, opening addresss, 11
————, constant service mains in London, 826
———— to the metroplis, new works at Bushey, 891
Watherston, Edward J., *disc.*, hall marking, 339
Watney, Mr., *disc.*, sewage (see "Sewage Conference")
Watkins, C. *disc.*, trade marks, 50
Watts, W. L., *paper*, Iceland, its scenery and volcanic rocks, 169
Weather forecasts in France, 826
Webber, Mr., *disc.*, contagious diseases of animals, 269; hall marking, 339
Webster, S. M., *disc.*, sewage (see "Sewage Conference")
Weighing machine, self-registering, 678
Weldon, W., *chair.*, manufacture of salt-cake, 639
Welton, T. A., *letters*, unhealthy trades, 195 trade of Trieste, 964
Westminster, Duke of, *chair.*, annual meeting of cookery school, 819; speech at Rhyl on national training school of music, 1015
White, C., *disc.*, health, &c., in the house, 73
——, H. C., *letter*, model dwellings for the rich, 517
——, James, *disc.*, sewage (see "Sewage Conference")
——, J. S., *disc.*, land revenue of India, 446
——, Mr., *disc.*, hall-marking, 339; model dwellings for the rich, 465
——, W. H., *paper*, model dwellings for the rich, 456
White lead manufacture, dangers of, *Times* on, 932; *letter*, Prof. Barff, 984
Whitehouse, Mr., *disc.*, sewage (see "Sewage Conference")
Whitley, Mr., *disc.*, sewage (see "Sewage Conference")
Whitlock, Mr., *disc.*, education (see "Educational Conference")
Whitmore, Dr., *disc.*, public meeting of sewage committee, 1010
Williams, W. Mattieu, *disc.*, pure charcoal steel direct from the ore, 93; recent metallurgical processes, 290; *lectures* on iron and steel manufacture (see "Cantor Lectures")
Williamson, Prof., *chair.*, dextrine maltose, 404
Willis, Miss, *paper*, importance of practical knowledge of clothing (see "Educational Conference")
Wills, T., *disc.*, sewage grounds, 42; sole leather tanning, 224; combustion of coal gas, 242; estimating illuminating power of purity of coal gas, 474
Wilson, Dr., *disc.*, sewage (see "Sewage Conference")
——, Newton, *disc.*, trade marks, 52
Wood, H. T., *paper* on registration of trade marks, 17; *disc*, 49; *disc.*, hall-marking, 340; appointed as Assistant Secretary, 177; thanks of Council for paper, 791
——, James T., *letter*, fall in the price of silver, 433; *disc.*, 357; *disc.*, land revenue of India, 445
——, J. T., onyx-marble deposits near Mexico, 510
Woodall, C., *disc.*, estimating illuminating power and purity of coal gas, 473
Woodcroft, Bennet, F.R.S., retirement of from Patent-office, 482
Woodward, Mr., *disc.*, sewage (see "Sewage Conference")
Wool, cleansing of, 499
—— dyeing, *lectures* on, by Dr. Jarmain (see "Cantor Lectures")
—— industry of Roumania, 924
Wright, Dr., *disc.*, sewage (see "Sewage Conference")
Wyld, J., *disc.*, sewage (see "Sewage Conference")
Wylde, Dr., *disc.*, model dwellings for the rich, 464

Y.

Yeats, Dr., *disc.*, education (see "Educational Conference")
Yeld, H. J., M.D., *disc.*, sewage (see "Sewage Conference")

Zinc white, 984

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22